Macro- and Micro-Plastic Debris in the Korean Coastal Environment

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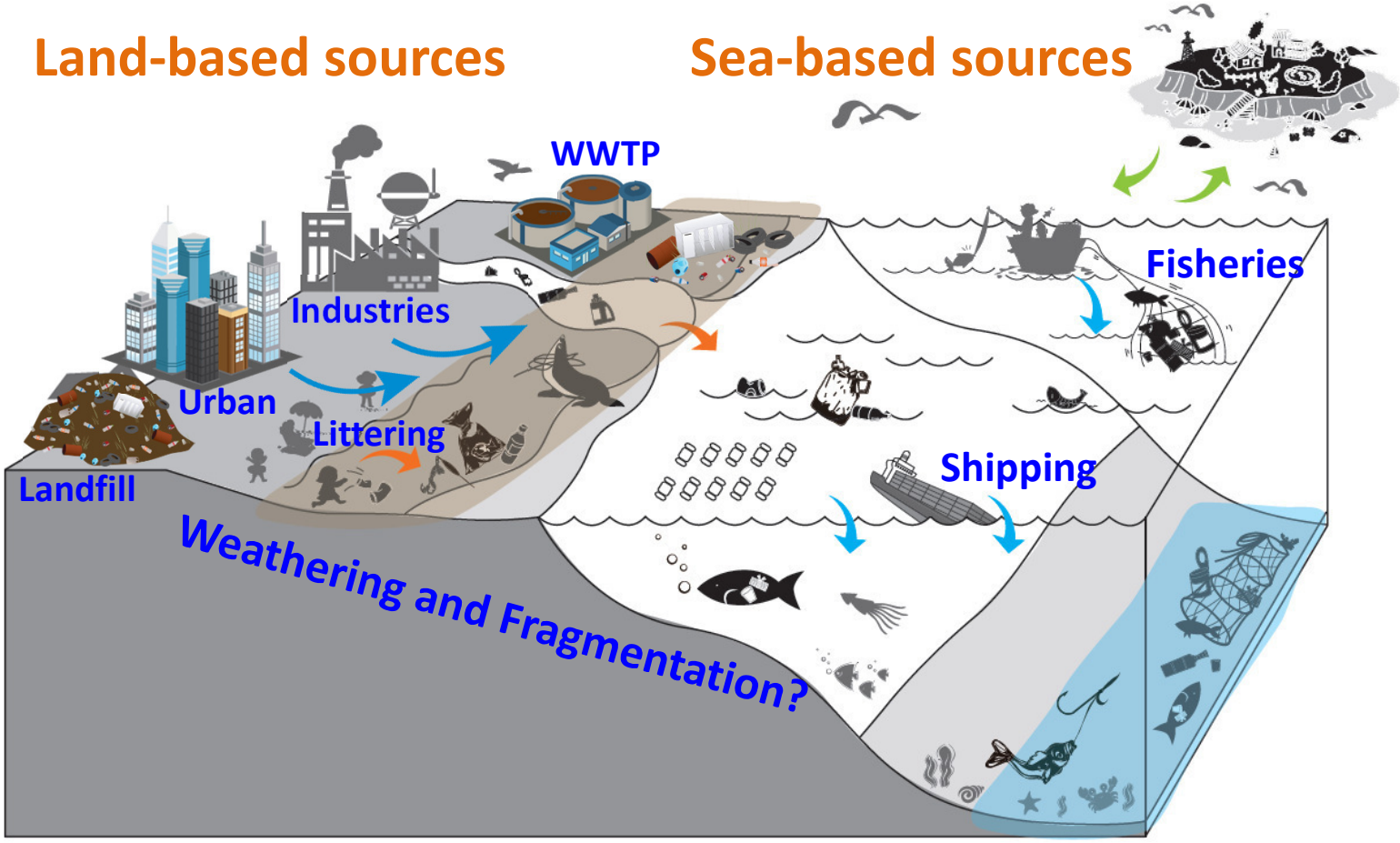
Content

- **Status and key issues of Marine debris and microplastic contamination in the Korean coastal environment based on**
  - **National Marine debris monitoring program**
  - **Microplastic research**

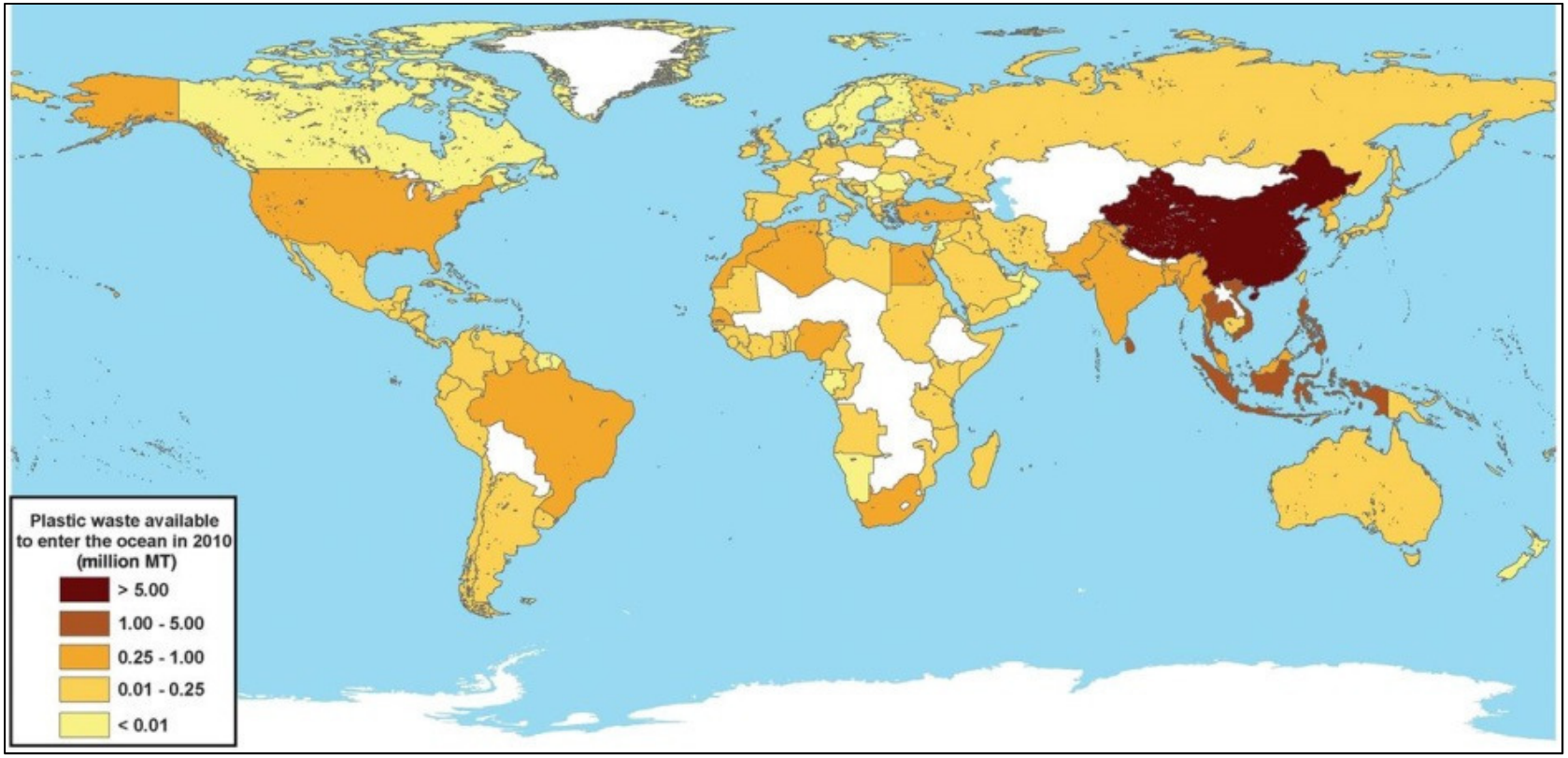
- **Occurrence and characteristics of microplastics in marine bivalves**

Input source and pathway of plastic debris and microplastics



Plastic Waste Inputs from Land into the Ocean

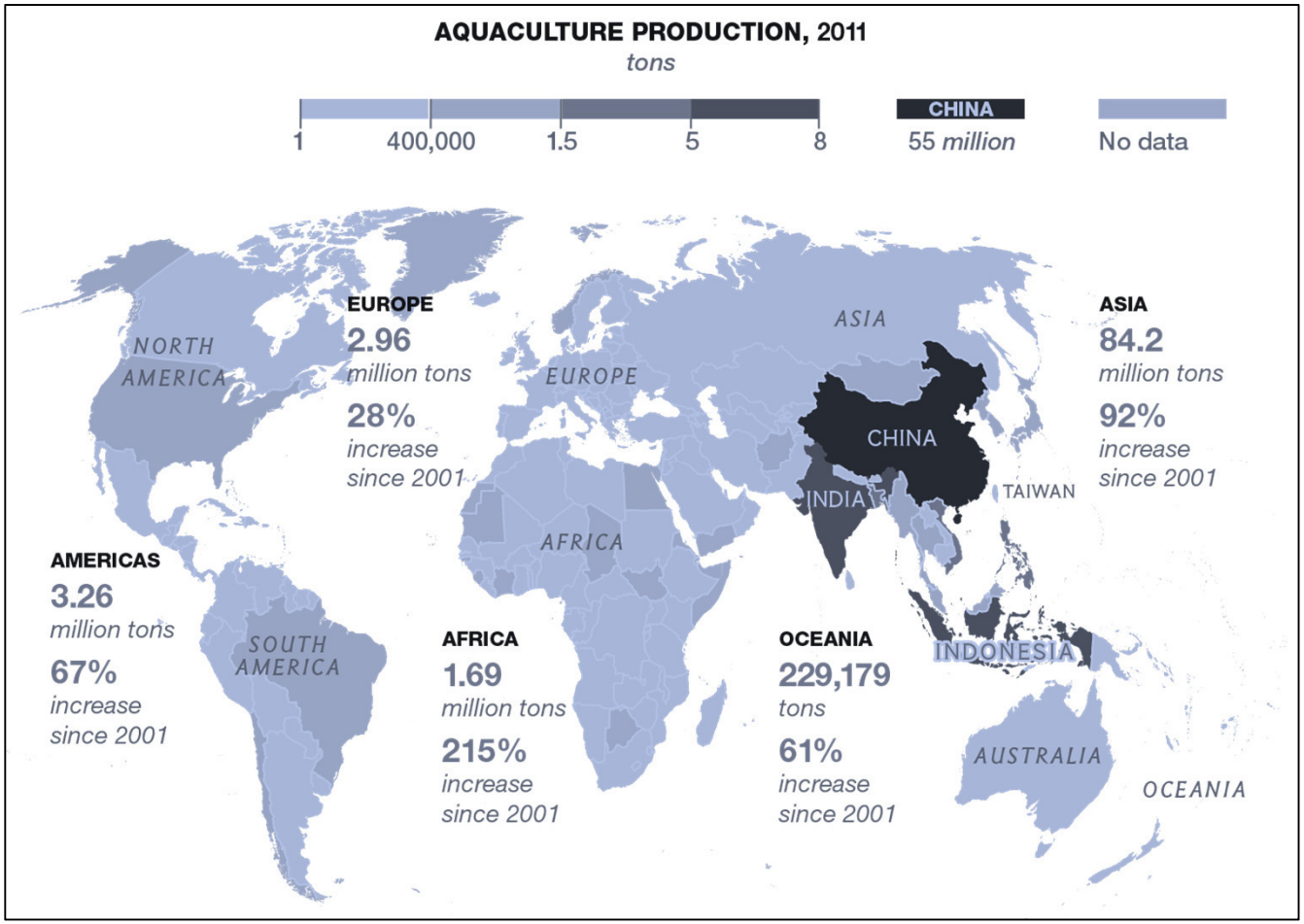
- ✓ Estimation of the mass of mismanaged plastic waste generated in 2010 by populations living within 50 km of the coast (192 countries)
- ✓ 275 million metric tons (MT) of plastic waste was generated in 192 coastal countries in 2010, with 4.8 to 12.7 million MT entering the ocean.
- ✓ Asia is the largest contributor of plastic waste to the ocean.



Jambeck et al. (2015) Science *347:768*

World Aqua Farming Industry

Aquaculture production, 2011



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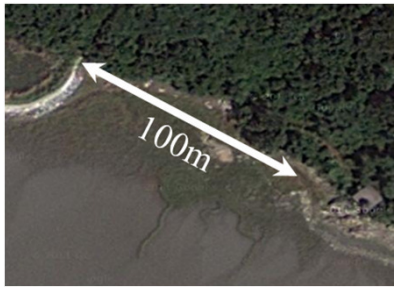
https://www.nationalgeographic.com/foodfeatures/aquaculture/

National Marine Debris Monitoring Program: Macro-beach debris

- 20 sites (since March 2008)
- Additional 20 sites (since September 2014)

- **January 2008~November 2017 (10 years)**
- **Nationwide coverage** (at 20 sites and additional 20 sites since 2014)
- Sand or pebble substrate
- Beach length over 100m
- Accessible but no regular cleaning
- Survey by non-profit organization trained
- Monitor quantity, composition, type and source



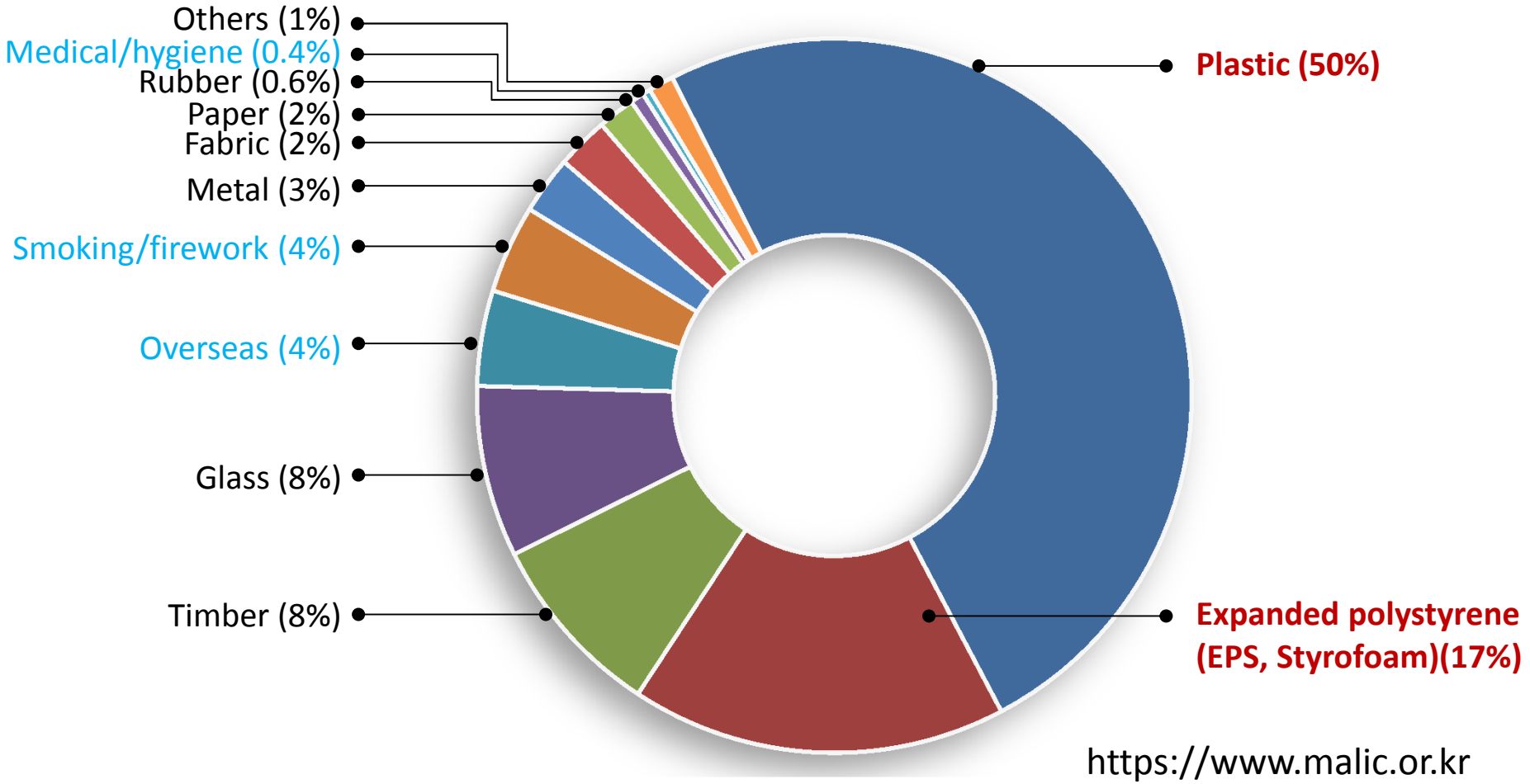
Example of site

https://www.malic.or.kr

Korea Marine Debris Monitoring Program: Macro-beach debris

2008 – 2017

✓ **Plastics (+ EPS + other categories) maintain high proportion.**

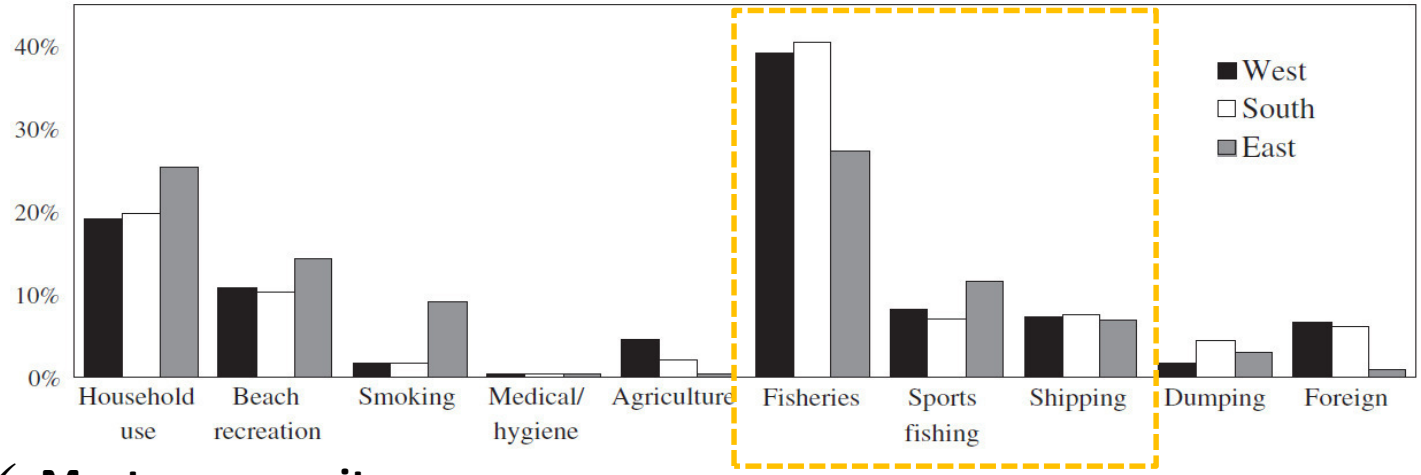


https://www.malic.or.kr

Korea Marine Debris Monitoring Program: Macro-beach debris

Hong et al. (2014) Mar. Pollut. Bull. *84: 27*

✓ Source

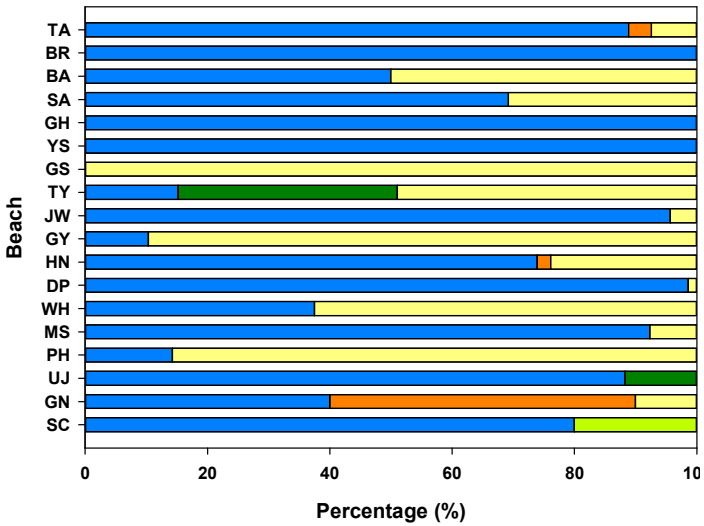


✓ Most common items

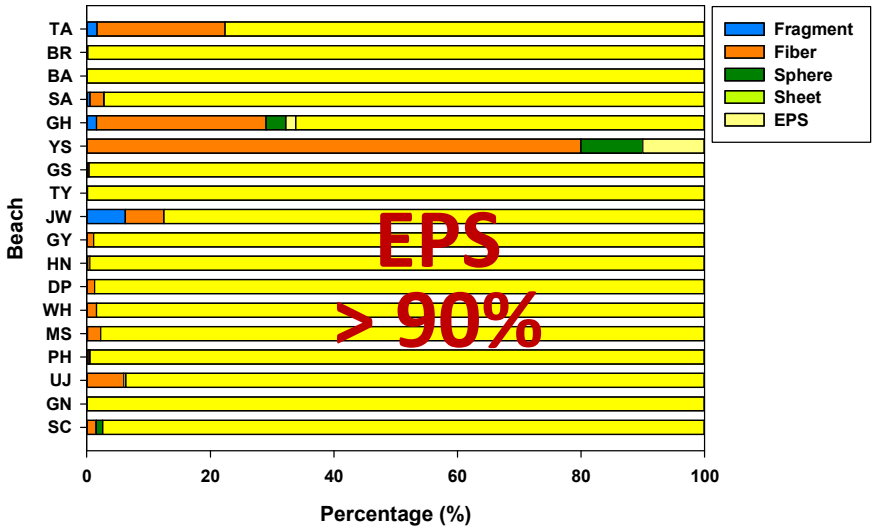
Rank	Items	%
1	**EPS(Styrofoam) buoys**	**12.8**
2	**Fishing ropes**	**8.2**
3	Beverage bottles (glass)	6.9
4	Plastic bags	6.6
5	Plastic food wrappers	6.4
6	Plastic caps and lids	4.9
7	Beverage bottles (plastic)	4.8
8	Plastic strapping bands	4.5
9	Miscellaneous plastic items	4
10	Timber (for ships and aquaculture facilities)	3.5
Total		62.7

Microplastics on Beaches

< 1 mm

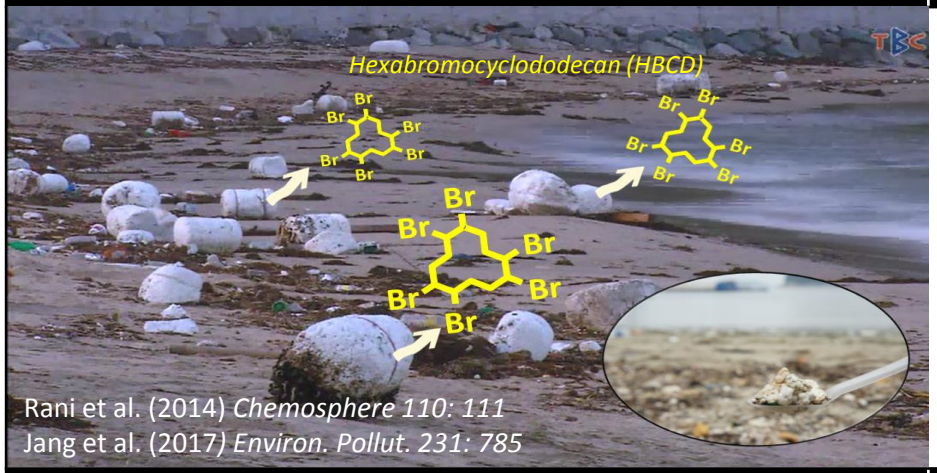


1mm < s < 5 mm



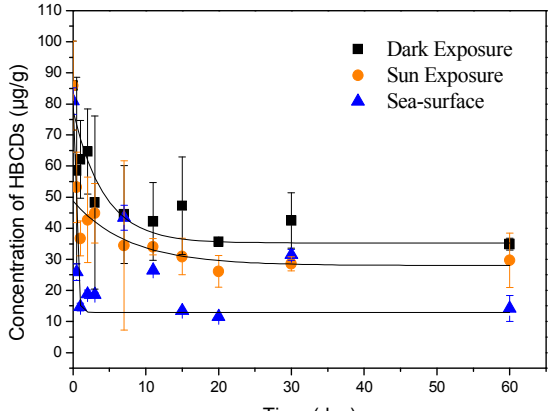
EPS debris as a source and vector of additive chemical

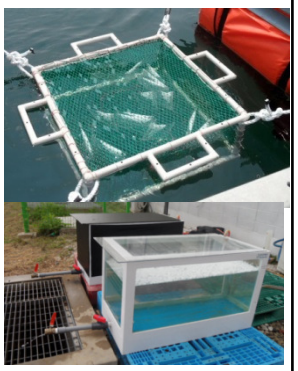
① Inclusion of hazardous chemical



Rani et al. (2014) *Chemosphere 110: 111*
Jang et al. (2017*) Environ. Pollut. 231: 785*

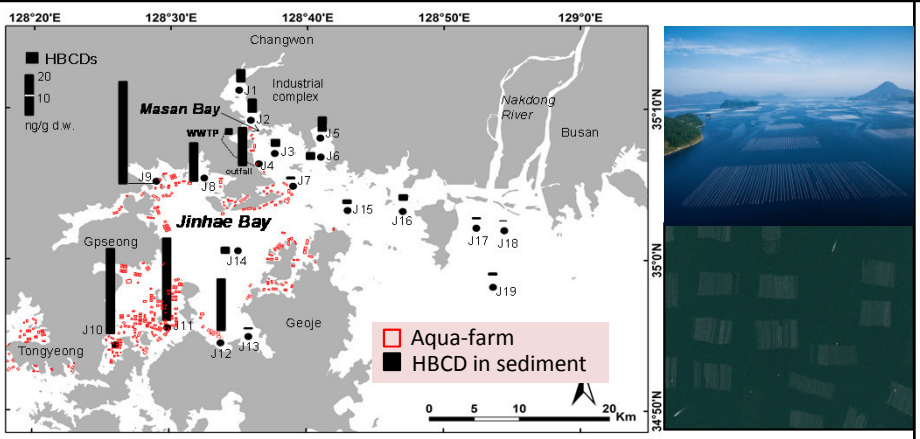
② Rapid releasing of additive chemicals





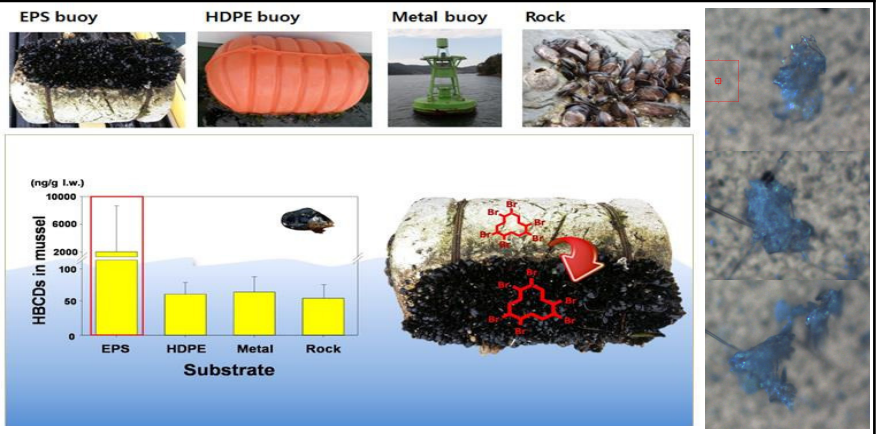
Rani et al. (2017) *Chemosphere 185: 798*

③ Enrichment of additive chemicals in nearby marine sediment



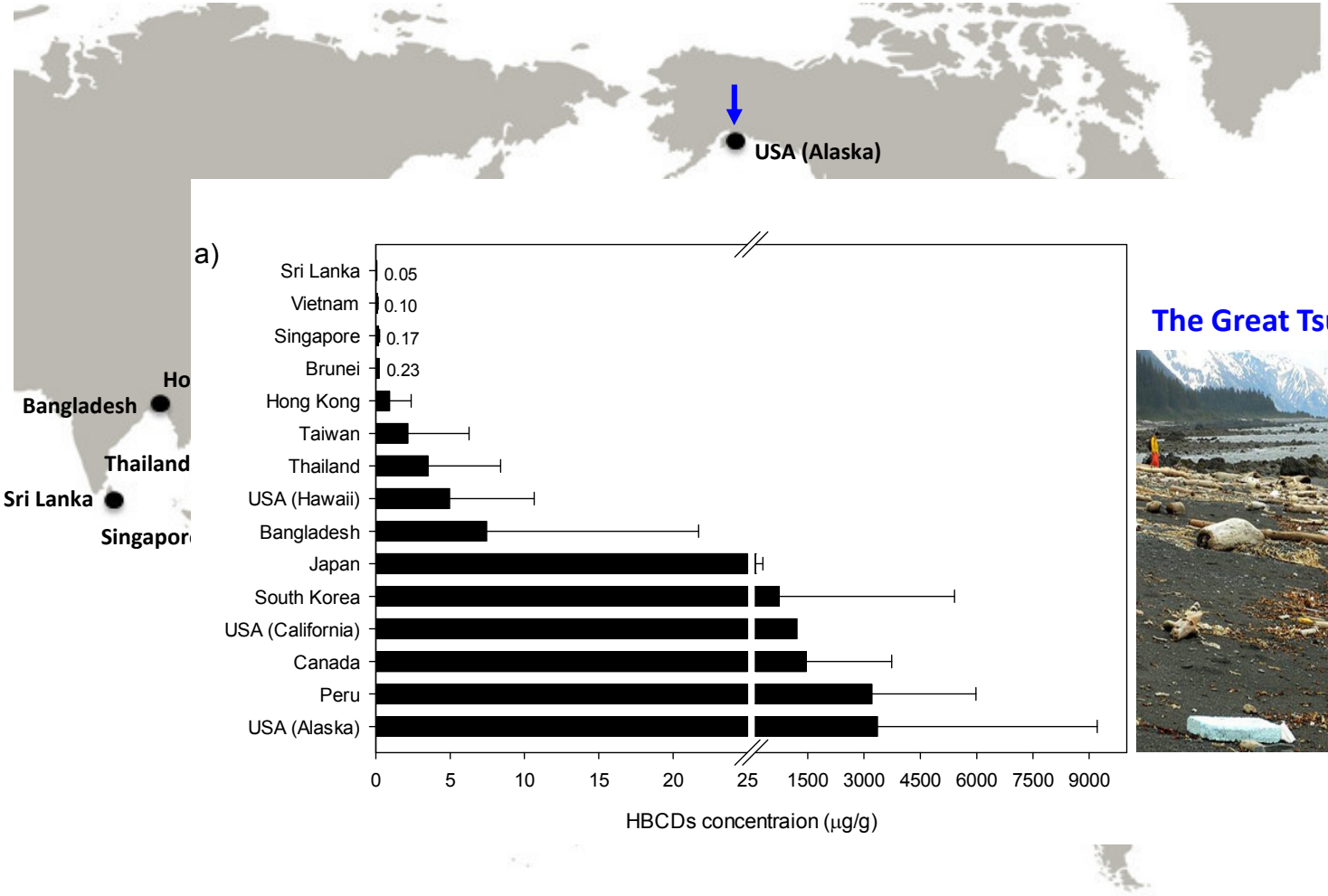
Al-Odani et al. (2014) *Sci. the Total Environ. 505: 290*

④ Ingestion by marine organisms and chemical transfer



Jang et al. (2016*) Environ. Sci. Technol. 231: 785*

HBCD in EPS debris from the Asia-Pacific region

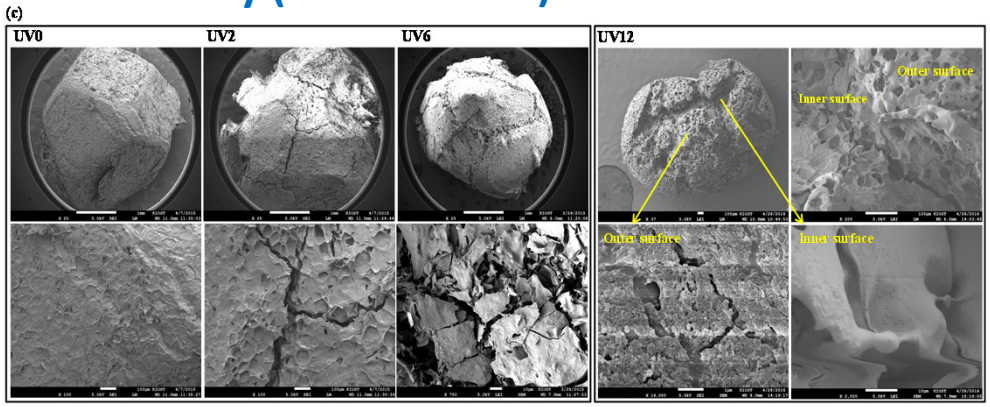


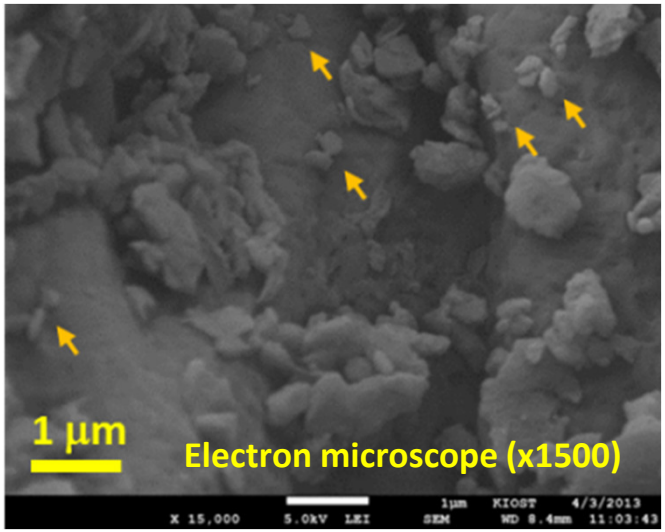
The Great Tsunami debris

Jang et al. (2017) *Environ. Pollut. 231: 785*

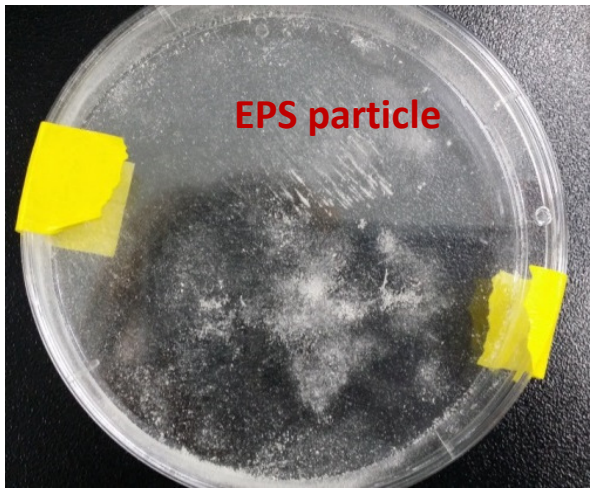
Rapid fragmentation of EPS through environmental weathering

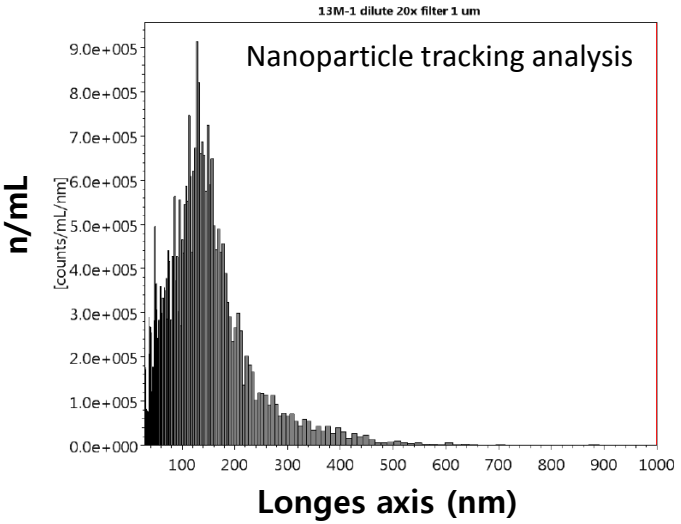
➢ Laboratory (UV radiation)





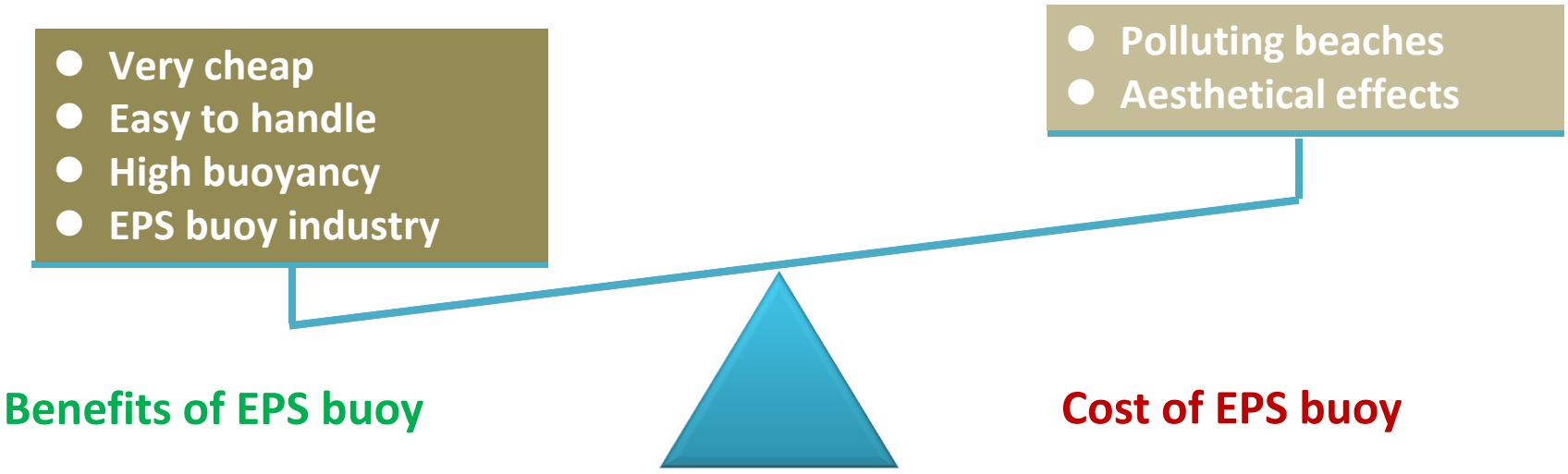
➢ Outdoor exposure





Song et al. (2017*) Environ. Sci. Technol. 51: 4368*

Policy changed



Policy changed

- Increase recovery rate of the used buoy (10% →30%)
- Replace EPS to alternative buoy (Government supports 40% of price)
- Regulate HBCD use in EPS buoy from 2017
- Development of alternative buoy

- Increasing cost
- Easy to handle
- High buoyancy
- Effects on EPS industry

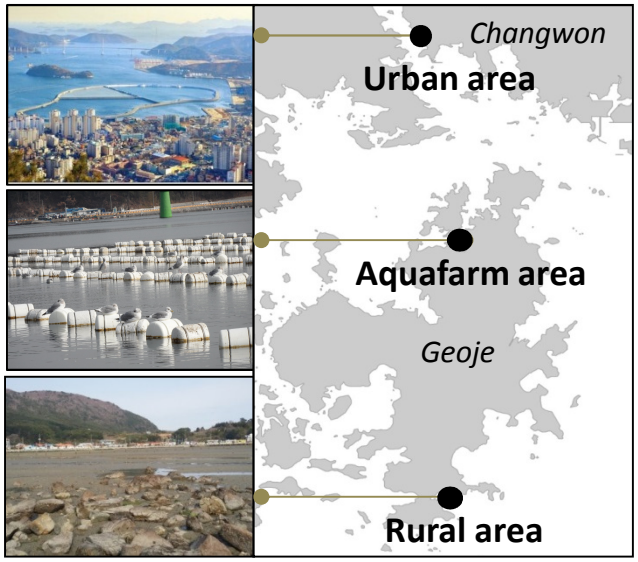
- >90% in mesoplastics
- Rapid fragmentation
- Leaching of HBCD
- Ingestion by organisms

- Polluting beaches
- Aesthetical effects

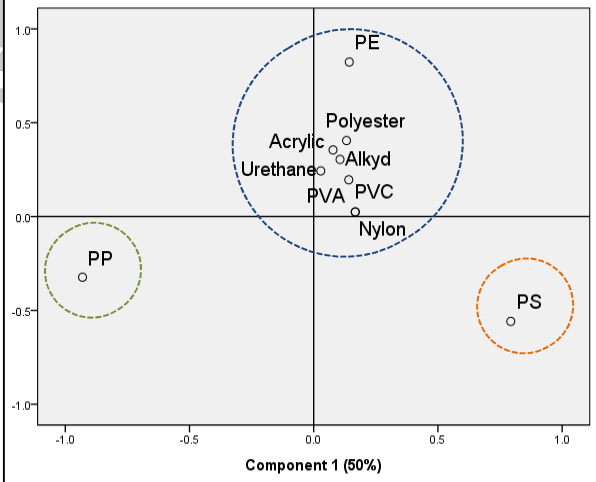
Benefits of EPS buoy

Cost of EPS buoy

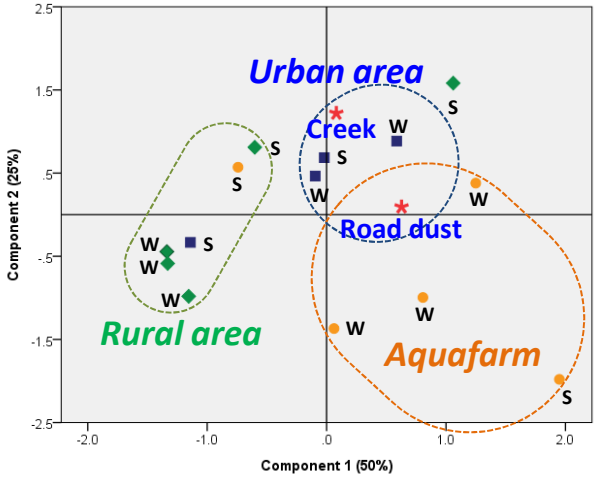
Microplastic Contamination according to Regional Activities



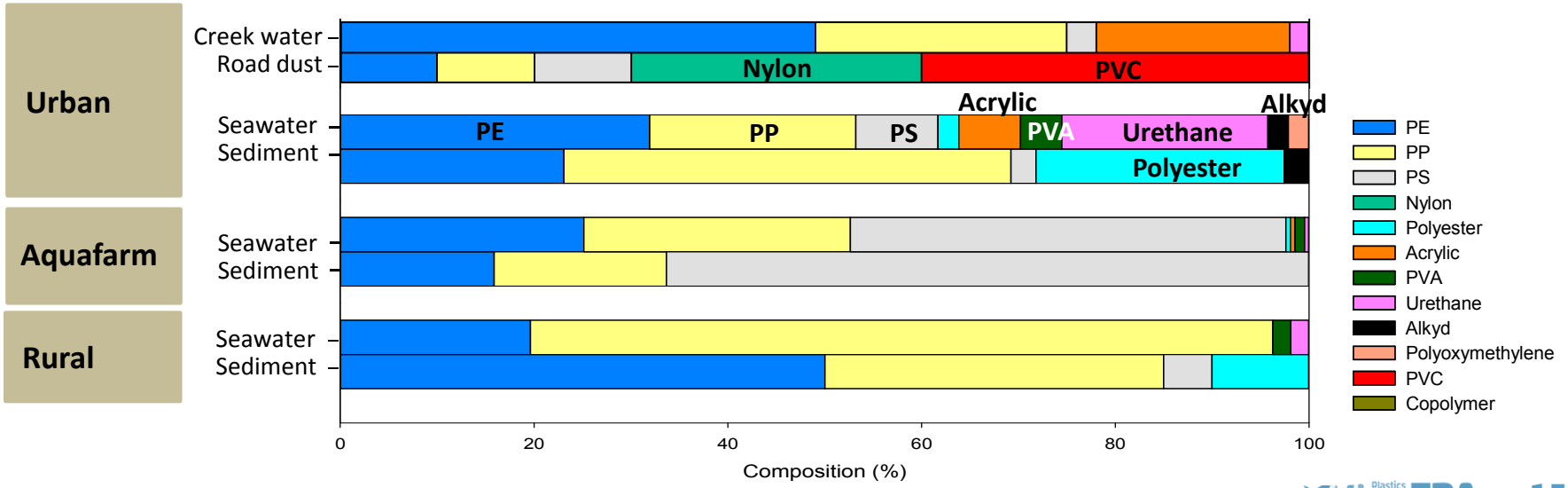
Loading plot



Score plot



W: seawater, S : sediment



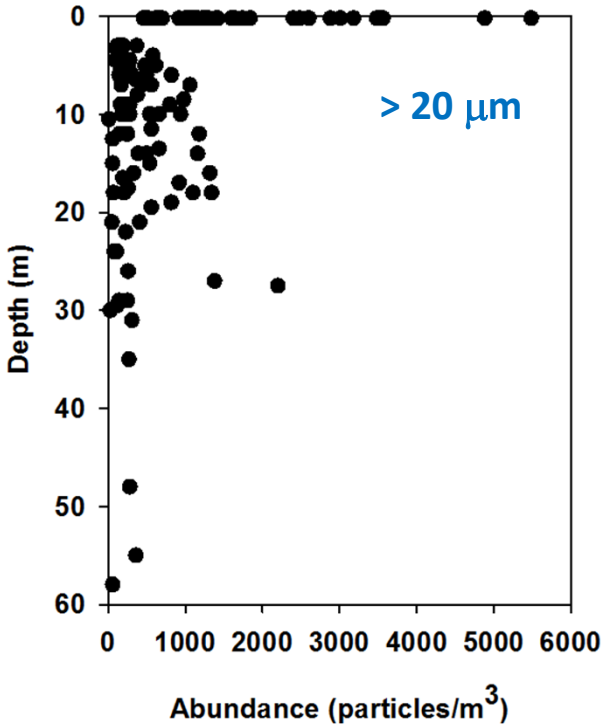
Microplastic Contamination according to Regional Activities

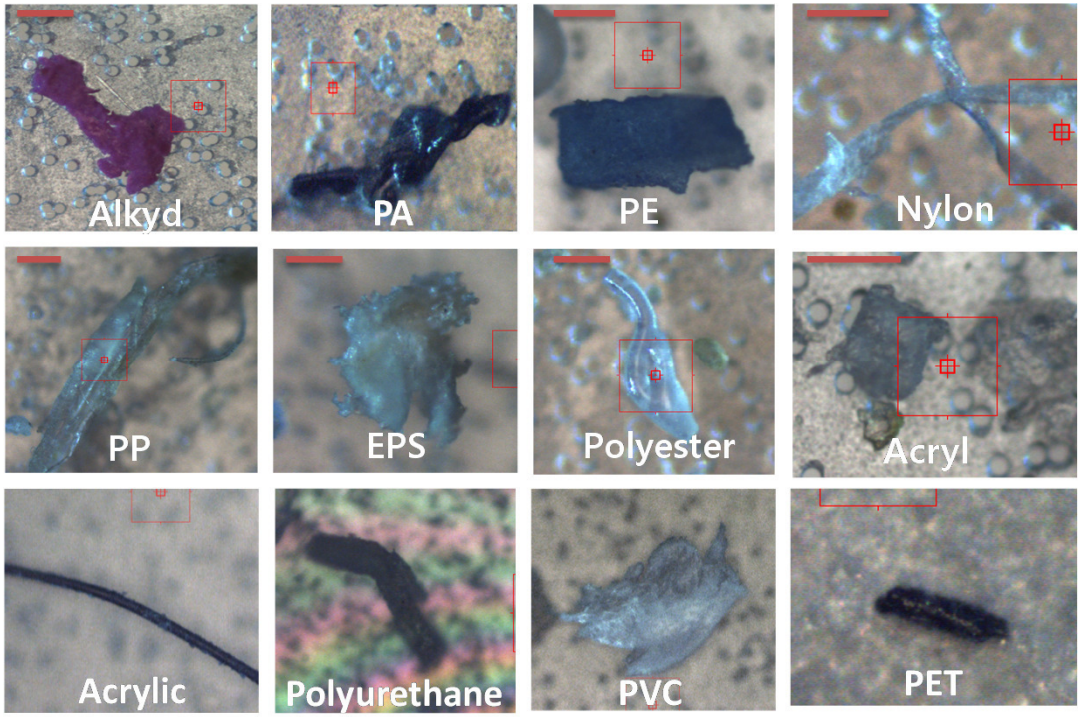
Urban area

Aqua-farm

Rural area

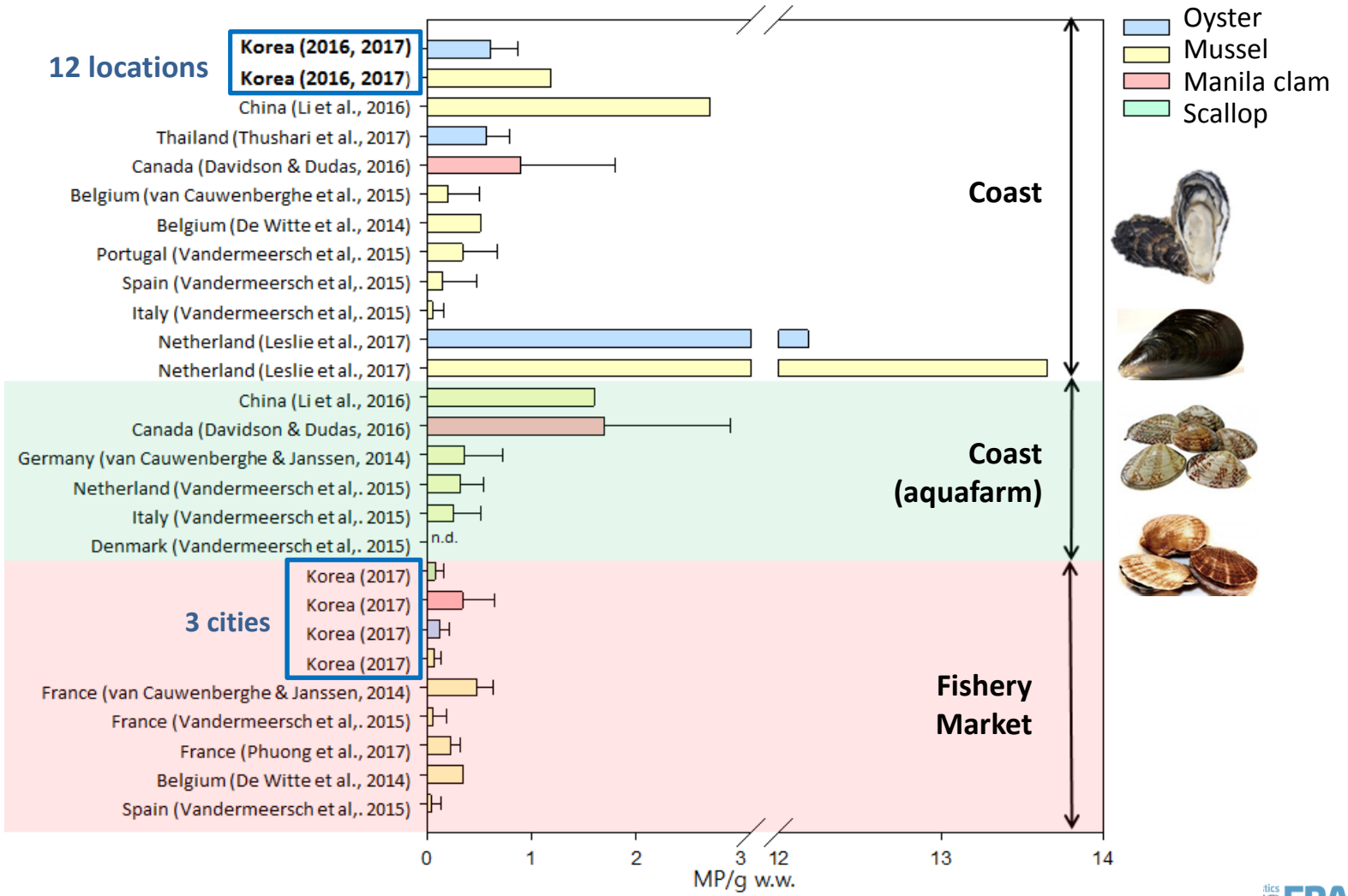
Microplastics in Water column and Marine biota



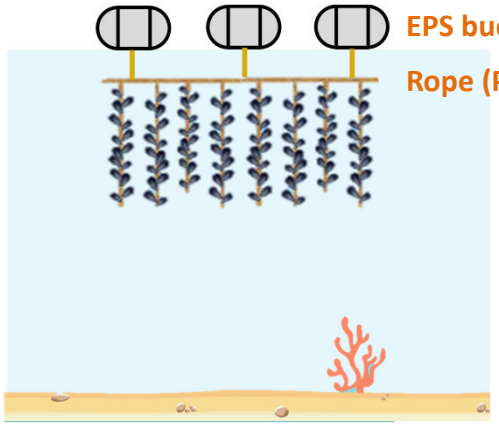


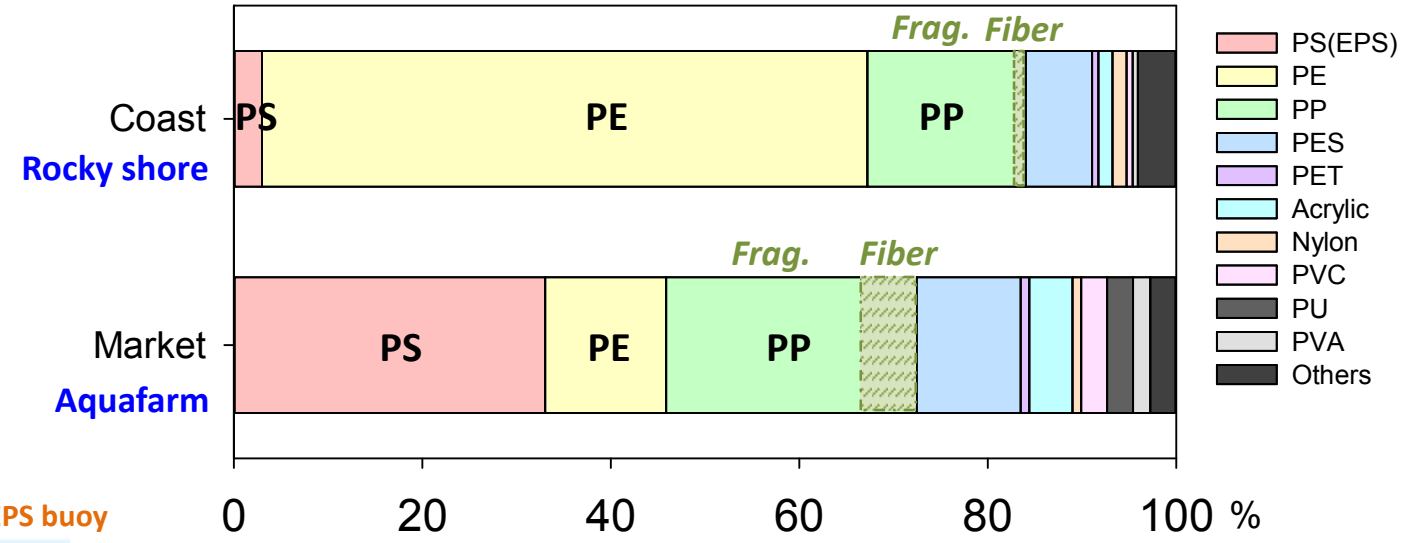
Microplastics in bivalves: coastal region vs fishery market

- ✓ Coastal region, Aquafarm > Market
- ✓ Depuration during storage and transportation, Environmental exposure condition

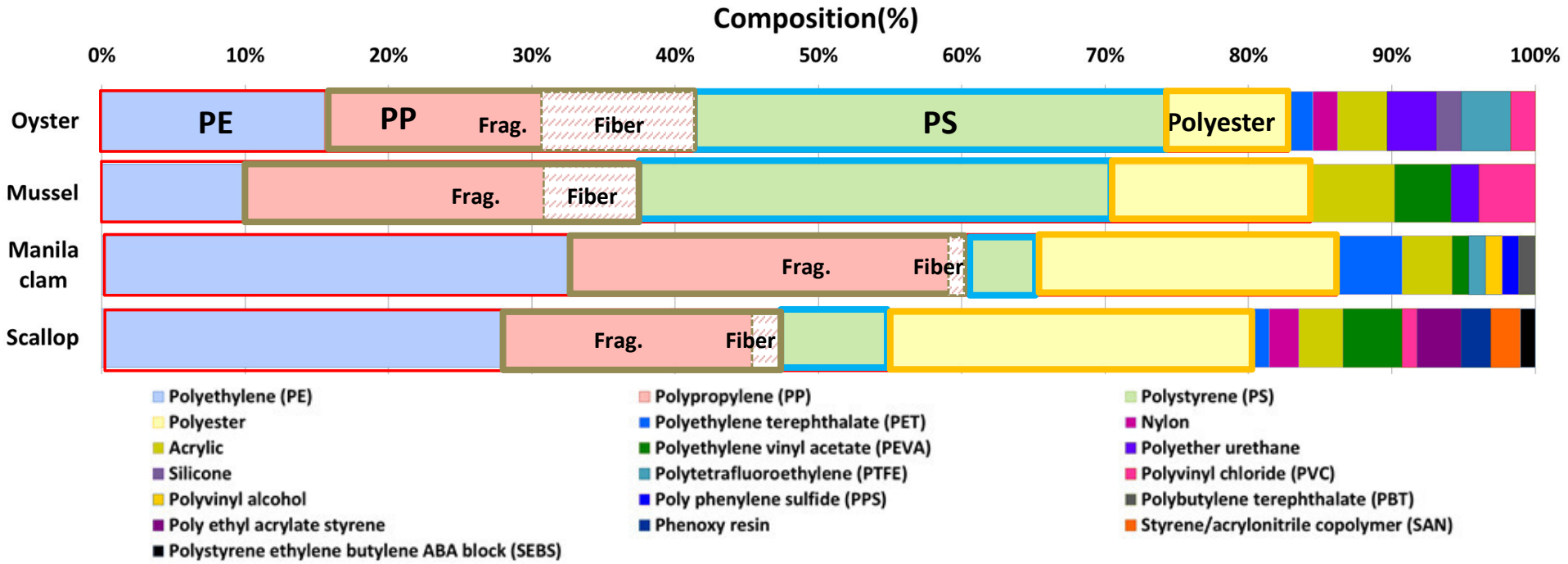


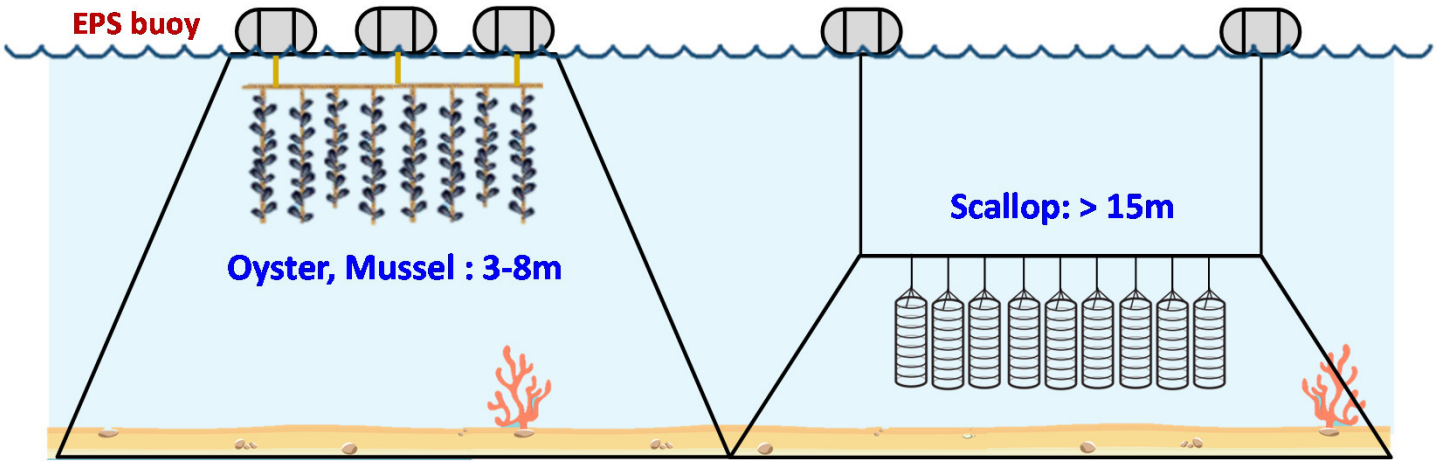
Polymer composition in Bivalves : Coast vs Market (aquafarm)





Polymer Composition in Bivalves *vs* Culturing Methods





Manila clam: mudflat

Governmental intervention

Korea National Marine litter Basic Management Plan (2009~)

Input *vs* Output

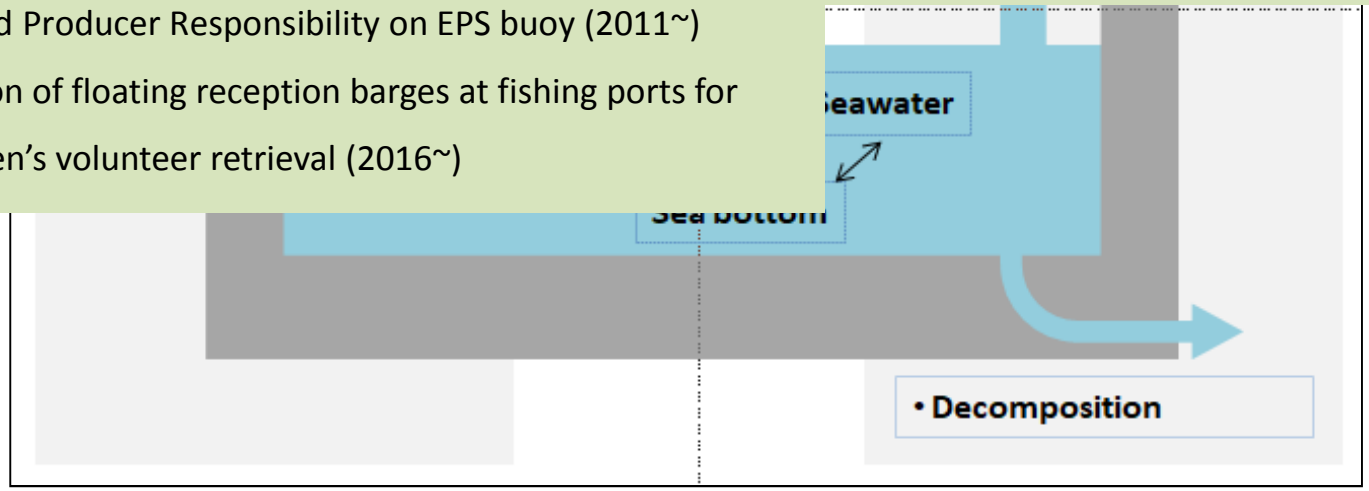
Input ↓↓↓ | Input <<<< Output | Output ↑↑↑

❖ **Reducing input**

- Encourage to exchange to durable buoy
  - Subsidy on high density EPS buoys (2009~)
  - Subsidy on durable alternative buoys (2015~)
- Dissemination of EPS compactors (2002~)
- Extended Producer Responsibility on EPS buoy (2011~)
- Operation of floating reception barges at fishing ports for fishermen's volunteer retrieval (2016~)

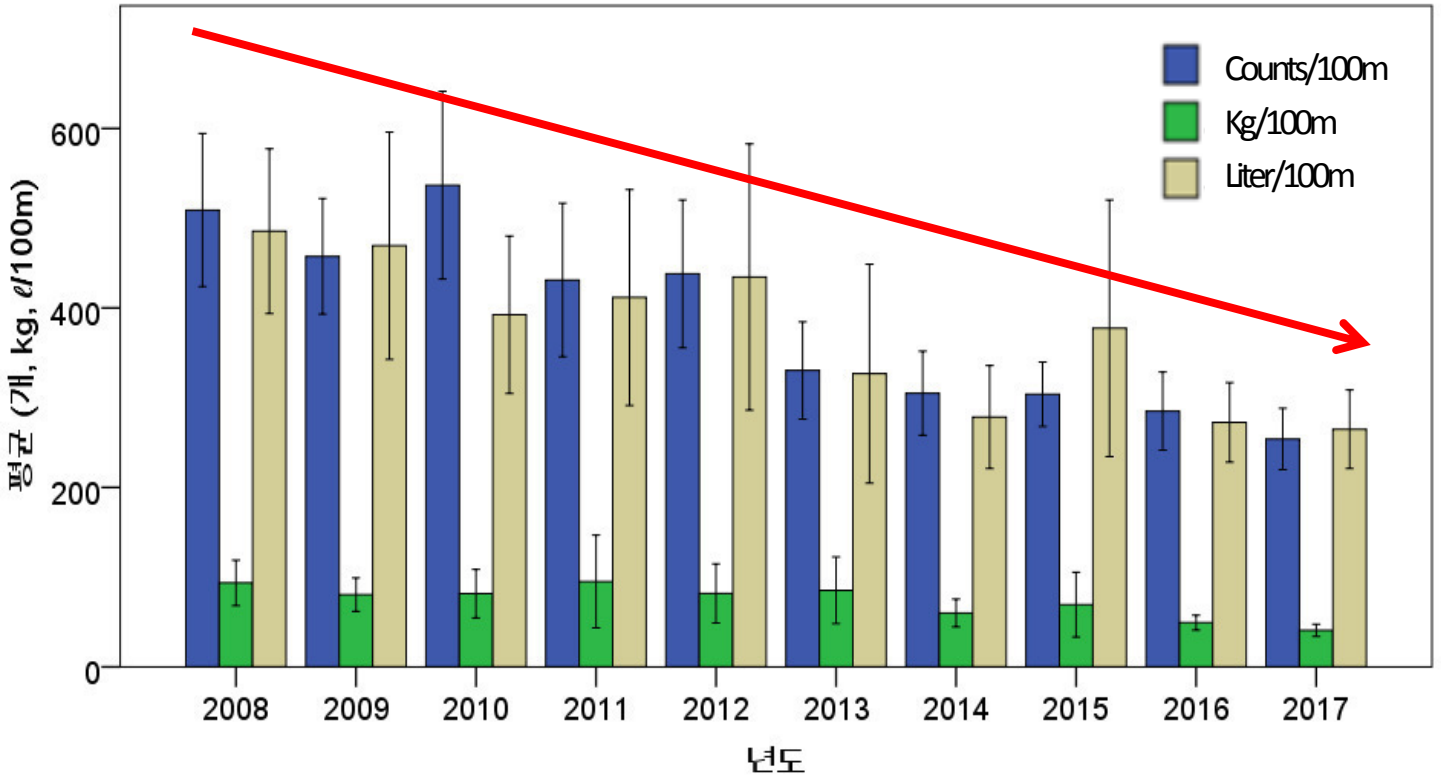
❖**Increasing output**

- Coastal cleanup program (2009~)
- Buyback program for fishing gear and marine litter (2003~)



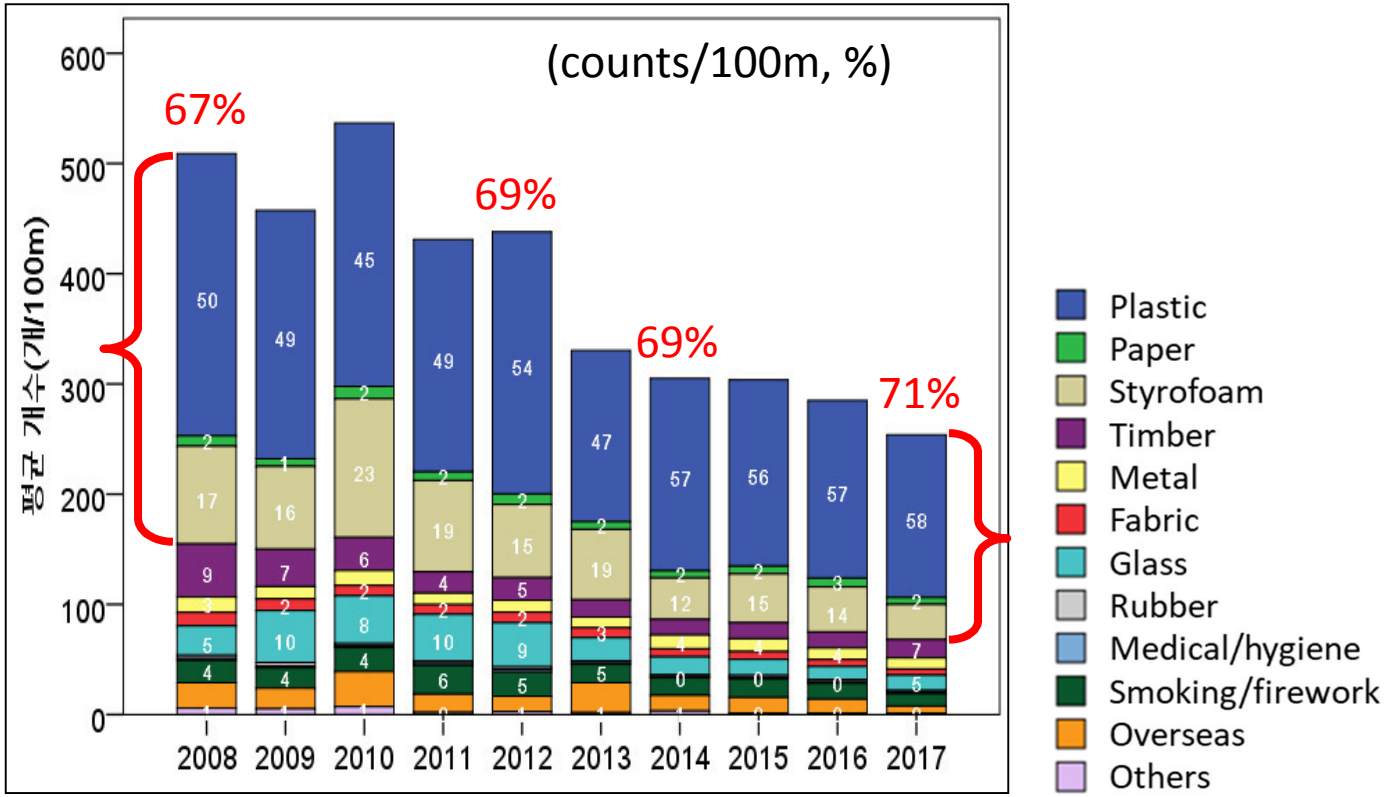
Temporal change in the quantity of macro-marine debris

✓ Quantities (count, weight, and volume) of marine debris have significantly decreased for 10 years.



Changes in the quantity of macro-beach debris

✓ Plastics (+Styrofoam) decrease ($p<0.05$) but maintain high proportion.



Conclusion

It need to improve marine debris policies

that can efficiently reduce the input and increase the output of marine debris based upon scientific evidence and monitoring program result

Acknowledgement

Ministry of Oceans and Fisheries

Ministry of Food and Drug Safety

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KOEM
Korea Marine Environment Management Corporation (KOEM)

Plastics MicroERA
Microplastics - Environmental Risk Assessment

Thank you!

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