

THE MOST BEAUTIFUL OCEAN

IS THE ONE WE HAVE YET TO CROSS.

THE LOVELIEST CHILD HAS YET TO GROW UP.

THE MOST BEAUTIFUL DAYS OF OUR LIVES

ARE THOSE WE HAVE YET TO LIVE.

AND THE LOVELIEST THINGS

I'D LIKE TO TELL YOU

ARE THOSE I HAVE YET TO TELL

Nazım Hikmet







富嶽三十六景 神奈川沖
浪裏

1831



LITTER!!!



Expert in garbology?

Title Garbology officer

Skills required Ability to interest younger generation in old rubbish. Strong constitution

Duties Helping school children explore their heritage by studying waste, through a variety of projects, including sifting of samples taken from waste sites; sowing of soil to look for seeds and animal bones; small-scale excavations; and, possibly, field trips to ancient rubbish sites. Also, using archaeological techniques to improve community awareness of changing waste patterns, and working with the elderly using retrieved objects as a focus for reminiscence

Reward Up to £25,000

Economic Instruments to Address Marine Litter – *Gobal threat & Challenge*

OVERVIEW





OCEANS -
1.3bn km²
Earth's largest
ecosystem.

The kidney
of our planet

Apollo 8.
30k km.
from earth
South is top

First ever photo of the whole earth



Data does not = information

Information does not =
knowledge

Knowledge does not =
wisdom.

We have oceans of data,
rivers of information,
puddles of knowledge and
the odd drop of wisdom

Definition of Marine Litter / Debris

70% sinks to the seabed, 15% drifts with the currents, and 15% appears on beaches with the same percentage appearing on land (Williams and Simmons, 1997, Topcu et al 2013, Rech et al 2014).



'any persistent, manufactured or processed solid material discarded, disposed of, or abandoned in the marine and coastal environment.'

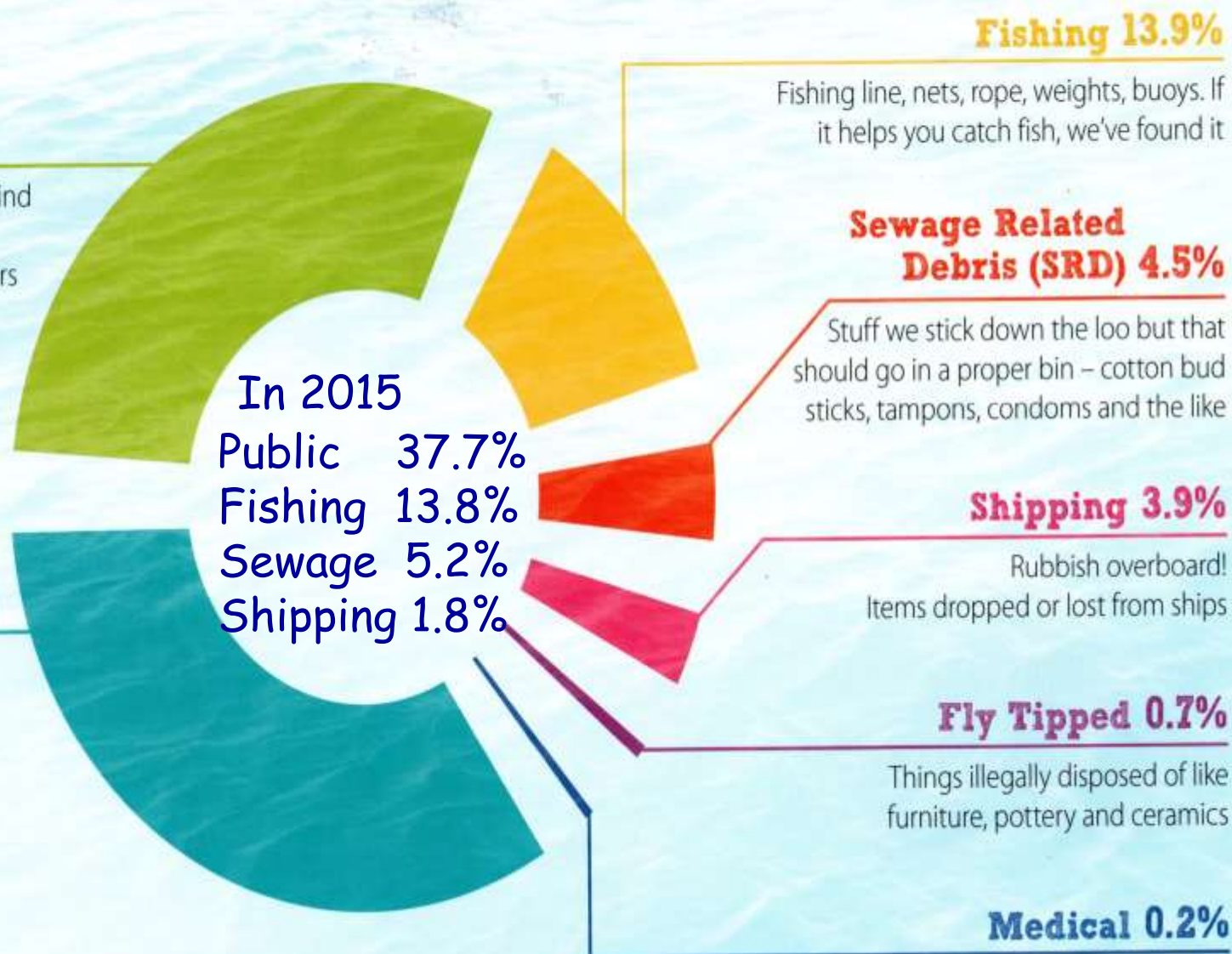
So where does all this rubbish come from?

Public 40.4%

The stuff we drop or leave behind on a trip to the beach or bits carried there by winds and rivers

Non-sourced 36.3%

This is the weird, small or damaged bits we find that we can't identify what they are or where they come from



TOP 10 ITEMS COLLECTED

1
Cigarette Butts
2,043,470

6
Grocery Bags
(Plastic)
441,493

2
Food Wrappers
(Candy, chips, etc.)
1,685,422

7
Beverage Bottles
(Glass)
394,796

3
Beverage Bottles
(Plastic)
940,170

8
Other Plastic Bags
389,088

4
Bottle Caps
(Plastic)
847,972

9
Paper Bags
368,746

5
Straws, Stirrers
555,007

10
Beverage Cans
339,170



Worldwide Marine Debris

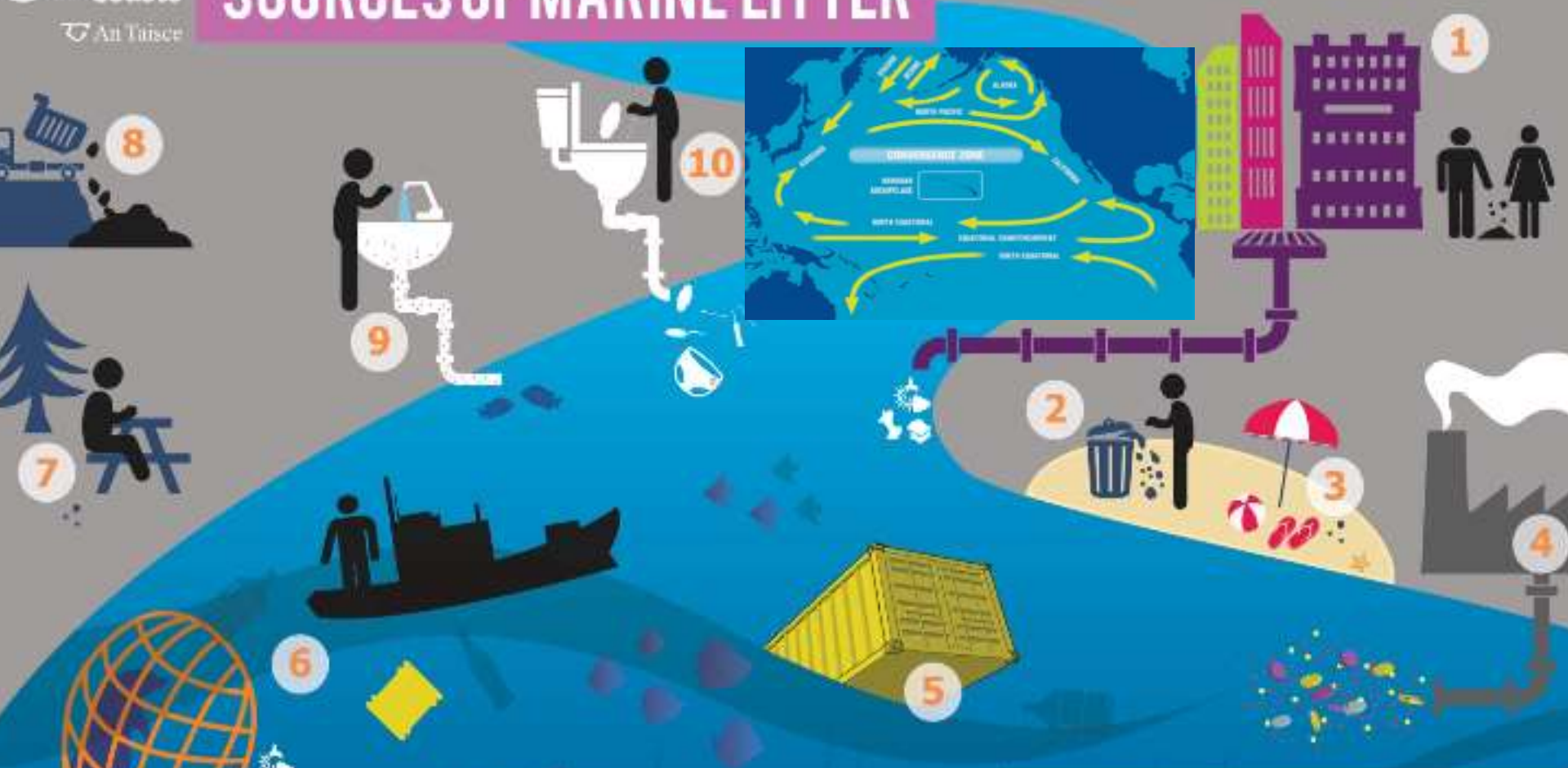
Recreation 61.0%



Location/Item	String/cord					Plastic/polystyrene <2.5cm					Plastic/polystyrene >2.5cm					Drinks/containers drums				
	Au	W	Sp	Su	Au	Au	W	Sp	Su	Au	Au	W	Sp	Su	Au	Au	W	Sp	Su	Au
Minearny	0	0	2	3	0	13	11	25	9	0	5	18	8	5	1	19	8	13	20	4
White Park Bay	105	65	0	6	A	83	36	148	23	A	17	24	47	13	A	8	2	1	5	A
Runkerry	9	13	1	20	8	231	51	86	37	34	98	33	45	32	39	3	7	10	0	1
Rathlin	94	157	214	115	108	55	31	54	4	0	80	35	22	10	63	5	5	2	0	2
Drains	5	0	7	5	3	5	10	18	3	3	9	5	21	10	1	10	3	10	2	0
Hazelbank	5	0	1	0	0	0	4	3	0	1	7	8	6	3	2	7	6	3	3	4
Ballywalter	1	6	82	12	4	0	30	3	7	4	2	39	14	2	3	0	1	3	0	0
Cloughey	10	20	22	45	14	30	9	5	5	7	28	24	3	4	5	0	13	1	1	3
Portavogie	20	14	85	45	54	109	31	124	87	28	91	104	78	45	40	31	75	130	4	3
Ballyhornan	70	47	132	130	191	38	65	52	70	87	110	54	43	61	97	14	32	15	35	56
Ardglass	102	44	166	122	87	40	50	40	50	29	21	59	40	39	38	28	9	79	57	24
Tyrella	38	125	114	32	21	3	23	16	10	9	0	45	16	18	9	2	22	25	4	9
Kilkeel north	25	13	40	72	93	70	75	83	29	0	335	108	117	45	110	109	179	226	272	97
Rostrevor	5	1	5	0	4	7	46	22	5	14	15	21	23	8	35	41	29	28	0	34

Location/Item	Caps					Sweets/wrappers/ crisps					Rope>1cm					Cotton buds				
Minearny	0	7	1	2	1	6	3	10	16	3	0	1	0	1	0	0	5	0	4	0
White Park Bay	15	21	31	9	A	23	11	7	9	A	16	19	27	8	A	23	1	58	22	A
Runkerry	123	57	31	57	42	19	12	4	8	5	11	4	0	10	5	92	35	21	41	21
Rathlin	77	23	14	1	36	36	32	17	7	58	6	21	21	14	19	3	30	9	0	59
Drains	8	3	21	9	1	2	2	24	6	3	1	2	4	0	0	1	0	0	0	0
Hazelbank	0	0	0	0	2	2	1	6	2	3	3	4	3	3	1	0	0	0	0	0
Ballywalter	0	2	21	5	1	0	1	33	5	0	1	3	17	2	0	0	0	10	3	1
Cloughey	5	7	10	9	0	21	17	6	6	7	0	5	7	9	1	4	5	1	1	0
Portavogie	26	37	61	26	11	19	39	105	20	7	7	14	66	30	41	31	108	33	67	6
Ballyhornan	22	42	48	45	96	53	26	25	50	63	35	42	33	52	99	3	22	12	8	30
Ardglass	7	0	19	23	2	31	22	48	27	27	43	15	55	17	22	0	0	14	1	1
Tyrella	8	27	25	14	0	77	74	17	16	8	2	34	42	23	7	9	6	22	9	0
Kilkeel north	22	20	7	34	34	21	4	17	17	35	40	41	45	17	60	1	0	0	0	4
Rostrevor	2	14	10	4	39	13	14	14	5	19	1	0	0	0	0	0	8	5	0	3

SOURCES OF MARINE LITTER



- 1 LITTER DROPPED IN TOWNS AND CITIES
- 2 OVERFLOWING LITTER BINS
- 3 LITTER DROPPED AT THE BEACH
- 4 POORLY MANAGED INDUSTRIAL WASTE DISCHARGES
- 5 LOST SHIPPING CONTAINERS
- 6 LOST/DISCHARGED FISHING GEAR
- 7 RECREATIONAL LITTER BLOWN BY THE WIND
- 8 POORLY MANAGED LANDFILL SITES
- 9 MICROBEADS FROM PERSONAL CARE PRODUCTS
- 10 SEWAGE RELATED LITTER



Marine Debris from Land and Sea In the environment a long, long time



Each year, tons of plastics and other litter are tossed into rivers, left on beaches, or dumped overboard from recreational and commercial vessels. Litter not only looks bad, but can put people and wildlife in danger. Marine debris can last a long time. Let's keep South Carolina's beaches safe and beautiful. Do your part to prevent trash from becoming marine debris. For more information, visit: http://www.scdhec.gov/environment/ocrm/outreach/marine_debris.htm



Estimated individual item time lines depend on production composition and environmental conditions.

100,000 marine mammals killed every year...
millions of sea birds...



ACCEPTANCE OF THE UNACCEPTABLE; LITTER



Familiar the way a landscape becomes familiar.
No matter how gruesome or spectacular, over time
you become used to it. Eventually, you can walk
through it without feeling any need to comment.'

†Fr. Richard John Neuhaus, Institute on Religion & Public Life



SOME PROBLEMS

- aesthetic, cosmetic, hygienic,
- entanglement and ingestion, death, injury, debilitation,
- 'quality of life', starvation.
- Ghost fishing,
- smothering, transport, dispersal vectors,
- toxicity, sea surface micro-layer,
- vessel hazard,
- tourism.

Barnes, (2005), -the 1982 report of 8 million marine debris items entering the world's oceans/seas each day needs to be updated by multiplying several fold





Paul Gauguin

D'où venons-nous? / Qui sommes-nous? / Où allons-nous

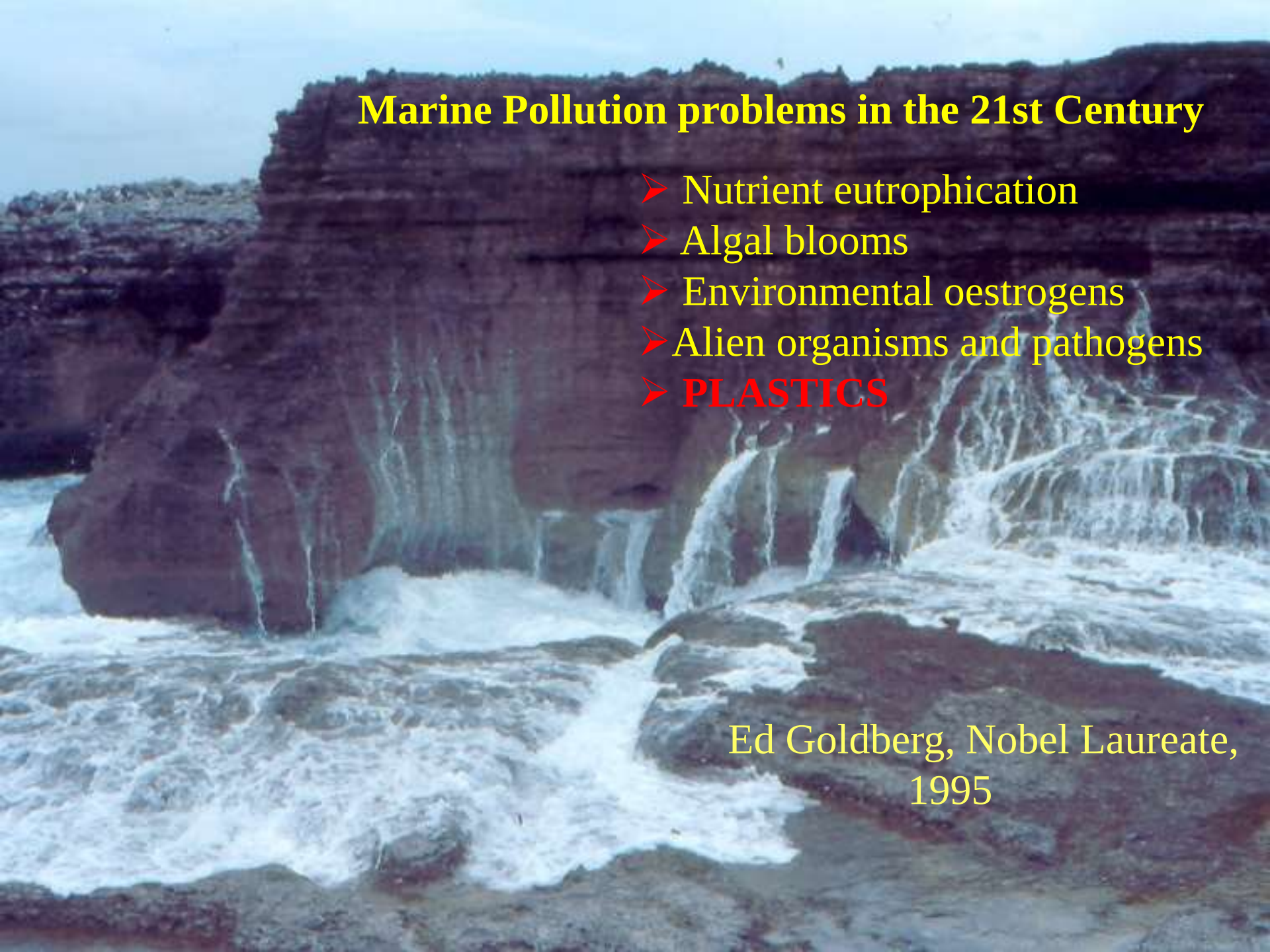
Where Do We Come From? What Are We? Where Are We Going?

Откуда мы пришли? Кто мы? Куда мы идём?

Ida dove veniamo? Chi siamo? Dove andiamo?

De dónde venimos? ¿Qué somos? ¿A dónde vamos?

Woher kommen wir? Wer sind wir? Wohin gehen wir?



Marine Pollution problems in the 21st Century

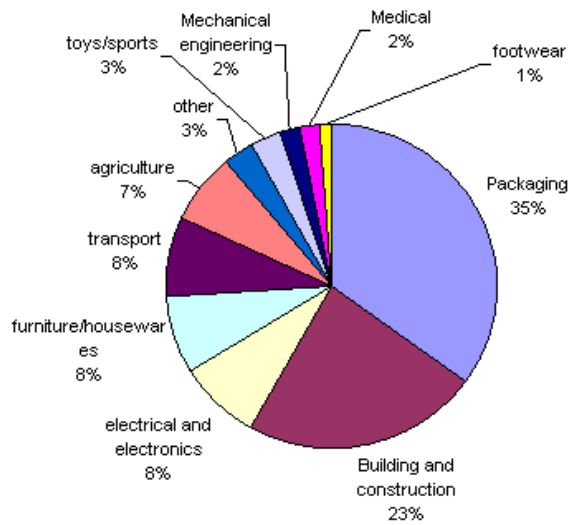
- Nutrient eutrophication
- Algal blooms
- Environmental oestrogens
- Alien organisms and pathogens
- **PLASTICS**

Ed Goldberg, Nobel Laureate,
1995

Top Concerns of Marine Scientists

Early in 2001 marine experts of United Nations organizations listed issues of global concern regarding deterioration of the marine environment (no particular order):

- Eutrophication and anoxia
- Harmful algal blooms (HABS)
- Classical contaminants (*e.g.* sewage, metals, petroleum hydrocarbons)
- Deforestation
- Increased or decreased mobilization of sediments
- Demise of coral reefs
- Loss of wetlands
- Habitat destruction
- Climate change and sea-level rise
- Inundation as a consequence of physical alteration
- Increased risks to human health
- Reduced biodiversity
- Over-fishing
- Exploitation of coastal mineral resources, particularly sand and gravel
- **LITTER**



Household waste

- The amount of plastic generated annually in the UK is *circa* 3 million tonnes.
- some 56% of all plastic waste is used packaging, 75% from households.
- Estimated that only 7% of plastics are recycled.

World's annual consumption of plastic materials - 5 m. tonnes (1950s) to 100 m. tonnes .

We produce and use 20x more plastic today than 50 years ago!

In UK, a total of 6.7 million tonnes of plastic products were used in various economic sectors in 2015.

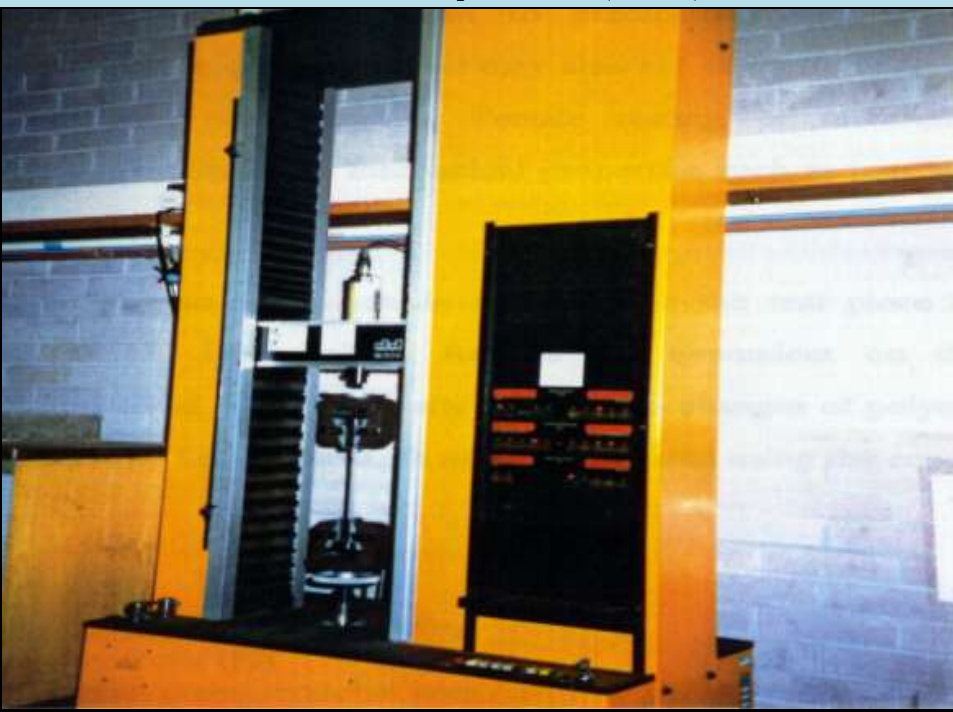
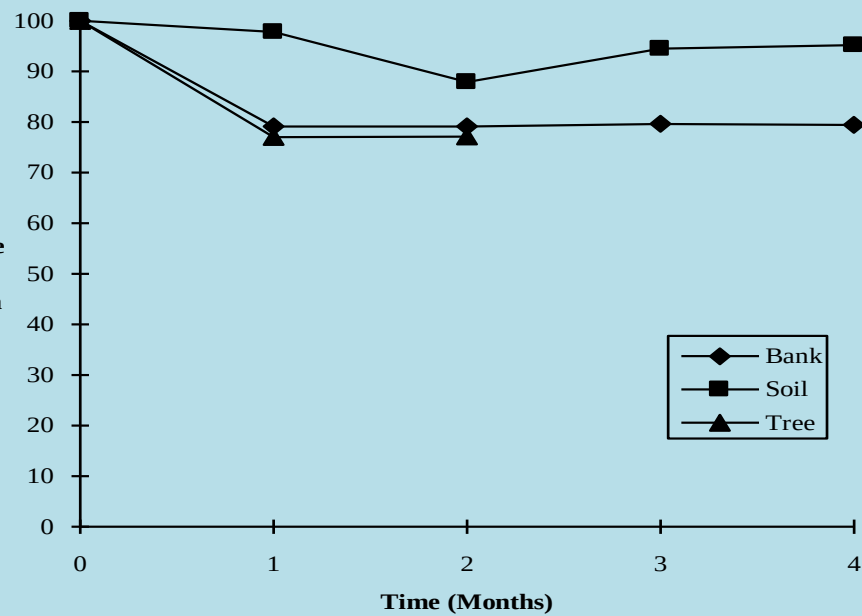
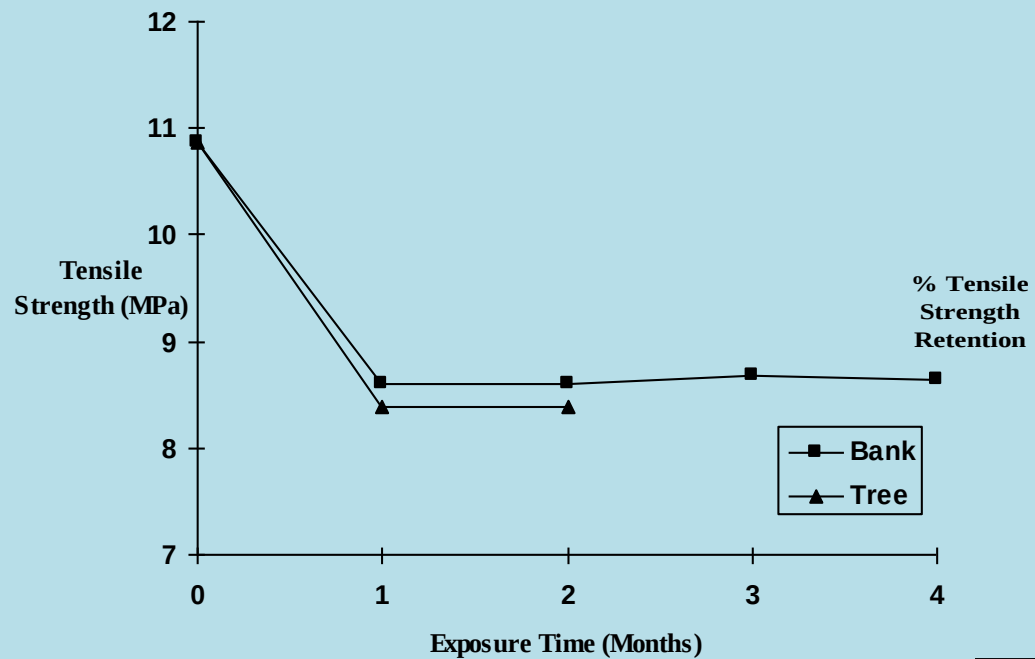
Packaging is the largest single sector of plastics use in the UK (35% of plastics used) and is the material of choice in 50% of all packaged goods.

Plastic consumption is growing by 4% /year in W Europe

- Extreme **versatility** and ability to be tailored to meet very specific technical needs.

BRITISH PLASTICS FEDERATION

- **Lighter weight** than competing materials, reducing fuel consumption during transportation.
- Extreme **durability** and relatively **inexpensive** to produce
- **Resistance** to chemicals, water and impact.
- **Good safety and hygiene properties** for food packaging.
- **Excellent thermal** and electrical insulation properties.
- 1 tonne of plastics is = 20k two litre drinks bottles or 120k carrier bags



Characteristics: in summary.

Consistency: non-degradable
variety of plastics (70-95%),
metals and glass; long-lived and
active for decades

Mobility: travels huge
distances around the
world with ocean currents & winds;
found across all the water column



PLASTIC BAGS/BOTTLES

- **Tesco**- 2006 it reduced number of bags given away by 1bn.
It has >3,500 recycling & reducing packages projects.
- **Ikea** - charges 10p a bag- it gave away 32bn in 2005.
Ireland introduced a charge in 2002 and reduced demand by 90%.
- They tend to be used for some 20 mn. each (once) and can stick around for X years. No one can extrapolate.
- **Packaging and Industrial Films Association**: 8bn/year
DEFRA: UK uses 10bn/year or 162/person.
Liberal Democrats say this is too low 12bn/year.
Consumption grows by 4%/year in Europe - uses 4% crude oil production.
- 35% UK plastic consumption is in packaging.
Packaging- 60% household waste -11% plastic (40% = bottles).
Each UK house uses 500 bottles per year-130 recycled (13bn/year)
80% plastics sent to tips, 8% incinerated, 7% recycled (EA).





Success of plastic bag tax (dropped by 6 m in England in 2015) due to 5p charge, next in line are coffee cups. Amount in circulation ~ 5 bn.

Problem is the plastic lining which makes cups impermeable, 100,000 trees used for UK's coffee

The paper can be recycled but the polyethylene is resistant to degradation (30 years to break down)

Even without the plastic as high quality paper is used to break down the cellulose fibre-takes 2 years but produces methane!

Lib Dems are calling for a 5p a cup tax. FRUGALPAC developing a 100% recyclable cup.

Imperial College, is testing a resin that is 40% stronger than conventional plastics- melting polypropylene high impact polystyrene and introducing filler within the extrusion line. Additives are added so the cellulose fibres can bond with the polymer.

2.6bn - no access to toilet/latrine.

90% of sewage is discharged untreated.

Every 15 seconds a child dies of diarrhoea - Pakistan spends 47 times more on military despite 120 k diarrhoea deaths per year.

Nappies account for 922k tonnes of waste/year in UK (c/p 1,264k tonnes of paper & card; kitchen waste of 640k; Friends of the Earth

'The Big Necessity', Rose George, Portobello, 2008.





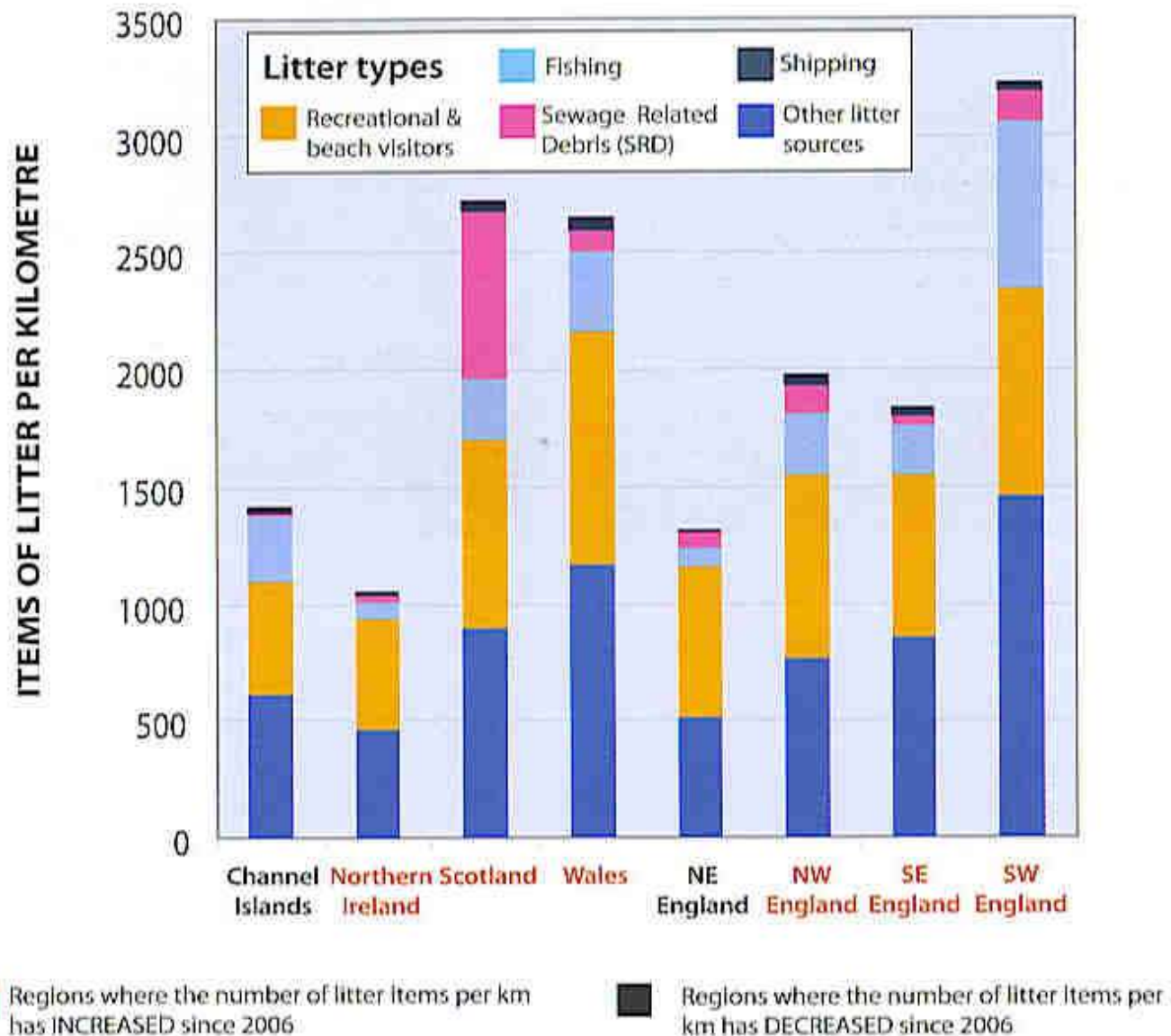
**More than 20 Million tons/year 13,000 plastic objects/km² – most of it does not degrade!
and – input quantities are increasing...**

UNEP study
Indicates >46k
pieces of
plastic /mile² of
ocean.

In UK the
density is 1189
items/km, an
increase of
126% since
1994.

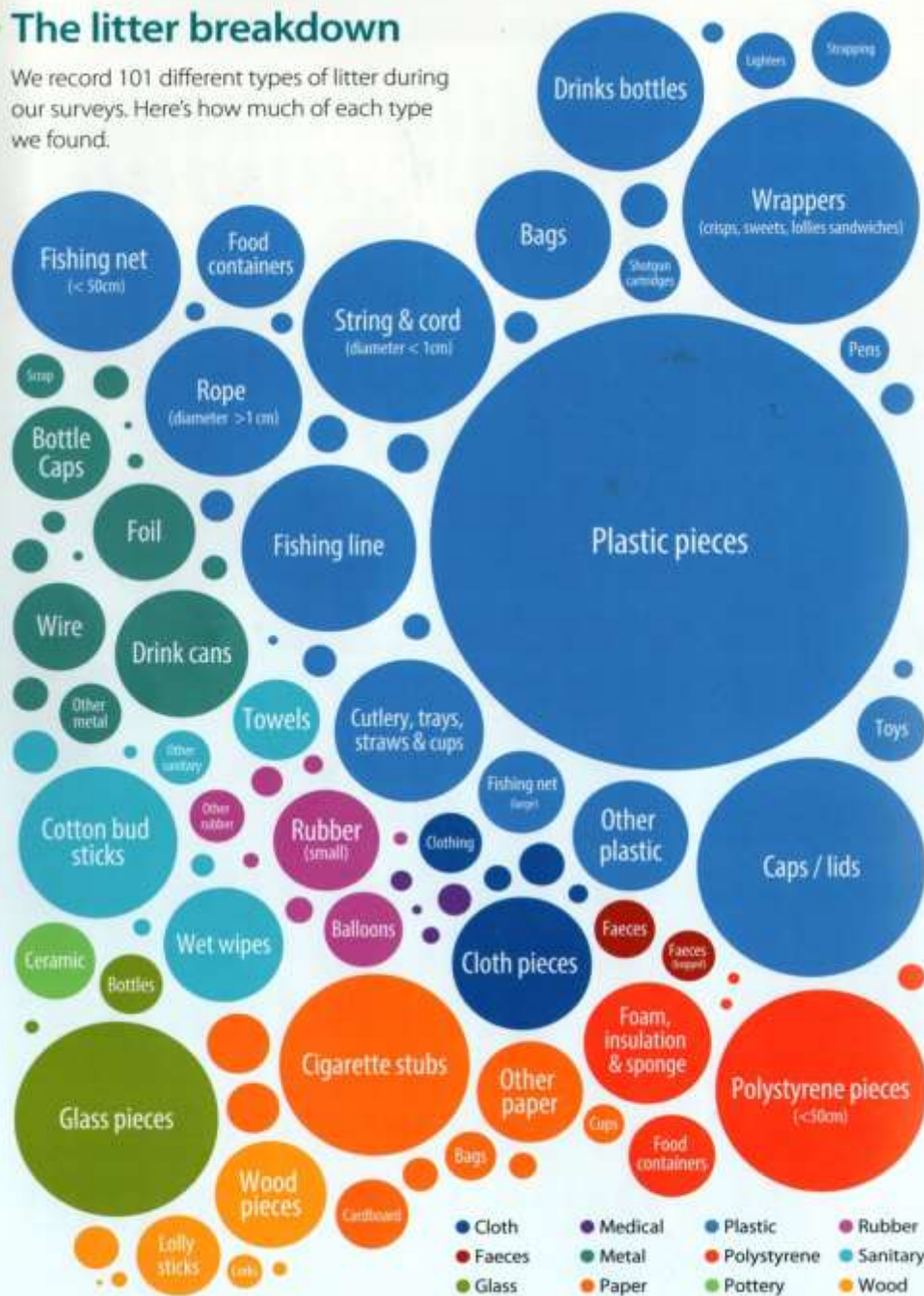
Nb. pollutants
can be
attracted to
plastic pieces
and ingested
by animals.

Regional variations in sources and densities of litter



→ The litter breakdown

We record 101 different types of litter during our surveys. Here's how much of each type we found.



EC 2015. Final Economic Policy Package for waste.

Recycling target of 75% of
all waste & landfill max.
of 10% of all waste by
2030.

The Circular Economy Package can 'close the loop' of product lifecycles (more recycling/reuse) to obtain max. value and use from all materials, products & waste.

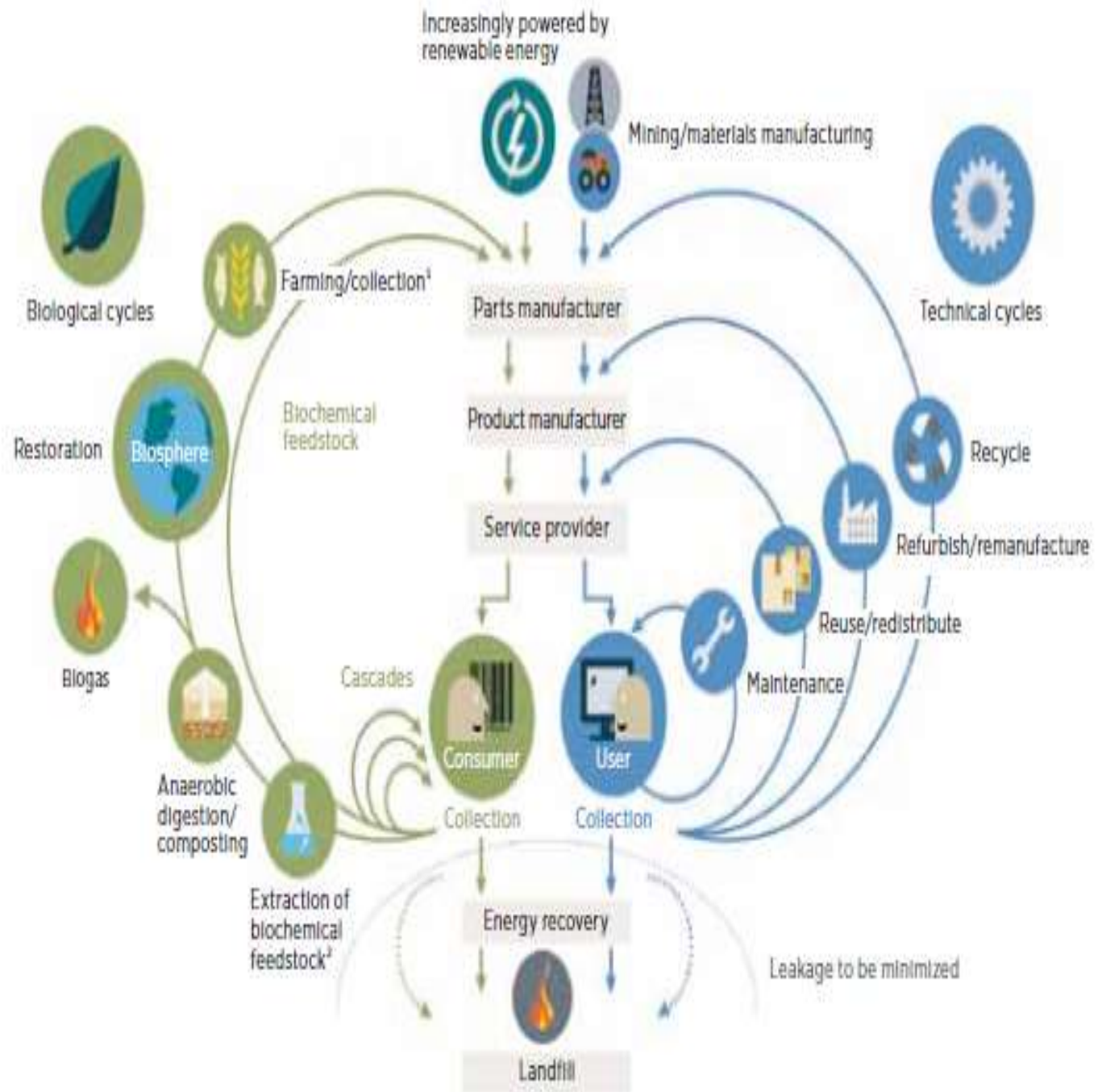
Are we today throwing away
the resources of tomorrow?



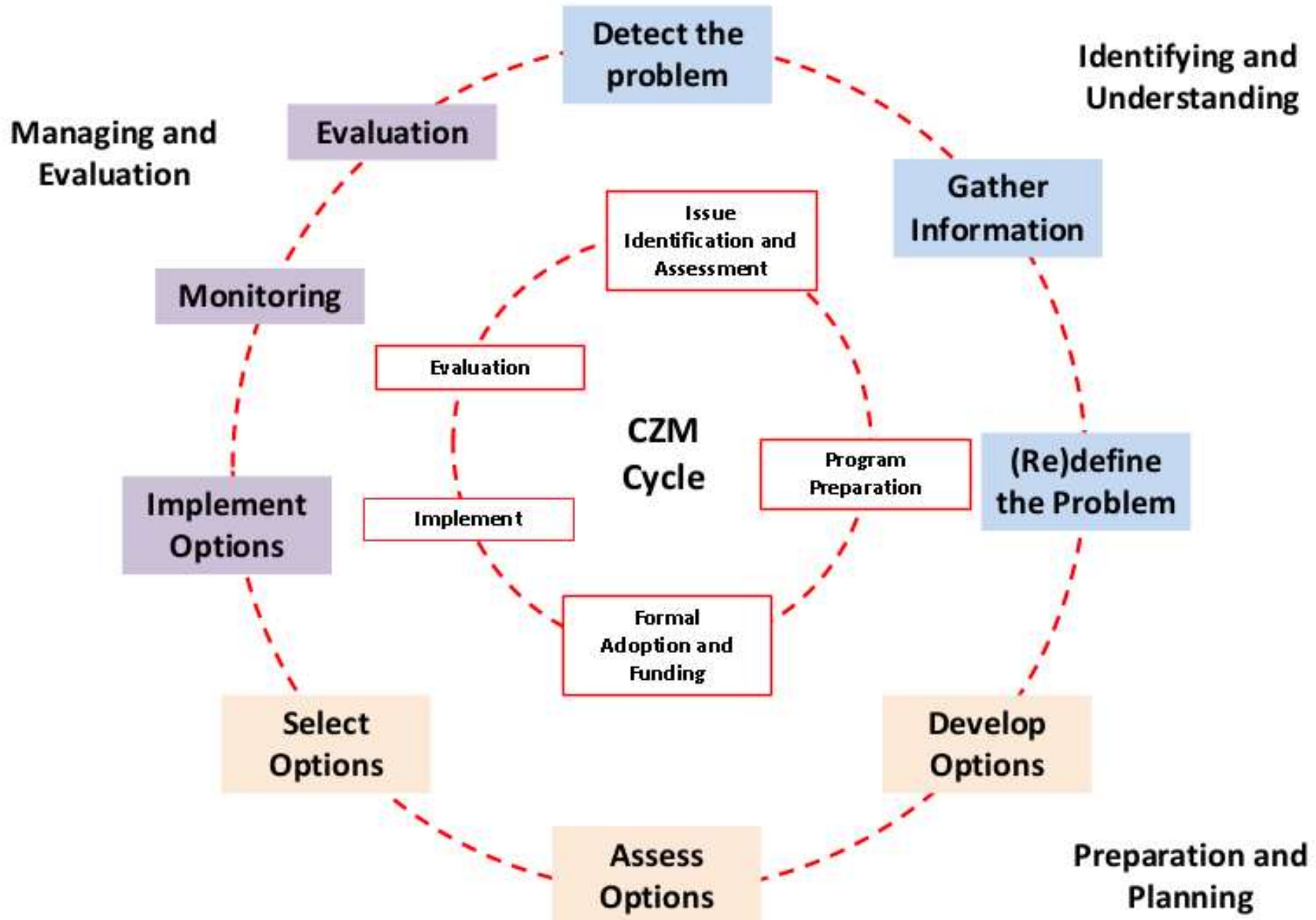
A circular economy is restorative & regenerative by design, and aims to keep products, components, materials at the highest utility & value, distinguishing between technical & biological cycles

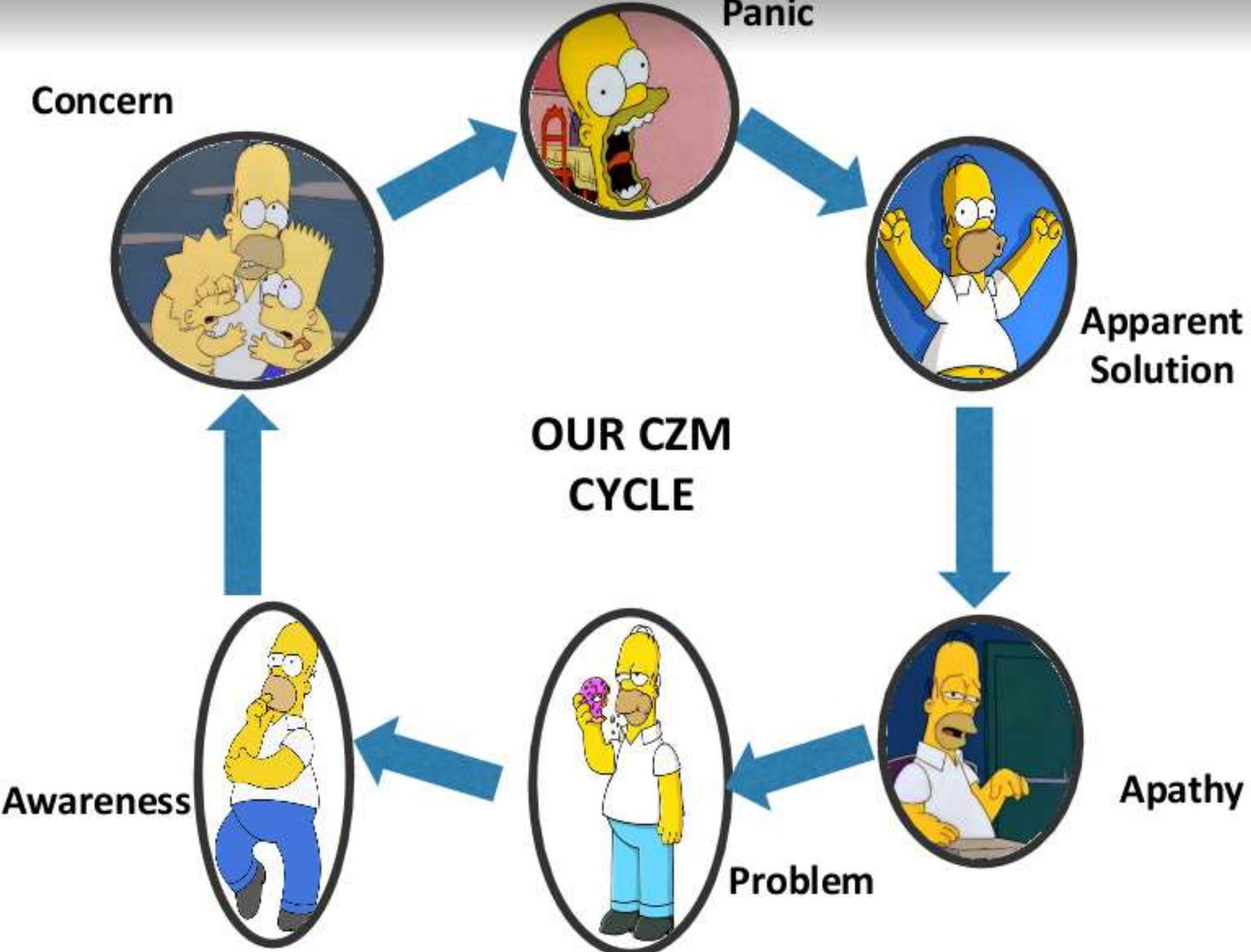


THE CIRCULAR ECONOMY



Considerations for Coastal Management





THREE PILLARS OF THE CIRCULAR ECONOMY

Rethinking products for reuse, refurbish, remanufacture and recycle. Focus not on disposing and buying new; but **on reusing, refurbishing, re-manufacturing and recycling**.

Biomimicry: Humans are relatively new species on the planet - ancestral species in plants, animals, fishes and various microorganisms. By analysing the ancestral species ecosystems - insights in developing our own sustainable future i.e. **learning from nature** and designing systems analogous to natural algorithms.

Selling performance instead of products

Since the industrial revolution, the world economy has been **production oriented and resource intensive**, because tools and analytics to predict the long term repercussions of such an economic system were non-existent/deemed irrelevant.

In the resource rich 18th century, **a linear economic model** (making consumerism mainstream over decades) would have been the norm **but not anymore**. Pressure for higher consumption has been ever increasing with declining GDP growth trends promoting underutilization of value of goods we buy, and all resources embodied in those goods

The average European car is driven 5% of its time. It has a capacity for 5 people, on average it transports 1.5 person/trip.

Parked 92% of the time; sits in congestion for 1% & looking for parking for 1.6% of the time - a massive resource under-utilization.

31% of food produced is lost or wasted - (UNFAO). Fruits and vegetables lose as much as 46% of their edible mass.

Space utilization is not very optimal. With growing global population - need to utilize urban spaces more efficiently. Currently, 60% of an average European office is not utilized even in working hours; 10-15% of building material is wasted during construction.

970,000 'countable' pieces of plastics per sq. km.
and - unknown quantities of >5 mm pieces...

**An increase
of x3 in the
last 10 years**



Yamuna River in New Delhi

15.4% expected growth in bio-plastics 2015-2022

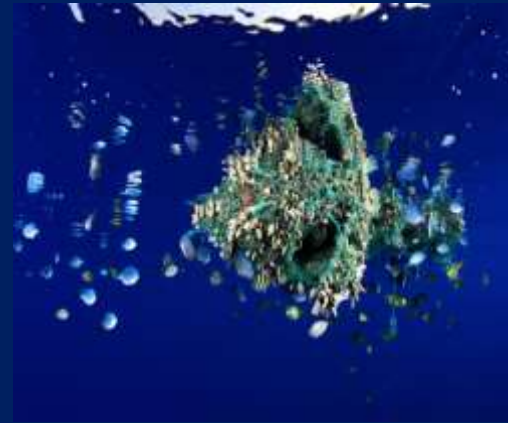
15,800 kilotonnes of plastic used in packaging, 2015.

7,800 kilotonnes was in the Asia-Pacific market.

80% of global share in 2015 = food & drink beverages.

3.3% rise in paper volume from 2015-2022

Source; *Global Flexible Packaging Market report*,
by Grand VIEW research.



BOYAN SLAT <https://www.youtube.com/watch?v=ROW9F-c0klQ>

7.25 million years to clean up Pacific garbage patch. Slat states 5 years! 24 platforms (manta ray shapes). Can obtain & sell plastics found - \$500 m (55 ship containers /day)

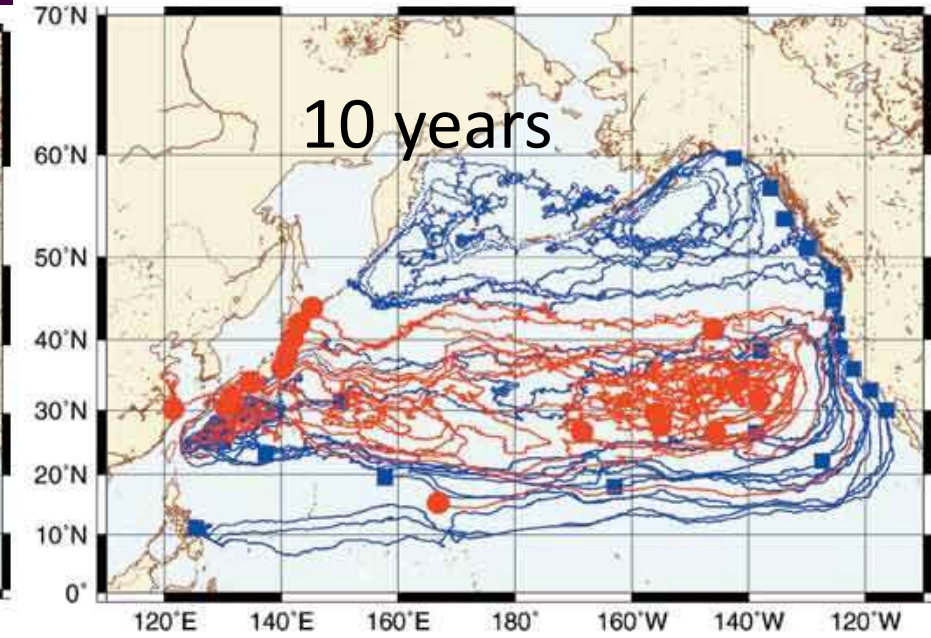
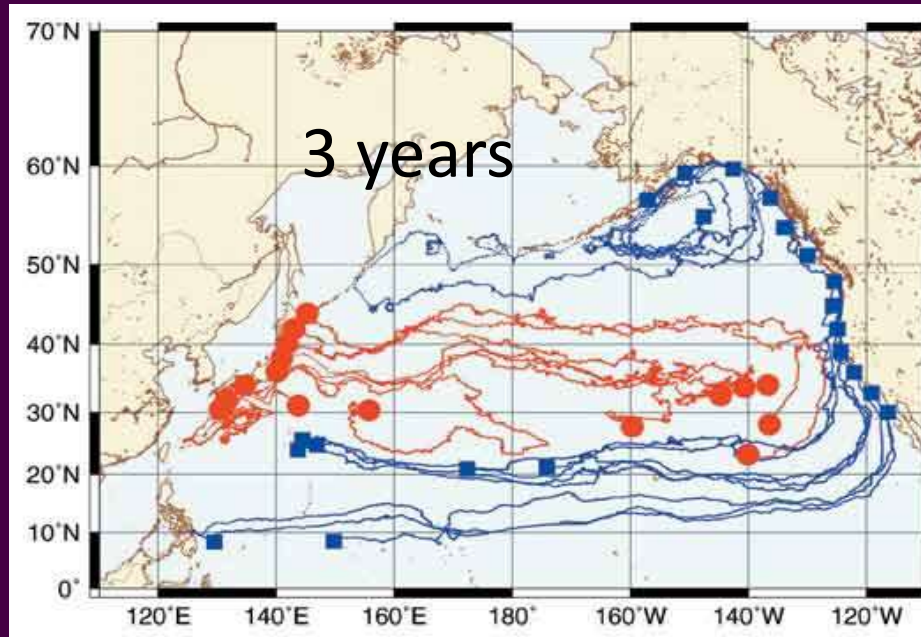
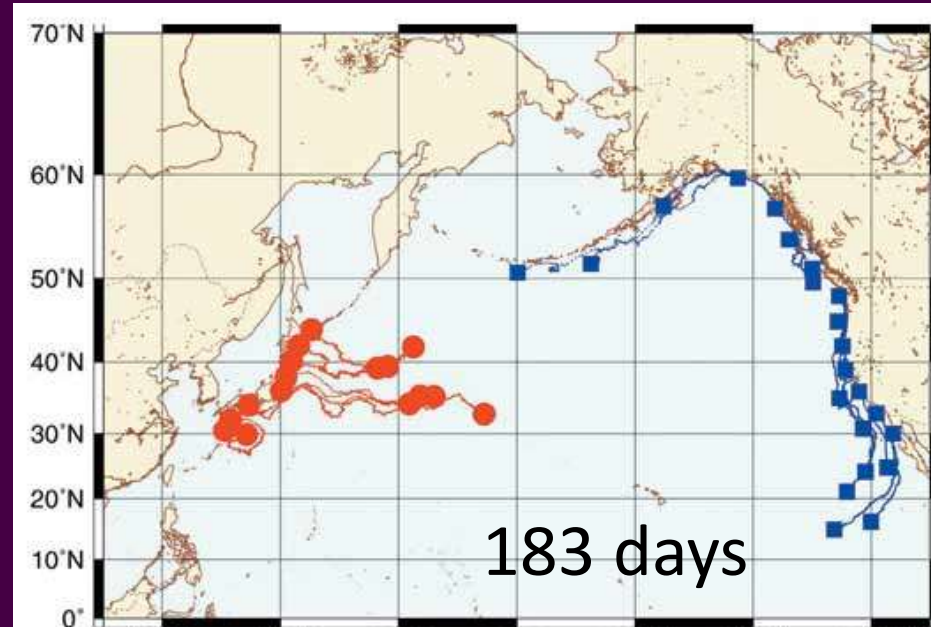
The mid-ocean gyres – huge swirling masses of plastic – turning into **microplastics** and **nanoplastics**



Ocean Surface Current Simulator
(OSCURS) model developed by W.
James Ingraham Jr., an
oceanographer at the National
Oceanic and Atmospheric
Administration (NOAA),

It predicts the trajectory of drift
originating along the coasts of the
North Pacific rim. Drift from Japan is
shown in red; drift from the United
States, in blue.

(<http://www.naturalhistorymag.com>)





MV Evergreen Ever Laurel, owned by Technomar Shipping (Greece), operated by Taiwanese Evergreen Marine Corp.

Left Hong Kong, and on 10. 01 1992 - it happened.

Hurricane winds, 12 containers lost - 28,000 plastic animals 44.7°N 178.1° E. They went north due to El Nino.

A superlative pollutant.





The Sea of Sadness (and Plastics)

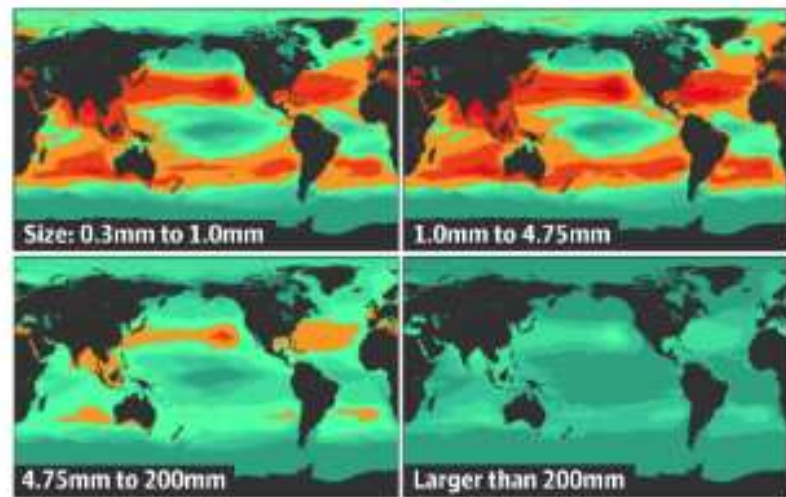


One Hundred Million tons of Plastics in the Mid Pacific Trash Vortex...

Plastic pollution in the oceans

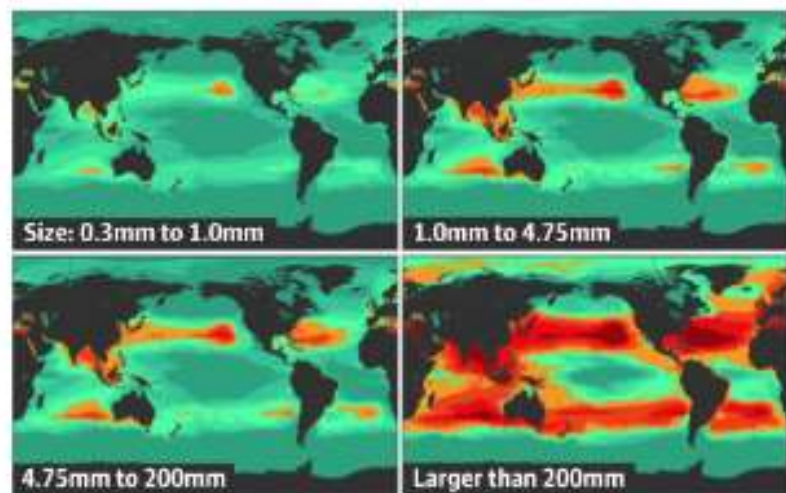
Pieces of plastic debris by size, pieces per square km

1m 100,000 10,000 1,000 100 10 1



Weight of plastic debris by size, grams per square km

10,000 1,000 100 10 1



GUARDIAN GRAPHIC

SOURCE: 5 GYRES/PLOS ONE

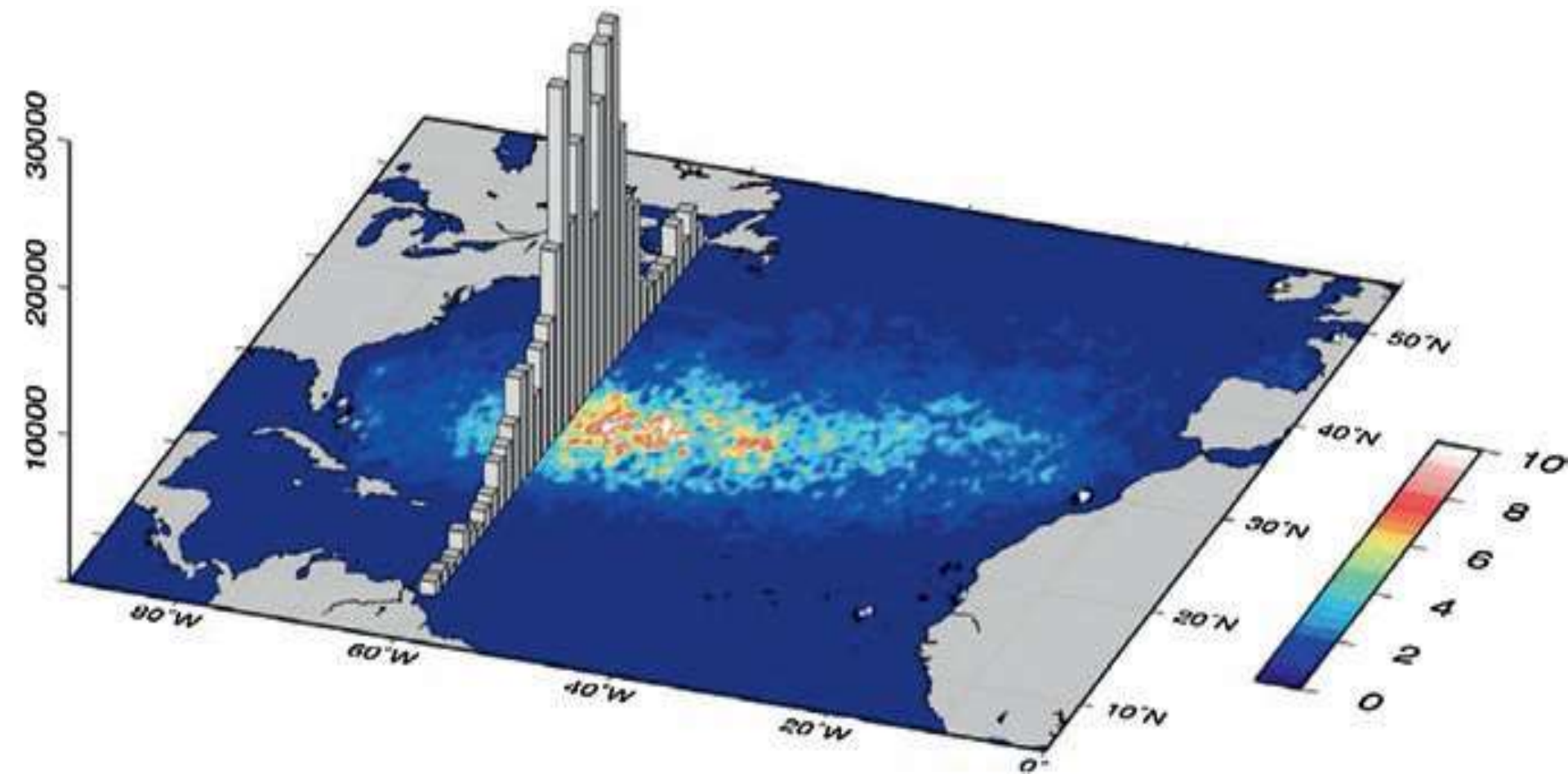
Damage through the food chain (mainly food/drink packaging, bags/nets, cloth).

24 expeditions over a 6 year period to 2013. Research, pub. **PLOS One**, 2014.

Micro-plastic endgame is interaction with entire ocean ecosystems. & not only the 5 ‘subtropical gyres’
They act as ‘shredders’ to the plastic before dispersing it.

100,000 microbeads (non bio-degradable) released in usage of a cosmetic product; 1,600 fibres every garment wash

Put more responsibility on producer - then that would be part of the solution.



Average plastic concentration as a function of latitude (bars, units of pieces km^{-2}), and concentration, C (*color shading*), of initially homogeneous ($C = 1$) surface tracer after 10-year model integration.

Averages and standard errors were computed in one-degree latitude bins. The highest plastic concentrations were observed in subtropical latitudes ($22\text{--}38^\circ\text{N}$) where model tracer concentration is also a maximum. Reproduced from Law et al. (2010) with permission

'Although nature begins with the cause and ends with the experience, we must follow the exact opposite course, namely, begin with experience and by the means of it investigate the cause.'

Have you seen 130,000 blow-up rubber breasts?



It's amazing what you find washed up on beaches these days, so watch out for some plastic breasts

Weird fact of the day

There are about 10,000,000,000,000,000,000 – ten quintillion – insects alive on Earth at any time. In all, they'd weigh about 300 times as much as all us humans put together.



If you've recently found 130,000 inflatable breasts washed up on a beach, a men's magazine would like to hear from you. Australian lads' mag Ralph had planned to give away the comedy breasts with its January issue. But while the container left the docks in Beijing fully loaded two weeks ago, by the time it reached Sydney the mag's £88,000 cargo had mysteriously vanished. Editor

By **Phillips**

Santi Pintado has launched an appeal for information on their whereabouts. 'Unless Somali pirates have stolen them, it's difficult to explain where on Earth they have got to. If anyone finds any washed up on their local beach, please do let us know.' However, it seems that even if a beachcomber does come across

the breasts, it will still be too late for the magazine to include them in its next issue – leaving its readership deflated. In 1992, 30,000 Chinese plastic ducks en route to the US were washed overboard in a ferocious Pacific storm. It led to a 1.5-year 'endless odyssey' as the duck-slick roamed the currents of the world's oceans, before menacing the English coastline last year.



Leonardo da Vinci, Notebooks, (1512).

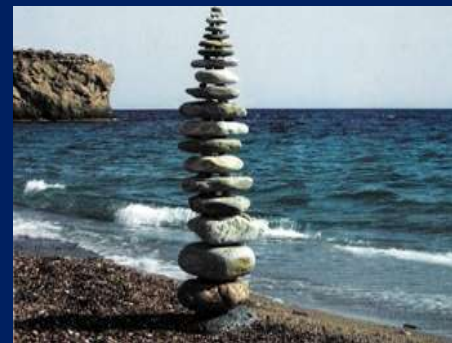
Problems and bottlenecks

Despite international, regional and national efforts, there are indications that marine litter is increasing;

- Lack of scientific data.
- Lack of international legal instruments (except for MARPOL Annex V) or Global Programmes.
- Deficiencies in implementation and existing regulations.
- Lack of awareness among main stakeholders and the general public.



(10 mn trawl, France)





More than 5tn pieces of plastic in the world's oceans, weighing some 269,000 tonnes, 0.1% of annual global plastic production

The tiny fibres were found at depths from 300m down in the Mediterranean to over 3,000m deep, at volumes 1,000 times higher than those at the surface of the sea.



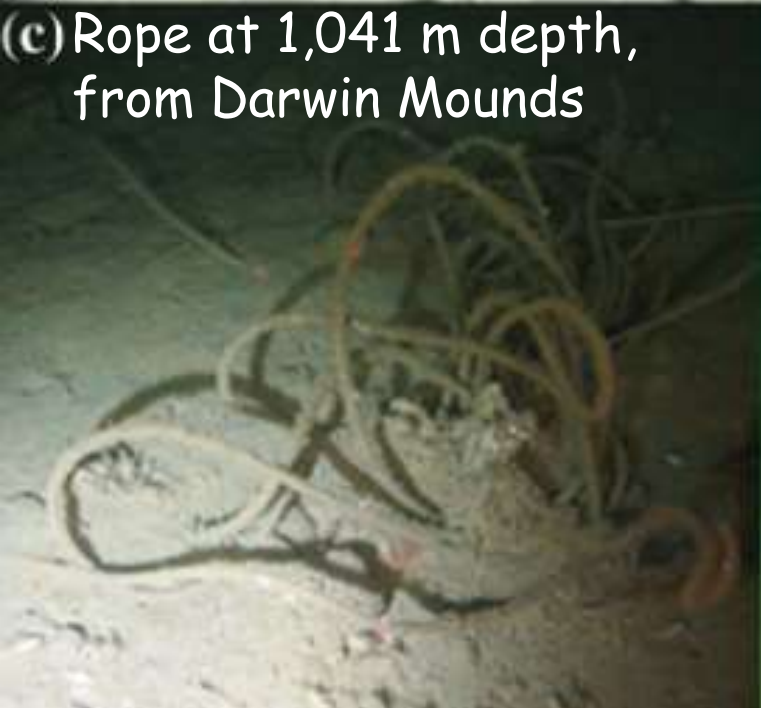
(a) 20 km off the French Mediterranean coast at 1,000 m



(b) Food package entrapped at 1,058 m in deep-water coral colony



(c) Rope at 1,041 m depth, from Darwin Mounds



Waste disposal bin or vacuum cleaner + prawns on seafloor, Mauritania 1,312 m depth

(e) Plastic carrier bag at ~2,500 m depth



Crab entangled in derelict net



(a)



(b)

Fishing net wrapped around coral,
NW Hawaiian Islands



(c)

Plastic fragment
entangled
in trawled sponge



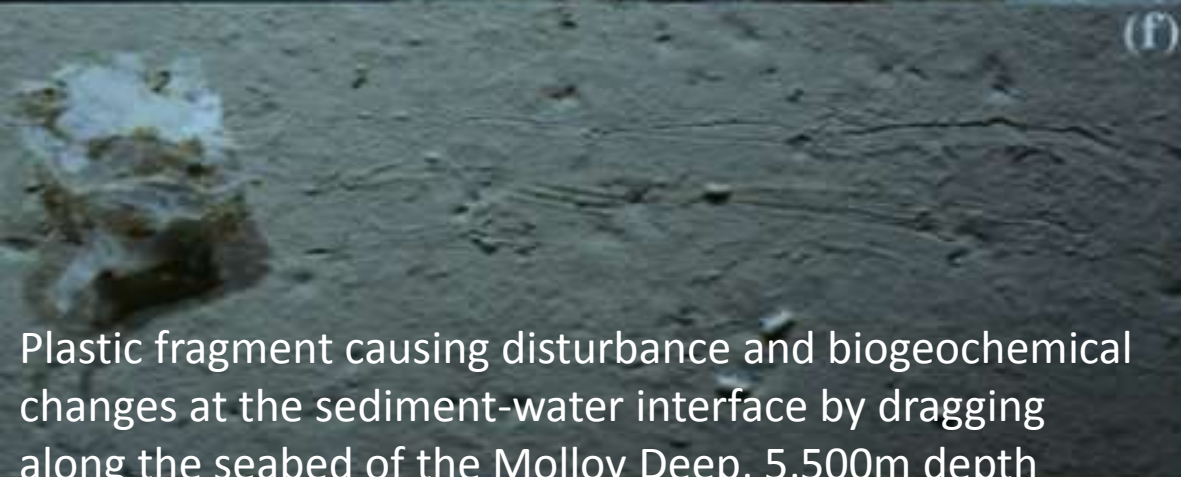
(d)

Rubbish bag wrapped around deep-sea
gorgonian at 2,115 m depth in Astoria Canyon



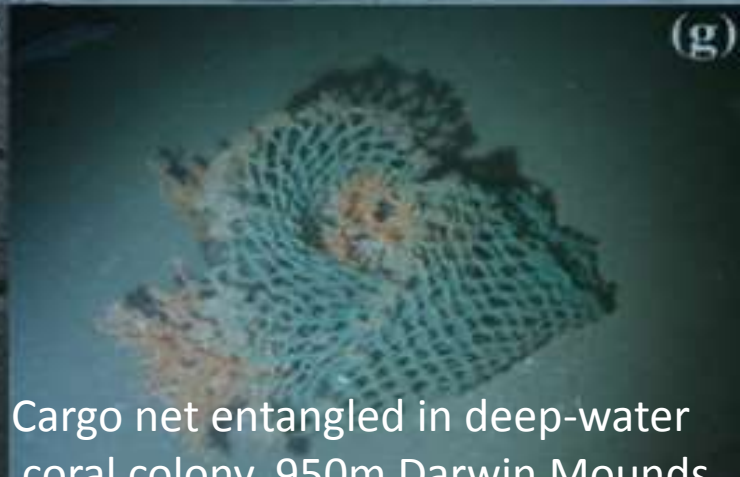
(e)

Mediterranean soft-sediment habitat at
450 m depth smothered with plastic litter



(f)

Plastic fragment causing disturbance and biogeochemical
changes at the sediment-water interface by dragging
along the seabed of the Molloy Deep, 5,500m depth



(g)

Cargo net entangled in deep-water
coral colony, 950m Darwin Mounds



Effects:

A threat to marine life and human health



Impact:

Economic losses to fishermen, coastal communities, tourism, boat owners, power stations, navy, etc.

Social impact on communities and tourism
Environmental impact on life and biodiversity





**This is
also
'costs'...**

Abandoned and Lost Fishing Gear

- It is a **trans-boundary** issue causing political conflicts and tension.
- **Concern** derelict fishing gear (ghost nets).
- In Asia-Pacific derelict fishing gear represents **the greatest proportion** of litter major concern to communities.
- In many regions, abandoned fishing nets have caused **loss of life** through damage to vessels at sea.





Cleanup of lost fishing gear – south west Japan

MARINE LITTER

A multi-sectoral problem

A trans-boundary **problem**



Platform for invasive species

- ML is probably the most 'exposed' environmental problem to the public & millions of people who are economically affected.
- No other marine pollution phenomena mobilizes such public participation and readiness to act.



Large volumes of plastic litter drifts onto coasts and remote islands on the west of Japan



Household articles



Fishing nets and ropes



Styrofoam Floats



Plastic container

- **UK** – \$3.9M to clean 900 km; collected 10,000 tons; Extrapolate for Europe...
- **California** – \$350,000 for 6 miles...
- **Shetland** – each fishing boat loss – \$16,000 to \$50,000 per year.
- **Sweden** – a small fishing community loss over \$1M p/y.
- **USA** – insurance companies: over \$50M claims from fishermen due to ML.
- **UK** – >200 rescues at sea because of fouled propellers - >\$1.6M p/y.

Neuston catamaran, manta trawl net few studies used mesh sizes $< 300\ \mu\text{m}$ Nets are usually 3-4.5 m long and a mesh size of around $300\ \mu\text{m}$.



100m floating dam to trap litter
Ocean Cleanup, postulated in
late 2016 off Dutch Coast.

By 2020- 62 mile V shaped barrier
in the Great Pacific garbage patch



BEACH LITTER

What do beach users want from a beach?

Water Quality

Safety

Facilities

Scenery

No litter.

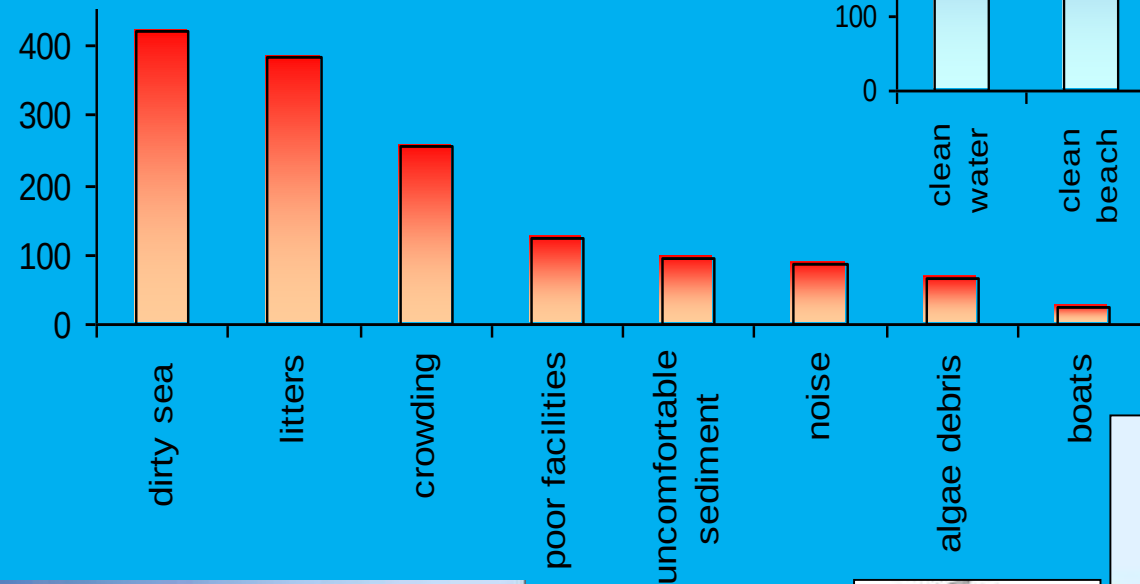
Nb. At Tuvalu (South Pacific) 4k people live on 2.4 sq.km generating 20k cubic metres/ year of litter.

Kiribati's is the capital of South Tarawa (40k people on a string of islets some 30km long). Generates 6,500 tonnes of waste /year, It has 3 landfill sites only, 1 with a sea wall, so waste is swept away. **Density > Tokyo.**

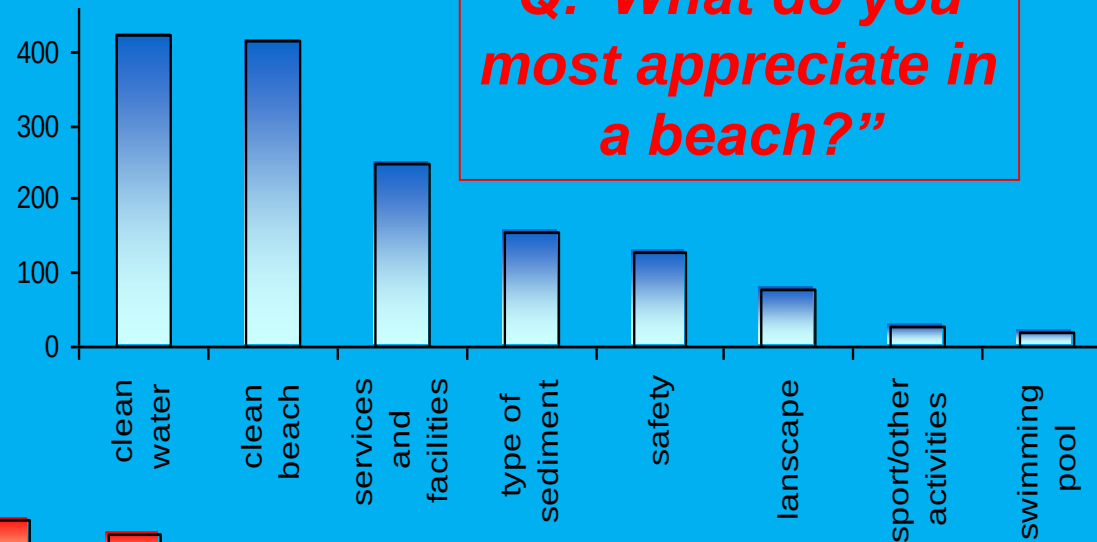


RESULTS: USERS' PREFERENCES

Q: "What annoys you most on a beach?"



Q: "What do you most appreciate in a beach?"



THE SOCRATES DIALOGUE



Gnosis

'Why is it so difficult to go from planning to implementation?'

van der Meulen, 2001

We are still battling to produce practical results'

van der Meulen, 2005

Action

Judgement





The position of marine litter ?????

Beachwatch - 400 beaches >5k volunteers.
Euros 18m/year to clean up UK litter from
beaches.
E7-11 billion is what coastal tourism brings in.
Lost earnings by Scot fishermen by net
contamination is E11-13m /yr,
41% visitors; 15% fishing; 5% SRD; 2% shipping.



SOURCES

Commercial recreational fisheries and aquaculture.

Vessels – e.g. cargo, military, research, passenger & pleasure crafts.

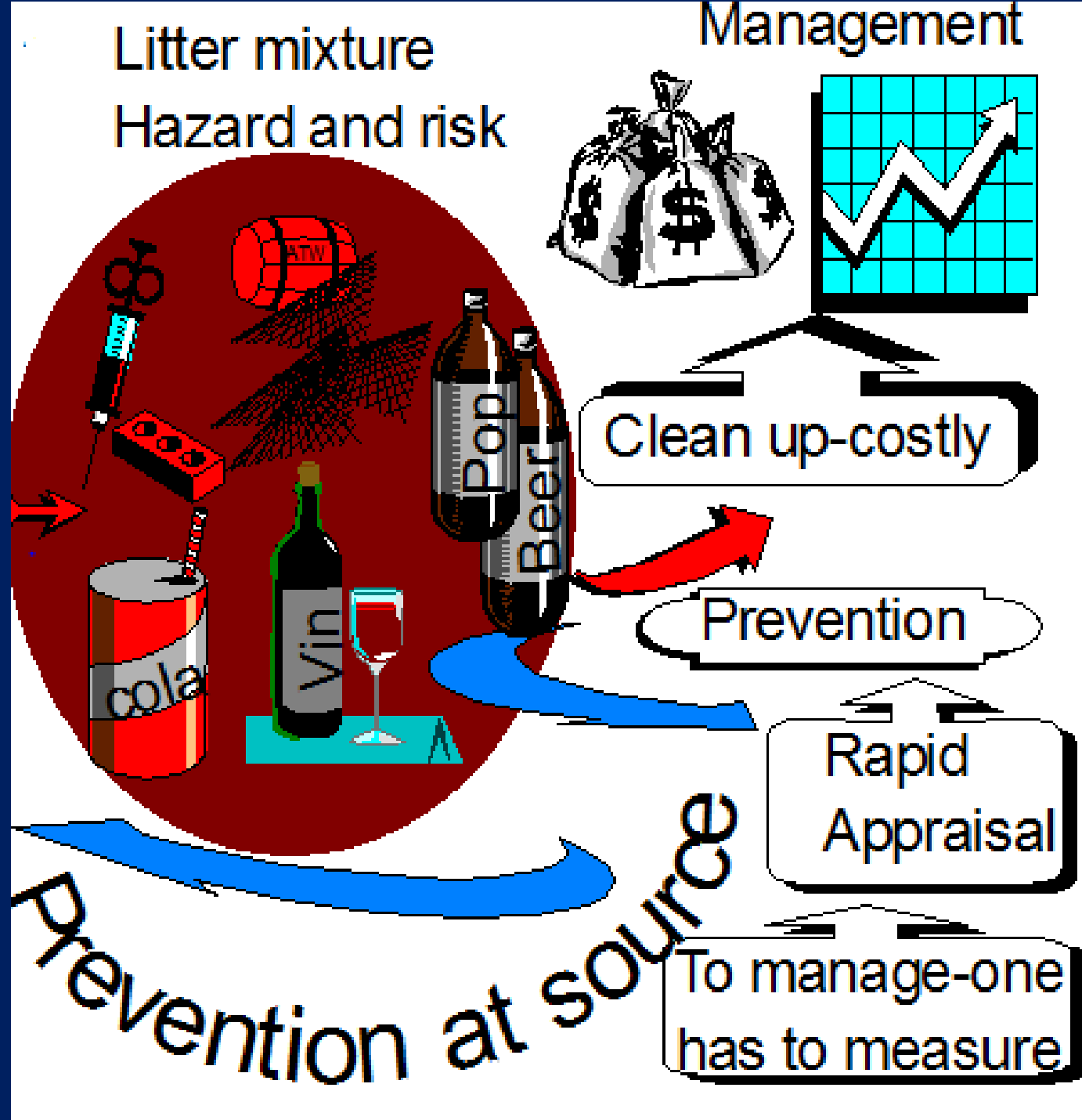
Stormwater & urban run-off.

Wind - blown from land.

Riverine inputs.

Beach users, + deliberate illegal dumping.

Offshore oil rigs.



- 91% of local councils employ a dog warden
- 86% run anti-fouling campaigns.
- 50% of councils issued 5,500 verbal warnings, handed out 2,400 fixed penalties, 600 people to court

- Men are more reluctant than females to pick poo up.
- Residents of social housing are more likely to leave it.
- If you see someone else's, you are less likely to pick your own dogs up.
- You are unlikely to get caught - esp. at night!

Toxicara canis Faeces of an infected animal - can remain dormant in soil for 3 years.

North East: 30% households have dog(s);
South west: 29% ;
South east: 17%;
London: 7%.



10 million viruses & 1 million bacteria in 1 gram of faeces. one million eggs, can become infectious some 2-3 week after deposition.

The beach where your little Fido is allowed to enter, play free and bathe



← **The problem**
The Dogs (Fouling of Land) Act, 1996

Sampling size unit - function of aims.



- Beach survey from water's edge to splash zone (Dubsky, 1995).
- Varying width transects to find the optimum.
- Transect line quadrats (Dixon and Hawksley, 1980).
- Strand line counts (Williams and Simmons, 1997).
- Postal surveys (Dixon, 1992)
- Offshore water column.
(Williams et al, 1993)
- Number of plastic bin bags/
trucks etc.
- NALG 2000.

	Survey	5m	15m	25m	50m
➤ 1		29%	61	65	84
➤ 2		28	62	75	81
➤ 3		28	51	62	80
➤ 4		53	65	74	82
➤ 5		33	61	66	75
➤ 6		46	76	62	92

% litter in different sized transects

Categories for Grading a Beach:

	Category	Type	A	B	C	D
1	Sewage Related Debris	General	0	1-5	6-14	>15
		Cotton Buds	0-9	10-49	50-99	>100
2	Gross Litter		0	1-5	6-14	>15
3	General Litter		0-49	50-499	500-999	>1000
4	Harmful Litter	Broken Glass	0	1-5	6-24	>25
		Other	0	1-4	5-9	>10
5	Accumulations	Number	0	1-4	5-9	>10
6	Oil		Absent	Trace	Noticeable	Objectionable
7	Faeces		0	1-5	6-24	>25

A:

B:

C:

D:

FACTORS IN SOURCING

- Identification
- Function
- Quantity
- Association



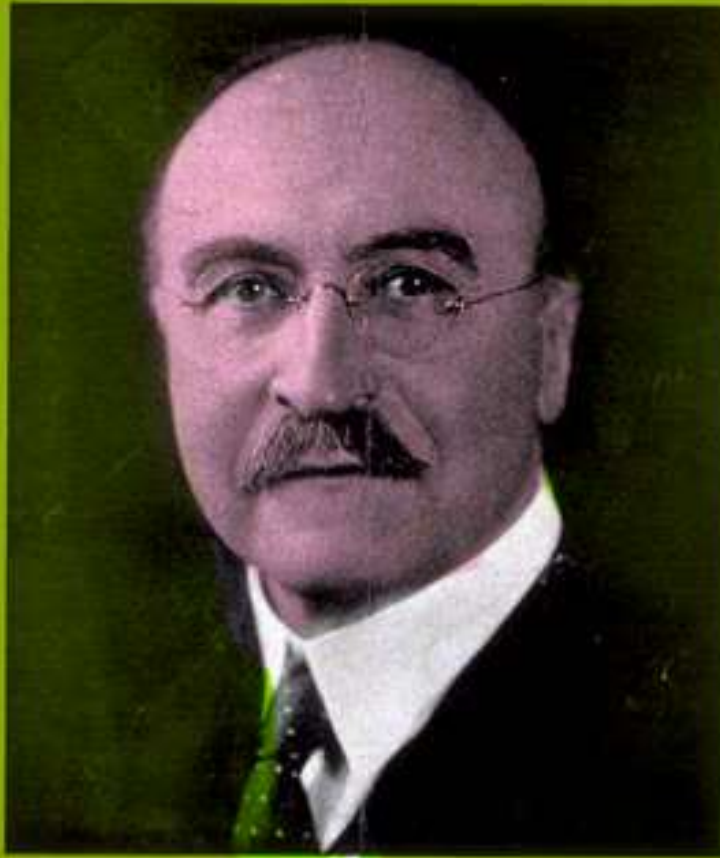


Rising landfill tax.
Local authorities charge for
collection of bulk waste.

More goods e.g. refrigerators,
TV sets, computers defined as
'special or hazardous waste.'

TIME

The Weekly News Magazine



VOL. IV NO. 12

DR. LEO H. BAEKELAND
"He said 'no' to nature. He said 'no' to death."
(See Page 20)

SEPTEMBER 22, 1924

Plastic primer: Invention

- Plastic celebrated its 100th birthday in 2007.
- Invented in 1907 Leo Baekeland: **Bakelite**. It was a mixture of formaldehyde and phenol. And the first purely synthetic material.



HISTORY OF PLASTIC



COST OF PLASTIC WASTE



COST OF MARINE LITTER

Marine litter costs us approximately \$8 billion per year
This is in the form of costs for fisheries, aquaculture, marine tourism and cleanups



Annual loss in tourism
of **\$622 million**



European Union fishing fleet
loses **\$81.7 million per year**

35 million plastic bottles/day used in UK. 16m recycled ([www. Recycle Now](http://www.RecycleNow.org))
Estimate is that by 2020 it will be 29m.
Average household uses 480 bottles/year, recycles only 270, the rest ends up in landfill sites

WANTED
FOR RECYCLING

**THE
UNUSUAL SUSPECTS**



MERMAID'S TEARS :

PLASTIC RESIN PELLETS AND THEIR THREAT TO THE OCEAN AND COASTAL ENVIORNMENT



Estimates :there are 100,000 particles of plastic per sq. km of seabed and 300,000 items of plastic per sq. km of sea surface



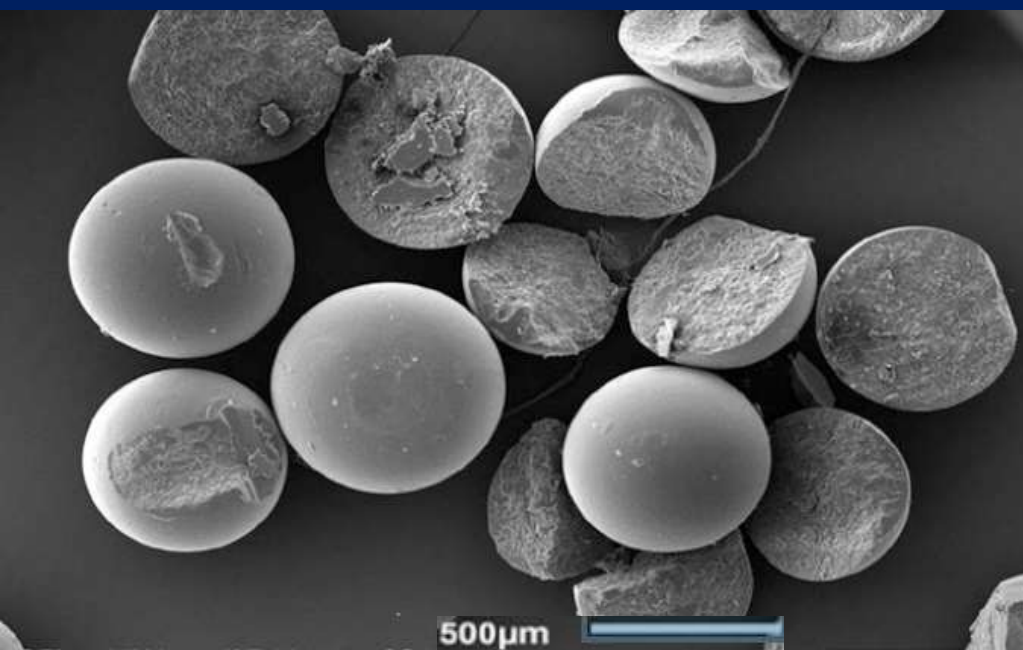
What are plastic resin pellets?

The USA intends
banning usage of
micro-beads in 2017
for cosmetic
products,



(bar is 1000 μ m)

Unilever, L'Oreal
phasing them out
2017,



It is estimated that in the **US** alone around **100 tons** of micro-plastics might enter the oceans annually (Gouin et al. 2011). In addition to the direct release of primary micro-plastics, **larger items** of plastic debris will progressively **become brittle** under the action of **ultraviolet light and heat** and then **fragment** with physical action from wind and waves (Andrady 2015). Hence large items of debris are likely to represent **a considerable source** of micro-plastics.

Prevalence: some numbers

- Ubiquitous on shores, in oceans, and on water surfaces across the globe (Mato et al. 2001).
- By mass 60-80% of marine litter is plastic (Derraik, 2002).
- 300,000 items of plastic per square kilometre of sea surface, and 100,000 per square kilometre of seabed (Thompson, 2006)
- 280 m tonnes production now.
- World plastic resin pellet consumption is expected to rise from the 2006 figure of £451.9 billion pounds to £562.2 billion in 2010.



Toxicity

(pure plastic -- relatively low toxicity;

insoluble in water and relatively chemically inert)

(1) Additive derived pollutants

- Plastic polymers contain additives to give the plastic marketable qualities.
- These additives are able to leach out of the polymer matrix into the environment. (Browne et al. 2007)

Examples:

- DEHP (di-2-ethylhexyl phthalate) a phthalate "plasticizers" used in PVC.
- PBDE (polybrominated diphenyl ethers) used in flame retardants.

(2) Monomer release

- Certain polymers have been shown to release toxic monomers linked to cancer and reproductive abnormalities in humans, rodents and invertebrates.

Examples:

- PVC, polystyrene, and polycarbonate



Degradation

1. Photolytic
2. Mechanical
3. Biological
 - Microplastics (less than 1mm in diameter)
 - The smaller the particle, the more potential for ingestion by organisms further down the food chain.
 - Shown to be ingested by amphipods, barnacles, and lugworms (Thompson et al. 2004)
 - They have greater surface area to volume ratio and therefore have greater potential to transport contaminants.

OK,
so what can be
done?



There is a solution for every problem...
BUT, some solutions are better than others!



We have to remember...

Marine litter is **not** an environmental problem that can be solved ONLY by means of legislation, law enforcement, beach cleaning campaigns and technical solutions.

Marine litter is also a **cultural problem**. Efforts to **change attitudes, behaviour, management approaches, education & involvement** of all sectors and interests, need to be undertaken.

- **Reduce** plastic input and change to **degradable plastics**
- **Regional Cooperation - and - with Fisheries**
- **Continue to clean the beaches**
- **Use Economic Instruments**
- **EDUCATION in ALL sectors**
- **Methodology**





Costs – millions spent on –

Vessels Rescue

**Damage to
vessels**

**Fisheries
damage**

**Beach and
urban waste
cleanups**

**Aesthetics and
tourism**

Seabed marine litter removal, Korea

Market Based Instrument	Explanation
Effluent charges	Payment of fees to pollute
Fines (law enforcement)	For littering
Deposits-refund systems	Repay deposits for items returned (fishing nets)
User and administrative charges	Product disposal and municipal charges
Auction or tender	Of a right to create pollution
Tax incentives/differentiation	Tax rebates for collection or litter prevention
Sales taxes	Plastic bags / On specific items to restrict use or inputs
Tradable permits systems	Right to trade with pollution outputs
Port reception facilities	Low or no cost to encourage disposal
Tourist taxes	‘Voluntary’ by tourists but imposed by authorities
Award based incentives	To encourage local communities

Type of Damage	Estimated Cost / year
Fishing – Japan - damage to fishing boats	6.6 Billion Yen
USA - Loss of fisheries production – ‘ghost nets’	\$250M in lobsters only
Canada - Loss of fishing gear and down time	\$10M only for retrieval
Leisure boats – USA - propeller's entanglement	\$792M
Human injury and fatality & search and rescue - UK	\$440,000
Shipping – Korea – Vessel loss	292 lives
Damage to cooling systems - UK	\$1.1M
Coastline tourism	\$28M
UK – loss of amenity and aesthetics to beaches	
Wildlife and marine ecosystems –	
Worldwide – assessment of ecosystem services	Unknown but estimated to be huge

AND THIS IS ONLY A FRACTION OF WHAT IS HAPPENNING GLOBALLY

➤ Apart from a few organisations - National Aquatic Litter Group (NALG), MCS, KIMO, Ocean Conservancy, there seems **little co-ordination** of effort to tackle marine litter. **WHAT WE KNOW**

- **Legislation** alone appears to be **ineffective** in reducing litter.
- Despite a lack of research into the subject, much evidence that the **economic impact** of marine litter to the UK **is significant**..
- Large volumes of litter can accumulate in shoreline and seabed sinks & estimates that **80% originates from land based sources**.
- A significant amount of **litter items** on our shores are **small** < 30cm).
- **50-90%** of beach litter comprises **plastics**, persists sea for a long time.
- **Much SRD** still originates from combined sewer overflows (**CSOs**). Huge negative impact on public perception of water quality & fitness for bathing
- Litter has led to many **volunteer-based survey** and clean-up schemes. A cost-effective means of gathering data.



*'We cannot think of a time that is oceanless
or an ocean not littered with waste'*
TS Eliot

WHAT WE DO NOT KNOW/ HAVE

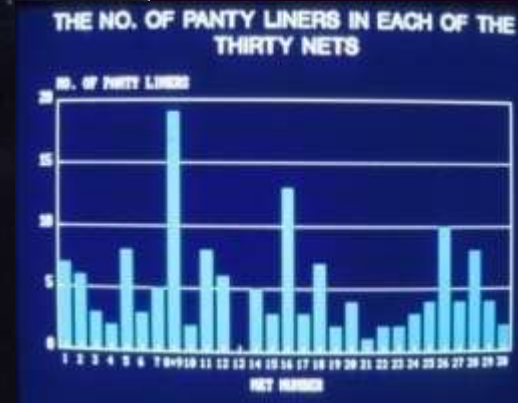
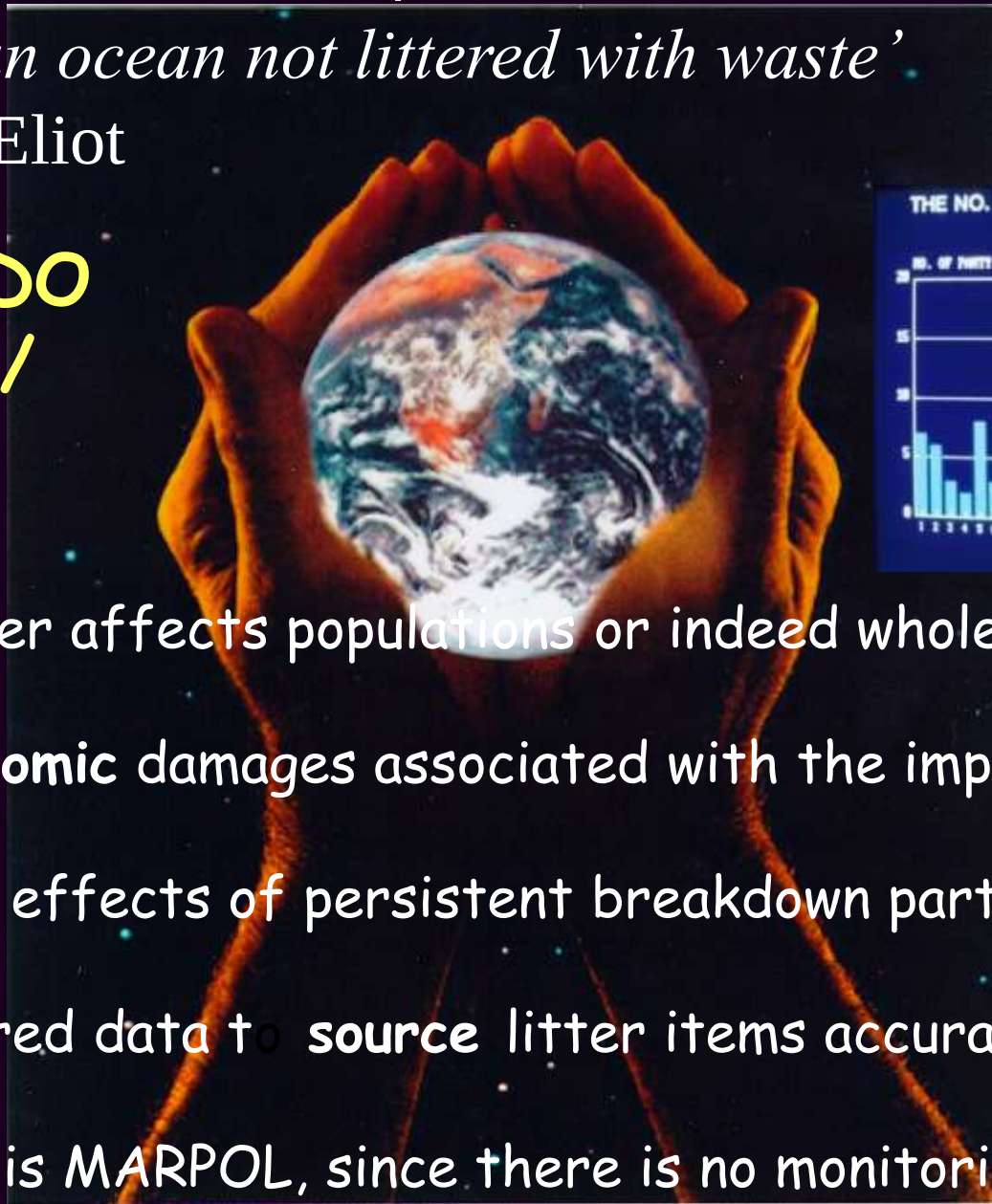
How marine litter affects populations or indeed whole **ecosystems**.

Assessing **economic** damages associated with the impact of litter.

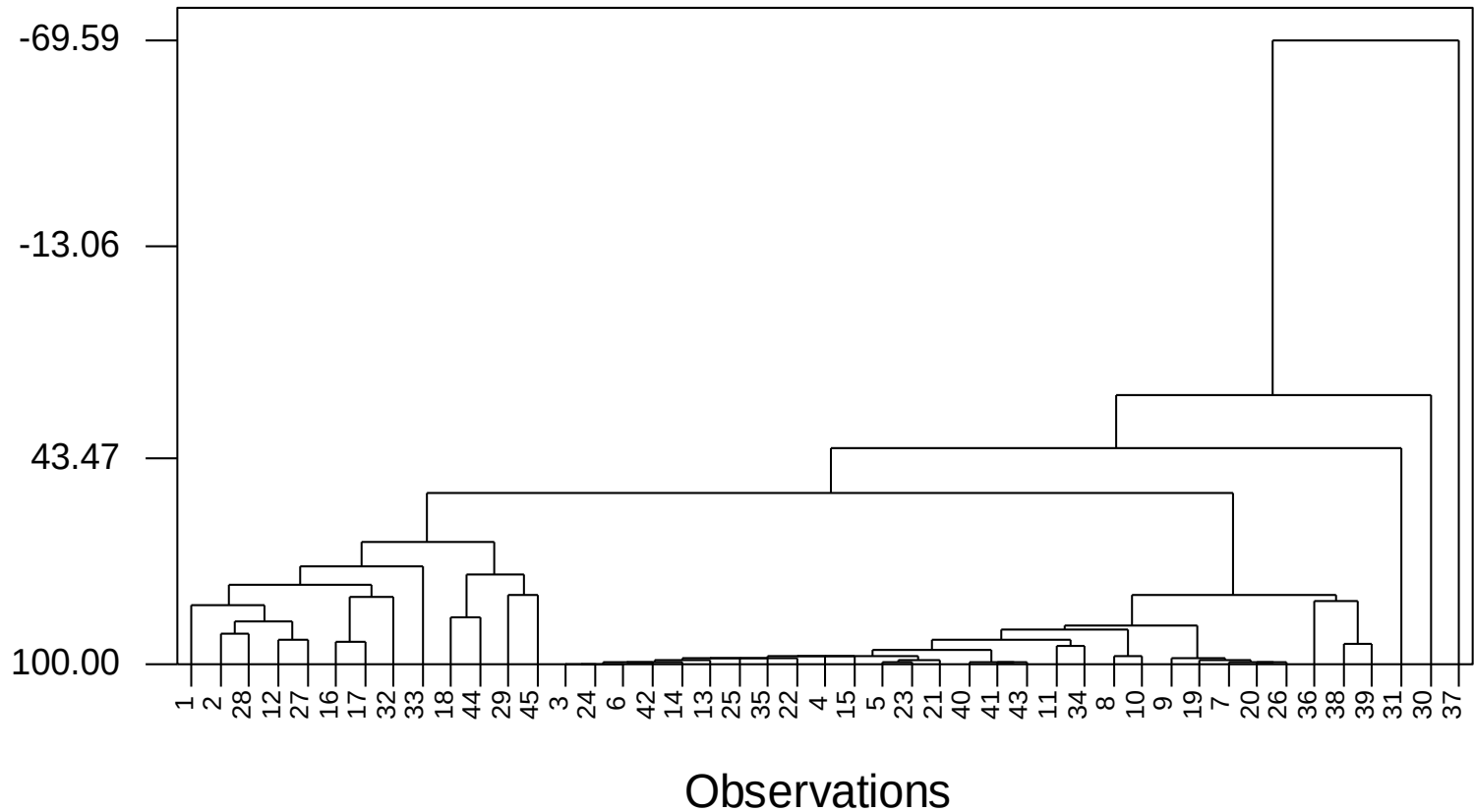
The **long-term** effects of persistent breakdown particles.

Enough monitored data to **source** litter items accurately.

How **effective** is MARPOL, since there is no monitoring system to measure any effects of legislation.



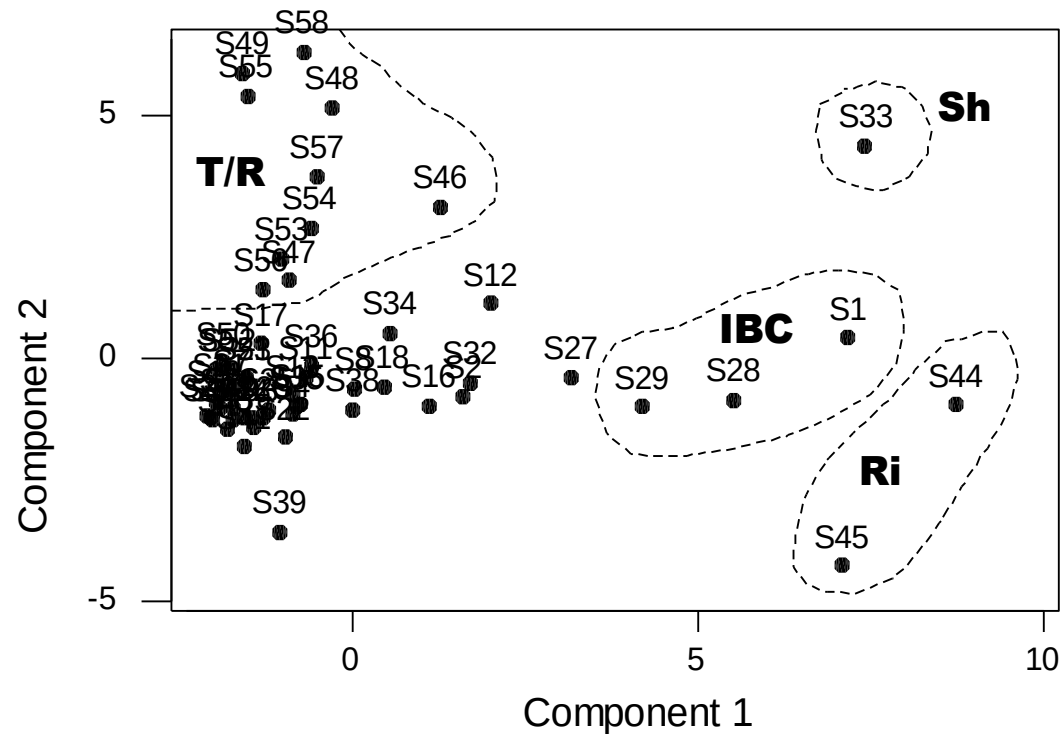
Similarity



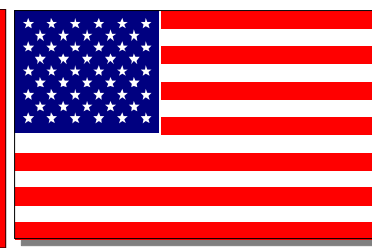
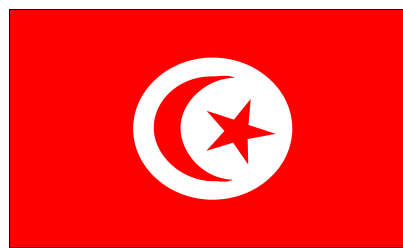
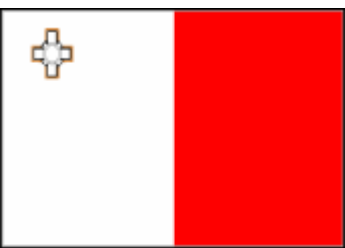
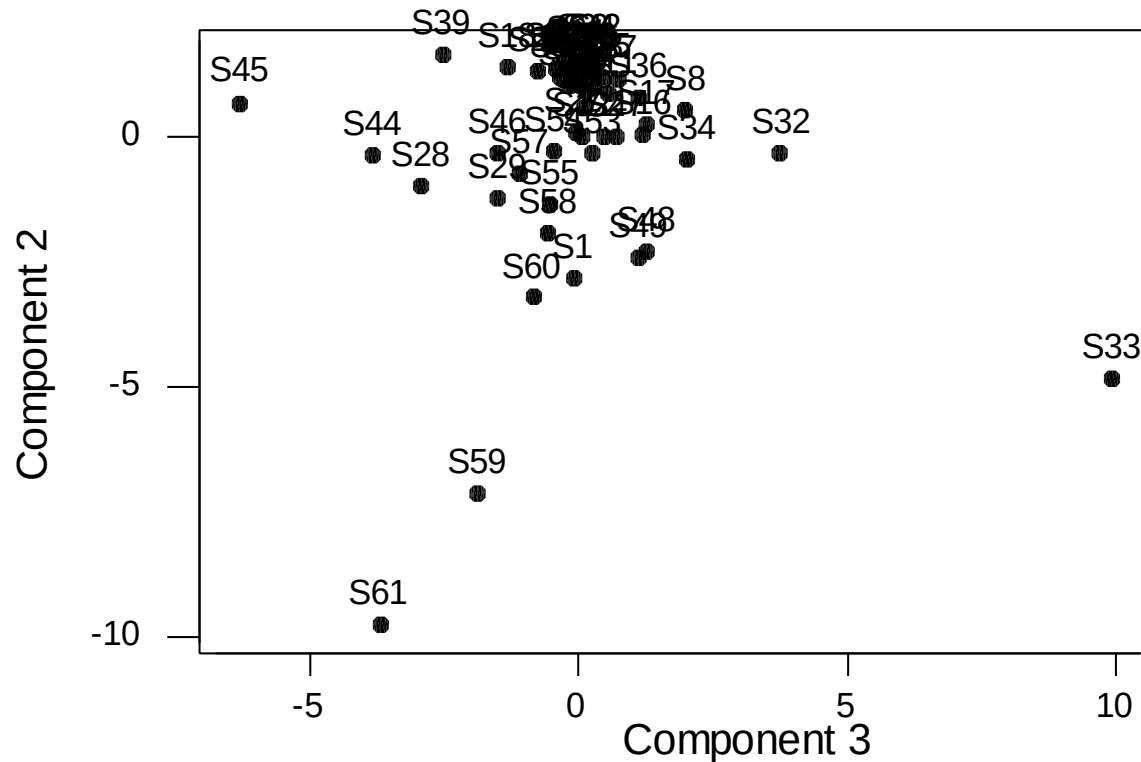
**Cluster Analysis - Specific Litter classification categories
(standardised variables)**



Figure 2a. Principal Component Analysis of Beach Survey Sites (excluding three UK outliers) using Specific Litter Item Classification. Principal Components 1 and 2 (standardised data). Key: T/R= Turkish/Roadside survey; IBC= Inner Bristol Channel; Ri= River source litter; Sh= Shipping source.



Principal Component Analysis (2&3 standardised data), of UK (excluding three UK outliers) and Turkish litter Items using Specific Litter Item Classification. Malta, Spain, Tunisia and USA beaches added.



Beachwatch - 400 beaches >5k volunteers.

Euros 18m/year to clean up UK litter from beaches.

E7-11 billion is what coastal tourism brings in.

Lost earnings by Scot fishermen by net contamination is E11-13m /yr,

41% visitors; 15% fishing; 5% SRD; 2% shipping.

Better enforcement of existing laws.

Re design of goods: Recycling, single use packaging.

Infra structure recycling, port facilities, CSOs, onboard facilities.

Education: industry, public, seafarers.

Marine Strategy Framework Directive -high level directive requiring member states to achieve Good Environmental Status by 2020.

What does it mean?

No agreement. Litter is a trans boundary issue; what is the extent of damage to *All*, plus harm due to microscopic plastic? Harm is social, economic and ecological.

No single authority.



RECOMMENDATIONS FOR FURTHER ACTION



- This requires action on a number of fronts and in particular ordination of existing activities in order to enhance their effectiveness. It can be done e.g. drink driving campaigns changed people's behaviour
- What **co-ordinating mechanisms** are needed to fulfill the aim of reducing litter input and impact, e.g., expand public/private partnership to monitor /reduce debris; community efforts, appoint a Lead Agency & 'General'.
- The promotion of **communication & education** to stimulate a more proactive approach to litter prevention and minimization through collaboration between various stakeholders, e.g. reduce, reuse, recycle.
- **Research** into the **economic and ecological** impacts of & effectiveness of current measures for its control; new technology risk assessment tools e.g. ERA, and contingency valuation techniques - wtp.,
- More studies on the **chemistry** to the many varieties of polymers when they enter the marine environment /digestive systems of organisms.

- ✓ Prevention and control of litter.
- ✓ Public awareness.
- ✓ Participation.
- ✓ Education and Enforcement.

URGENT





- Work in partnership with residents associations, the business, and voluntary sectors, to play their part in litter prevention.
- Heighten awareness of public responsibilities towards litter and littering.
- Avoid the creation of litter through own beach activities.
- Develop a complete education awareness programme with particular emphasis on schools, focusing on litter prevention measures and waste reduction.



- Implementation of a Beach Monitoring System.
- Carry out effective patrols aimed at identifying areas with litter problems and deterring further littering.
- Strong enforcement of all laws relating to litter.
- Promote better approaches to cleaning and collection of beach litter.

FOCUS ON....

- ✓ Detection of major beach litter hot spots.
- ✓ Comprehension of the underlying processes involved in the litter transport.
- ✓ Facilitate community involvement on beach litter issues and related problems to beach uses.
- ✓ Evaluate and determine the optimal options for beach litter control and management taking into account viewpoints of all stakeholders.



REFORM ON....

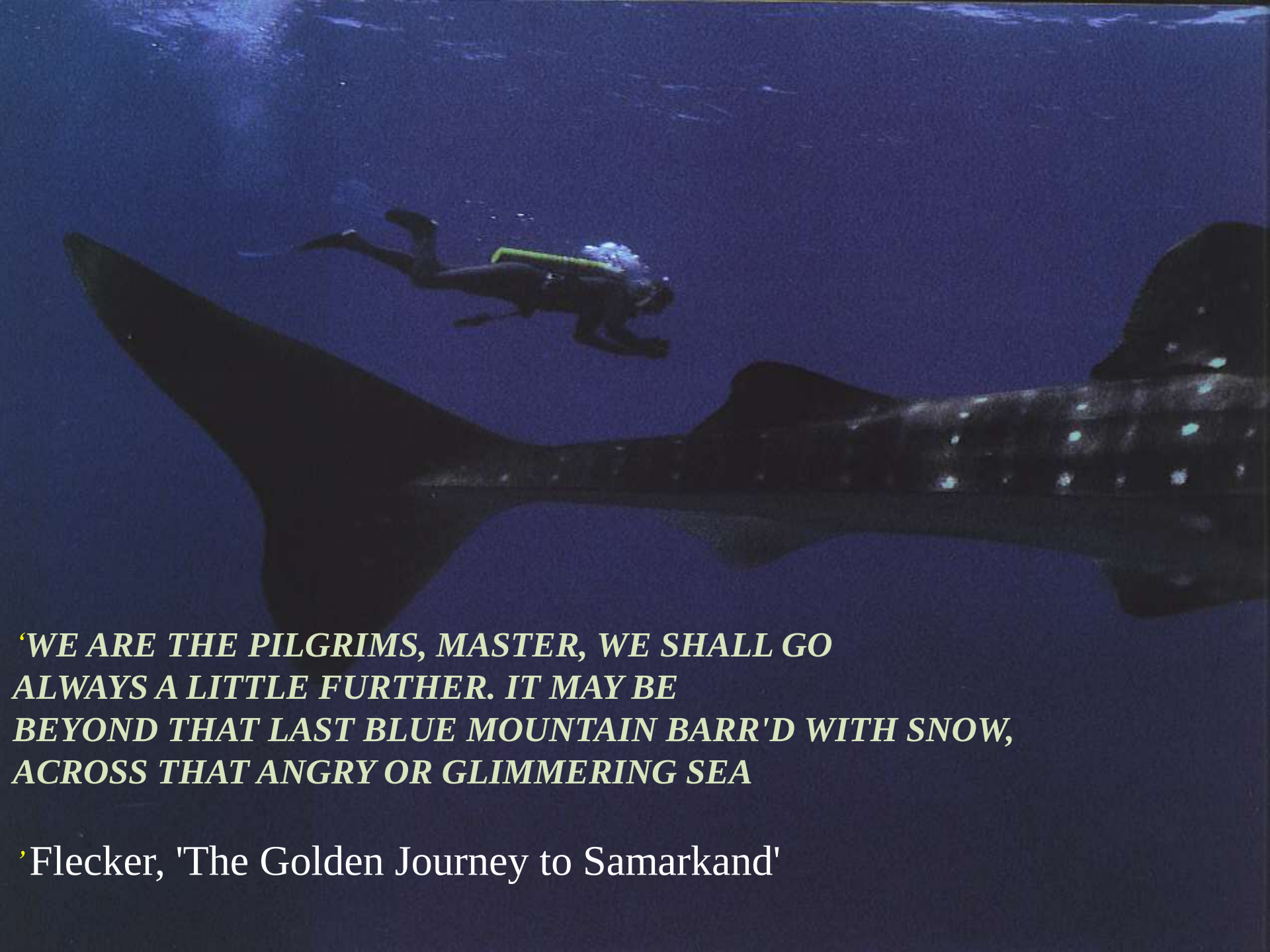
- ✓ Refresh the current legislation with strong coastal management laws, which must be implemented.
- ✓ New measures to better support decision-making, including a decision support framework, a new optimal coastal management/marine/spatial planning manual, and improved technical advice.
- ✓ More sustainable arrangements for funding and financing coastal management legislation.



ENSURE ON....

- ✓ Reducing the consequences for individuals, communities, businesses and the environment of beach litter effects.
- ✓ Raising public awareness about beach litter related risks.
- ✓ Providing an efficient and sustained response over beach litter.
- ✓ Prioritizing investment in communities most at risk.



A diver in a black wetsuit and yellow oxygen tank swims horizontally in the upper center of the frame. Below the diver, a large shark, possibly a tiger shark, swims horizontally across the frame. The shark's body is dark with lighter, mottled patterns. The background is a deep, dark blue, suggesting a deep-sea environment. Light rays are visible in the upper left corner.

*'WE ARE THE PILGRIMS, MASTER, WE SHALL GO
ALWAYS A LITTLE FURTHER. IT MAY BE
BEYOND THAT LAST BLUE MOUNTAIN BARR'D WITH SNOW,
ACROSS THAT ANGRY OR GLIMMERING SEA*

'Flecker, 'The Golden Journey to Samarkand'

Should we do this?

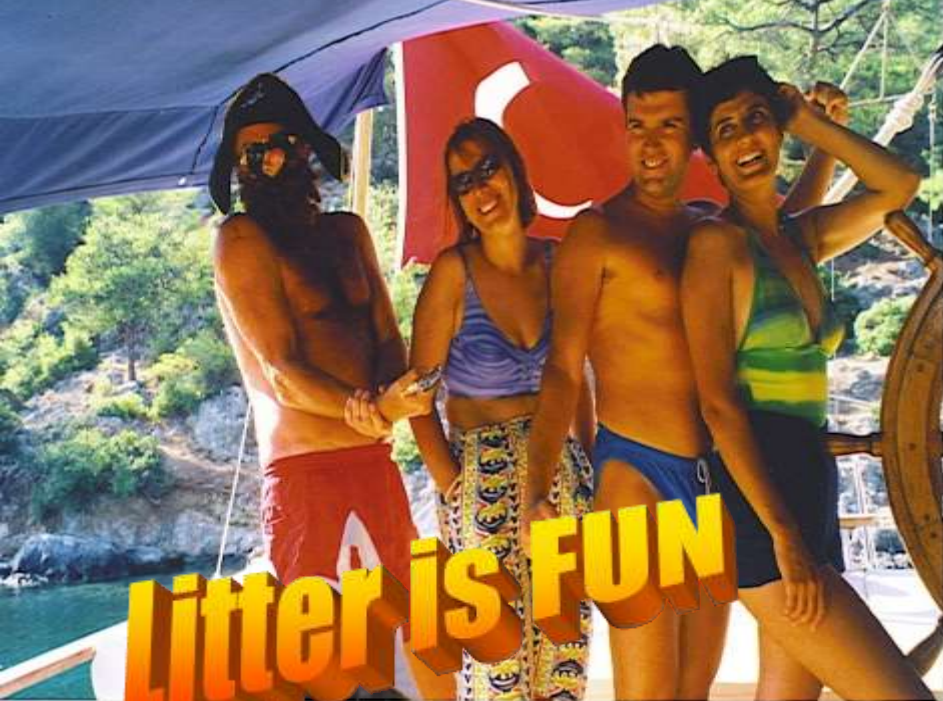
Take this, for
dropping
litter



Thank you



**ANY
QUESTIONS?**



So let us have a coffee break!

