A methodology to account for plastic emissions and associated impacts from seafood supply chains.

Application to French case studies

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Summary

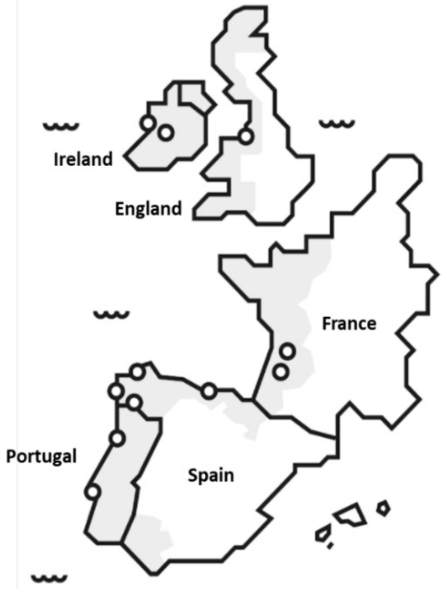
- Context and objectives
- **Methodology** to account for plastic emissions and associated impacts
- **Results**: plastic losses and impacts from French seafood life cycles
- Conclusions and perspectives

Context and objectives

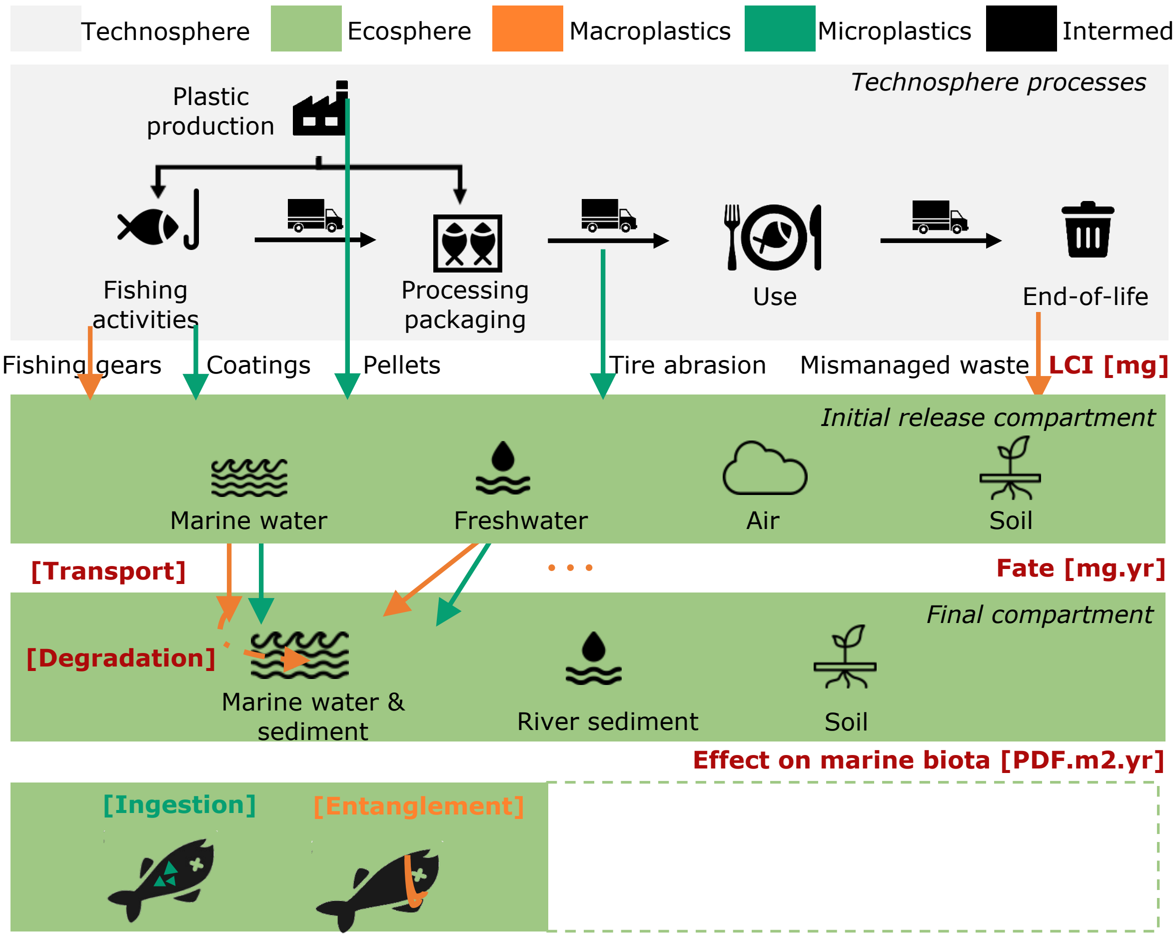
- NEPTUNUS Project (2019-2022)
- 11 partners in the Atlantic area
- General objectives of the project: aims to **promote the sustainable development** of the seafood sector in the Atlantic area by providing a consistent methodology for products **ecolabeling** and defining **eco-innovation strategies** for production and consumption.

- Within the project, one action related to marine debris with the following **objectives**:

  - **Quantify flows** of plastics from seafood life cycles in Europe-Atlantic area (LCI)
  - **Assess** the associated potential environmental impacts from these plastics (LCIA) **with existing methodologies from the literature**



General methodology and implementation in a spreadsheet tool



Raw data import from openLCA
[Processes for the functional unit]

Intermediate flows classification
[mg of plastics in the technosphere]

× **Loss rate**
[1] Loubet et al. 2022

Plastic losses elementary flows
Type/Shape/Size
[mg of plastics in the environment]

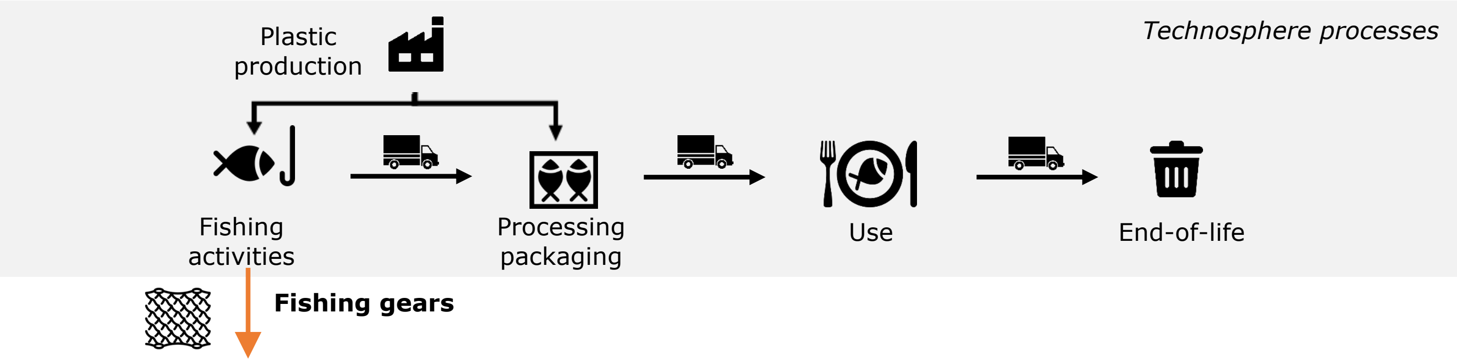
× **Fate factor**
[2] Maga et al. 2022

Fate of plastics: residence time
[mg.yr in each compartment, short/long term]

× **Effect factor**
[3] Lavoie et al. 2021
[4] Woods et al. 2019

Effect of plastics of the marine biota
[PDF.m^2.yr, short/long term]

Loss rate: fishing gears



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ORIGINAL ARTICLE

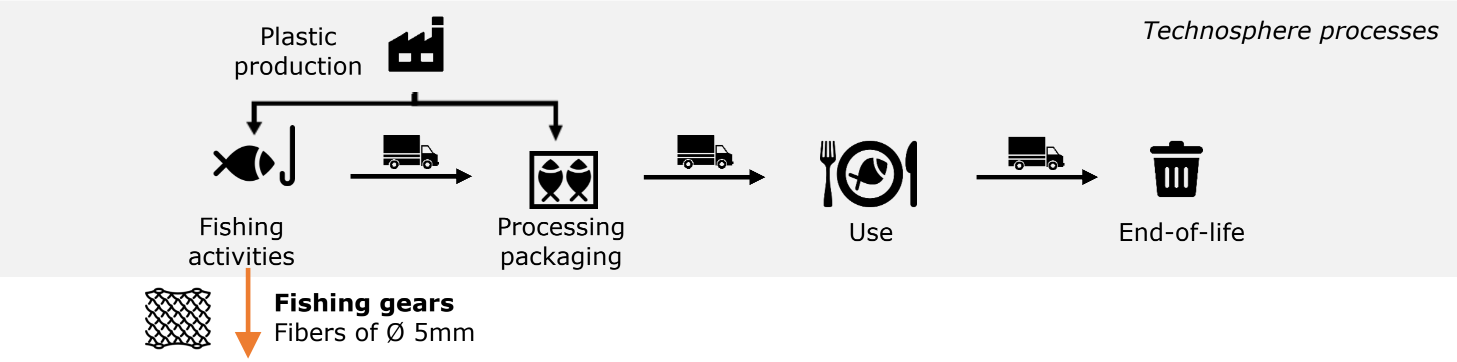
FISH and FISHERIES WILEY

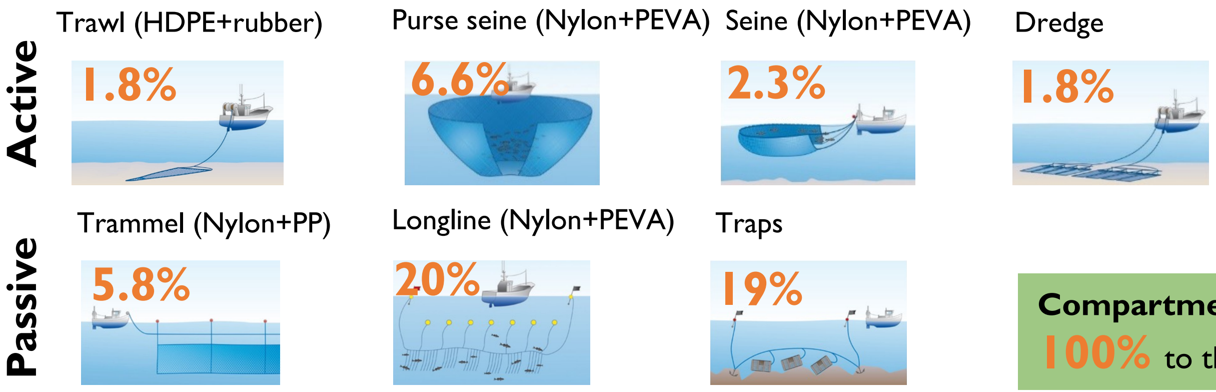
Estimates of fishing gear loss rates at a global scale: A literature review and meta-analysis

Kelsey Richardson[1,2] | Britta Denise Hardesty[1] | Chris Wilcox[1]

Source: Richardson et al. 2019. Estimates of fishing gear loss rates at a global scale: a literature review and meta-analysis. Fish Fish. 20, 1218–1231. https://doi.org/10.1111/faf.12407.

Loss rate: fishing gears

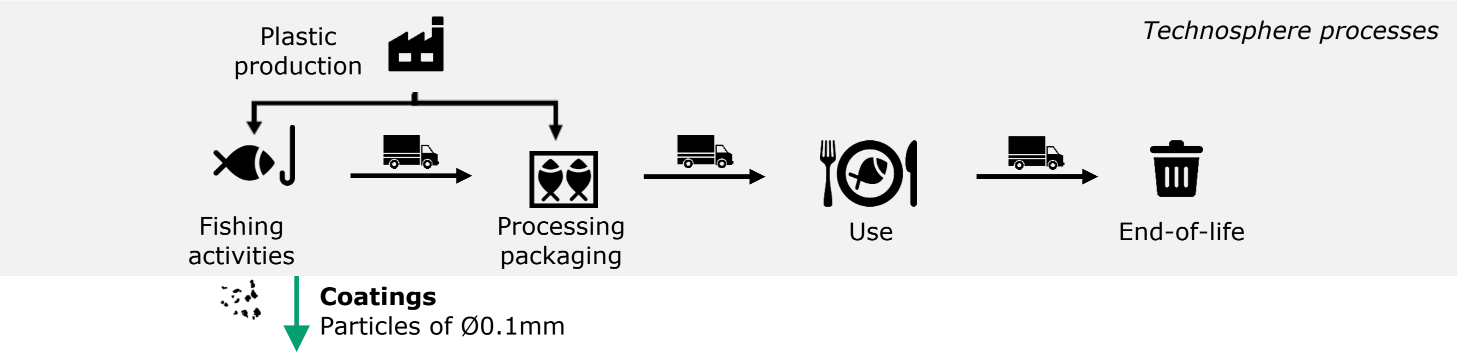




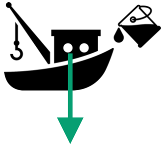
Compartment of release

100% to the ocean

Loss rate: marine coatings

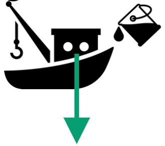


During maintenance at shipyard



1% of coatings mass is lost

During sea activities at sea



1% of coatings mass is lost

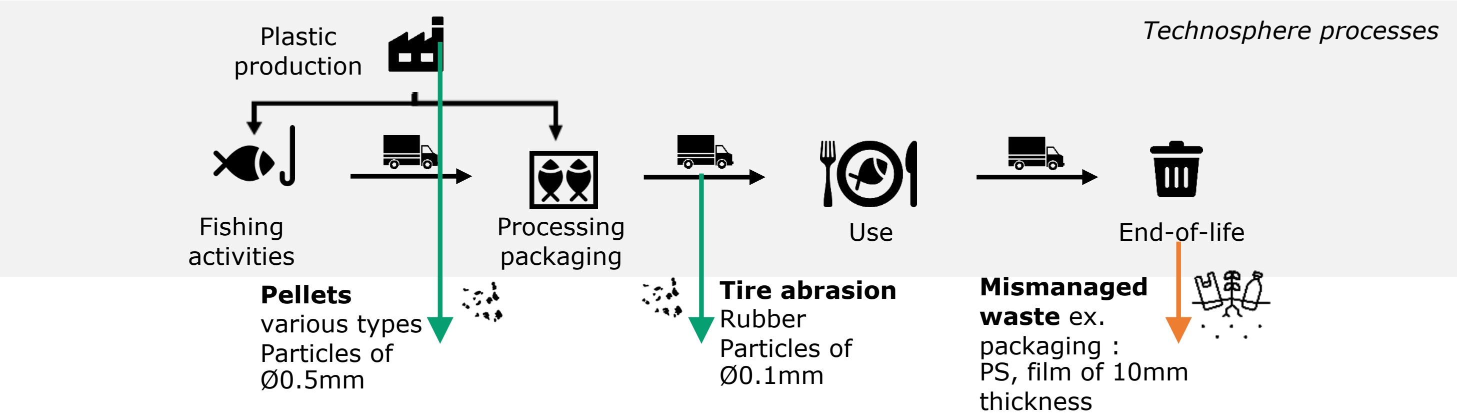
Compartment of release
100% to the ocean

60% of coatings are composed of polymers (assumed to be **nylon**)

Resulting in 1.2 % of coating mass leaking as microplastics (as **particle of 0.1mm**)

Source: Verschoor, A., et al. 2016. Abrasive cleaning agents, paints and tyre wear. Emission ofmicroplastics and potential mitigationmea- sures Bilthoven, the Netherlands.

Loss rate: plastic pellets, tire abrasion, mismanaged waste



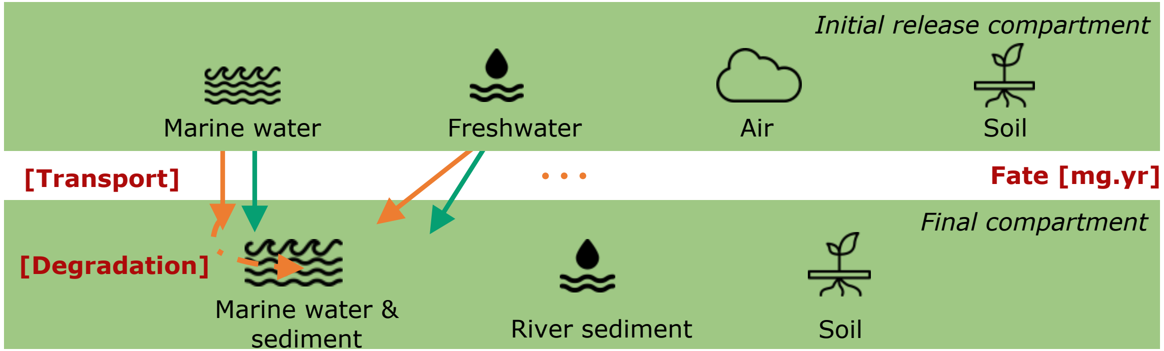
- Loss and initial release compartment gathered from **Plastic Leak Project**

Source: Peano, L., Kounina, A., Magaud, V., Chalumeau, S., Zgola, M., Boucher, J., 2020. Plastic Leak Project. Methodological Guidelines. Quantis and EA. quantis-intl.com/plastic-leak- project-guidelines.

Summary of plastic types, loss rates and initial release compartments

Type of losses	Variations	Type of plastic	Shape	Size	Loss rate LR (%)			Initial release comp. (%)			
					Average	Min	Max	Ocean	Fresh water	Soil	Air
Fishing gears (macroplastics)	Dredge	various	Fiber	Ø 5 mm	1.80%	1.60%	1.90%	100%	0%	0%	0%
	Trammel net	PP+Nylon			5.80%	5%	6.50%				
	Longline	PEVA+Nylon			20%	19%	22%				
	Purse seine	PEVA+Nylon			6.60%	5.90%	7.30%				
	Seine	PEVA+Nylon			2.30%	1.90%	2.80%				
	Trap/pot	various			19%	18.00%	20%				
	Trawl bottom	PE+Rubber			1.80%	1.60%	1.90%				
	Trawl pelagic	PE+Rubber			0.70%	0.58%	0.82%				
Marine coatings (microplastics)	-	Nylon (PA)	Particle	Ø 0.1mm	1.20%	0.50%	3%	100%	0%	0%	0%
Plastic pellets (microplastics)	-	Various	Particle	Ø 0.5mm	0.01%	0.001%	0.10%	0%	16%	68%	2%
Tire abrasion (microplastics)	Truck 16-32t (kg/tkm)	Rubber	Particle	Ø 0.1mm	2.74E-05	1.51E-05	5.79E-05	0%	16%	68%	2%
Mismanaged plastics at the end-of-life (macroplastics)	France	PS	Film (packaging)	5 to 10 mm thickness	0.02%	0.02%	4%	0%	40%	60%	0%

Fate factors from the literrature



- **Fate factors** (yr) are based on the work of Maga et al. 2022 that include:
  - **Degradation** in the short (100yrs) or long term (infinite), based on **surface** degradation rate (µm/yr)
  - **Transportation** to final compartments based on static redistribution rate between compartments (%)

=> **Result** : time-integrated mass (mg.yr) in each compartment

Influencing parameters

	Degradation	Transport
Emissing compartment (ex : ocean, freshwater)	✗	✓
Receiving compartment (ex : ocean, marine sediment)	✓	✓
Type of plastic (HDPE, PE, PS,…)	✓	✓
Size (ex. 5 mm of d for fishing gears)	✓	✗
Shape (fiber, particle, film)	✓	✗

Source: Maga D, Galafton C, Blömer J, et al (2022) Methodology to address potential impacts of plastic emissions in life cycle assessment. Int J Life Cycle Assess 27:469–491. https://doi.org/10.1007/s11367-022-02040-1

Example of fate factors

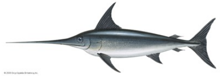
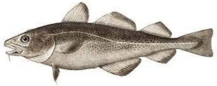
Type of losses	Type of plastic	Shape	Size	Degradation rate (µm/yr)	Emission comp.	Fate factors long term (yr) in receiving compartments			
						Marine water	Marine sediment	River sediment	Soil
Fishing gears (macroplastics)	HDPE	Fiber	Ø 5 mm	11,7 (mw)	Marine water	**71**			
	PP	Fiber	Ø 5 mm	6,1 (mw)	Marine water	**137**			
Plastic pellets (microplastics)	PEHD	Particle	Ø 0.5mm	11.7 (all comp.)	Freshwater	**5.3**			
					Soil		**0.1**		**5.2**
					Air	**0.2**			**5.1**
Mismanaged plastics packaging at the end-of-life (macroplastics)	PS	Film	10mm thickness	0.1 (all comp.)*	Freshwater		**2750**	**22250**	
					Soil		**75**	**675**	**24250**

Source: Maga D, Galafton C, Blömer J, et al (2022) Methodology to address potential impacts of plastic emissions in life cycle assessment. Int J Life Cycle Assess 27:469–491. https://doi.org/10.1007/s11367-022-02040-1

Application to French seafood life cycles

- 15 selected products from Agribalyse v3.0




Fish species	Fishing gear	Processing	Packaging
Mackerel	Trawl pelagic	Filleting	PS
Mackerel	Trawl pelagic	Filleting + caning	Aluminium
Saithe	Trawl bottom	Filleting	PS
Saithe	Trawl bottom	Freezing	LDPE
Albacore	Trawl pelagic	Filleting	PS
Albacore	Trawl pelagic	Filleting + caning	Aluminium
Herring	Trawl pelagic	Filleting	PS
Yellowfin tuna	Purse seine	Filleting	PS
Anchovy	Seine	Filleting	PS
Swordfish	Longline	Filleting	PS
Scallop with coral	Dredge	No preparation	PS
Cod (gadidae)	Trawl bottom	Filleting	PS
Eur. Pilchard (sardine)	Seine	Filleting	PS
Skipjack tuna	Purse seine	Filleting	PS
Sole	Gillnet	Filleting	PS



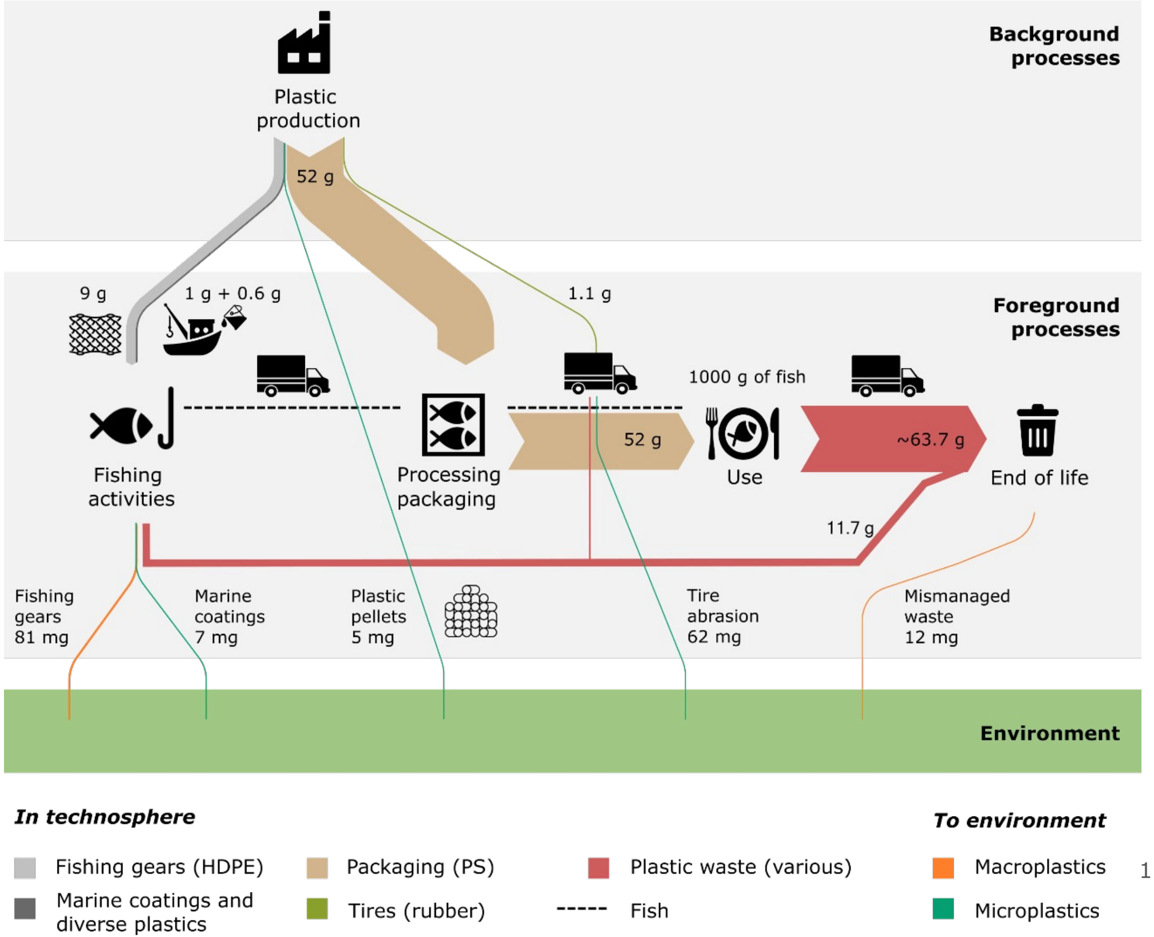



Results : plastic losses

- Plastic losses for **1kg** of fresh saithe at the consumer (bottomtrawl fishing) – average scenario

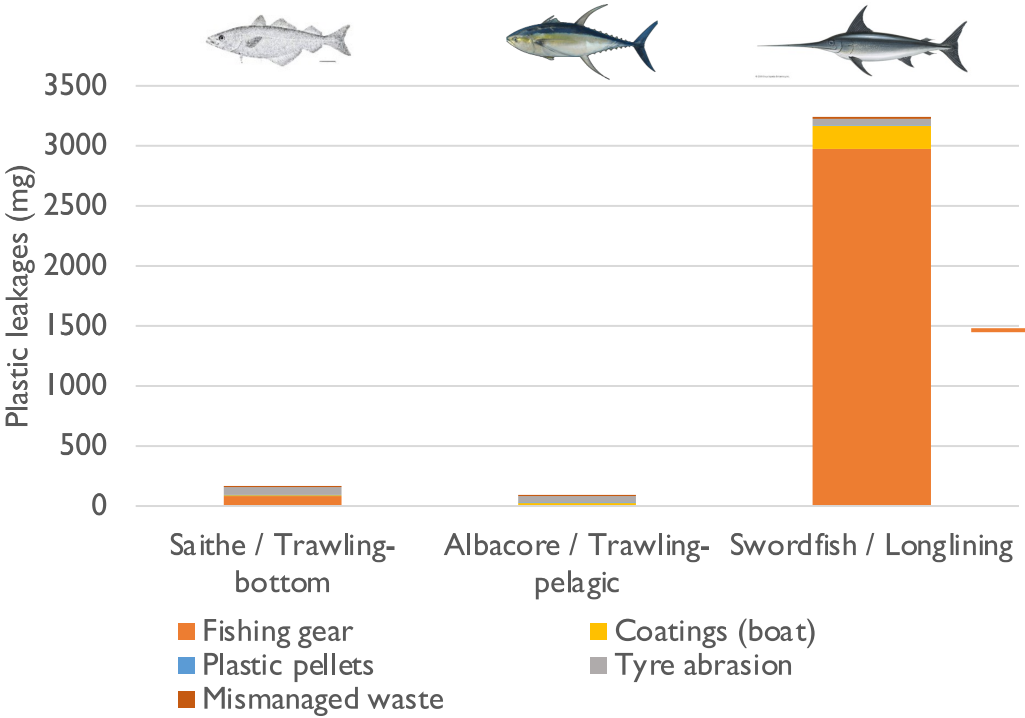
170 mg of plastic losses for 1 kg of fish at the user

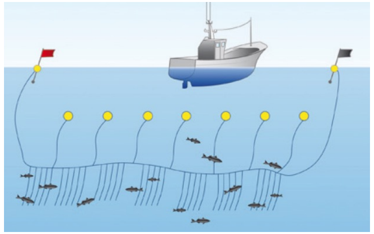
95 mg macroplastics
75 mg microplastics



Variability of results for plastic losses | fishing activities

- Comparison between **active** (trawl) and **passive** (longlining) fishing activity





Longlining :

- More plastics required for longlining : **15g/kg of swordfish** (9g/kg for Saithe)
- More plastic losses for longlining (**20%** instead of 1.8% for trawl)

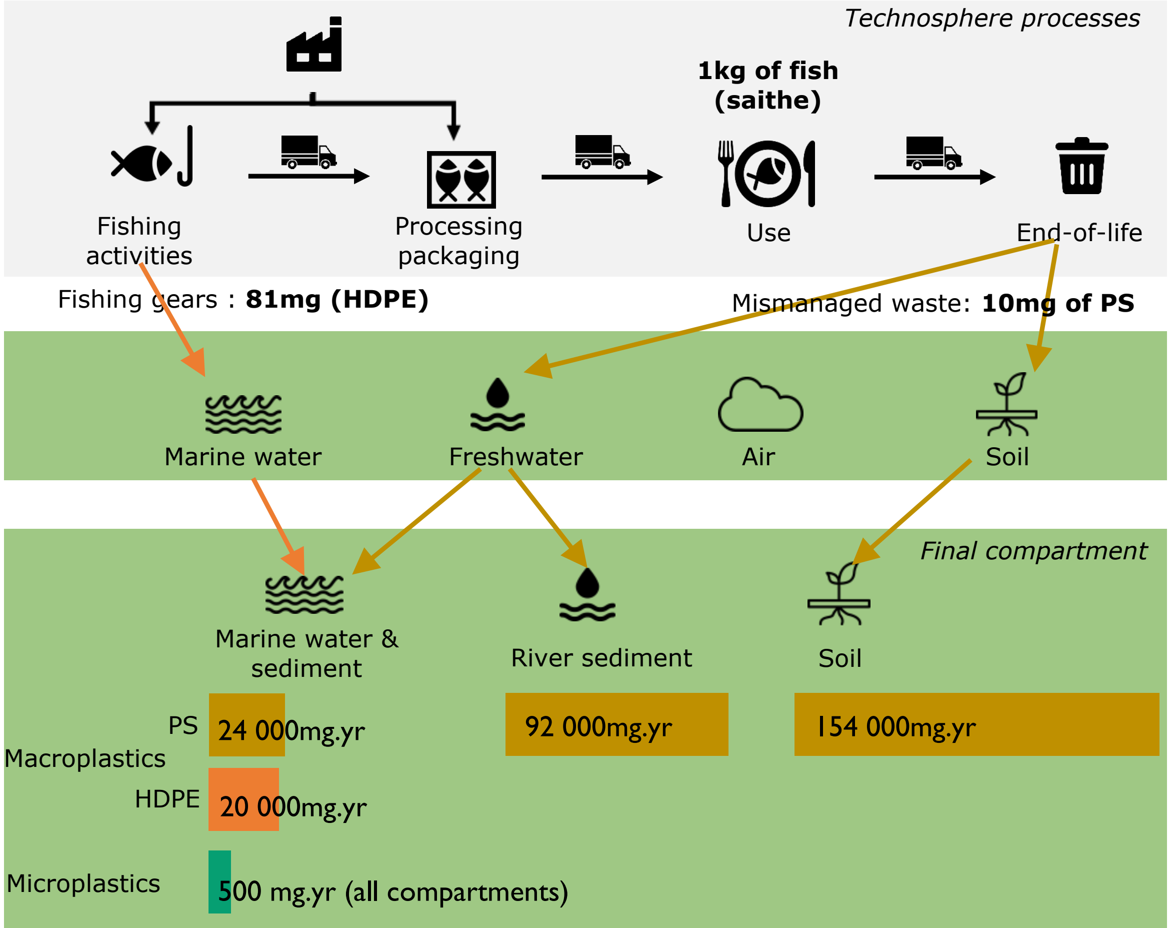
Results: fate long term (*preliminary* results)

- **Top 4** persistent plastic losses are **macroplastics**

=> Due to very high FF of **PS large size** (+10000yr; might be overestimated)

- Due to their faster degradation rate, fate of **microplastics** is very low compared to macroplastics

- What about **fragmentation** of macro into microplastics ?



Conclusion and perspectives

- **Conclusions**
  - **150mg** to **3000mg** of plastics losses per kg of fish at the consumer (average scenario)
  - **Fishing gear** and **tire abrasion** generate most of plastic losses, except when considering higher **mismanaged waste** at the end-of-life
  - Information on elementary flows is **compatible** with fate factor and takes into account type/shape/size of the plastic losses

- **Perspectives**
  - Apply **effect factors** to compute **damages** and compare with other damages of the product
  - Systematically study the **variability** and **uncertainty** of the results
  - **Implementation** of elementary flows into life cycle inventory database (e.g., Agribalyse)

Thank you for your attention!

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Know more:

https://neptunus-project.eu

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