PROPOSING METHODOLOGICAL STANDARDS FOR MONITORING MARINE LITTER, IN ORDER TO ACHIEVE GOOD ENVIRONMENTAL STATUS IN THE FRAMEWORK OF THE MARINE STRATEGY FRAMEWORK DIRECTIVE (MSFD)

Stelios Katsanevakis[1], Ezio Amato[2], Alexei Birkun[3], David Fleet[4], Jan A. van Franeker[5], Georg Hanke[6], Colin Janssen[7], Thomas Maes[8], John Mouat[9], Lex Oosterbaan[10], Isabelle Poitou[11], Richard Thompson[12], Francois Galgani[13]

[1]Institute of Marine Biological Resources, HCMR, Greece • [2]Department of Marine Environment Impact and Damage Assessment, ISPRA, Italy • [3]Brema Laboratory, Ukraine • [4]Landesbetrieb für Küstenschutz, Nationalpark und Meeresschutz Nationalparkverwaltung, Germany • [5]IMARES Wageningen UR, The Netherlands • [6]European Commission Joint Research Centre IES • [7]University of Ghent, Belgium • [8]CEFAS, United Kingdom • [9]Kommunenes Internasjonale Miljøorganisasjon (KIMO), United Kingdom • [10]North Sea Directorate, Ministry of Transport, The Netherlands • [11]MerTerre, France • [12]University of Plymouth, UK • [13]IFREMER, France

Communication: stelios@katsanevakis.com, Francois.Galgani@ifremer.fr

One of the main aspects of work in the first phase of the implementation of the **Marine Strategy Framework Directive** 2008/56/EC (MSFD) was the development of the criteria and methodological standards, which will ensure consistency and comparability in the determination of **Good Environmental Status** (GES) (MSFD Art. 9.3). JRC and ICES convened task groups for the eleven GES descriptors (MSFD Annex I) consisting of independent experts, selected on the basis of their individual expertise and experience, and ensuring coverage of the four marine regions specified in Article 4 of the MSFD (Baltic Sea, NE Atlantic, Mediterranean Sea, Black Sea).

Herein we present a summary of the report of Task Group 10 for the Descriptor: **"Properties and quantities of marine litter do not cause harm to the coastal and marine environment"**

Definition of 'marine litter'.

• Marine litter is any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment.

• Marine litter consists of items that have been made or used by people and deliberately discarded or unintentionally lost into the sea and on beaches including such materials transported into the marine environment from land by rivers, draining or sewage systems or winds. For example, marine litter consists of: plastics, wood, metals, glass, rubber, clothing, paper etc (Figure 1).

What is good environmental status

"Harm" can be divided into three general categories: **Social** (reduction in aesthetic value and public safety), **economic** (e.g. cost to tourism, damage to vessels, fishing gear and facilities, losses to fishery operations, cleaning costs) and **ecological** (mortality or sublethal effects on plants and animals through entanglements, captures and entanglement from ghost nets, physical damage and ingestion including uptake of microparticles (mainly microplastics) and the release of associated chemicals, facilitating the invasion of alien species, altering benthic community structure) (Figures 2 & 3).

Definitions of the acceptable levels of harm in these categories and good environmental status must consider impacts as assessed by the amount of litter in different compartments of the marine environment (seabed, sea surface, water column, coastline), ecological effects of the litter (e.g. plastics ingested by marine organisms; entanglement rates) and problems associated with degradation of litter (microparticles; Figure 4) as well as social and economic aspects. An overriding objective will be a measurable and significant decrease in the total amount of litter in the environment by 2020.

Figure 1: Marine litter is a greatly underestimated component of marine pollution; it may concentrate on the seafloor and on beaches reaching very high densities. (Top left) Marine litter collected during a beach cleanup in France. (Top right) Marine litter densities may be very high in shallow coastal areas, especially near metropolitan areas. This photo is from Korinthiakos Gulf, Greece. (Bottom left) The catch of an otter trawl hawl in the Ionian Sea, full of marine litter. (Bottom right) Plastic litter will eventually break into small fragments that aggregate on beaches or the sea bottom.
Top left photo: Isabelle Poitou; Top right & bottom right: Yiannis Issaris; Bottom left: copyright by HCMR (MEDITS project)

Figure 2: (Top) This demersal shark (*Scyliorhinus canicula*), caught by a trawler in Western Channel, was found with a plastic ring stuck around its neck causing severe abrasion on the sharks' tissues (© *Crown copyright 2010: permission granted by Cefas*). (Bottom) Many marine birds such as this gannet die because of entanglement in marine litter (*Photo: Jan Stok*).

Figure 3: A human perspective on 'harm'
The ingestion of plastic negatively affects the body condition of an animal which will reduce its chances for survival and successful reproduction. However, do current levels of marine litter affect populations at a level to be considered harmful?
In the North Sea almost every Fulmar has plastic in the stomach, with an average of around 30 pieces and 0.3 gram plastic mass per bird. Fulmars beached in the most polluted parts of the southern North Sea currently have an average of ca 0.6 gram of plastic in their stomach. Conclusive scientific evidence that such levels represent 'harm' to the Fulmar population is not possible. Such a question is maybe best approached by taking a human perspective. Imagine a Fulmar (ca. 700g) upgraded to the size of a human (~100 times heavier). If such a quantity of plastic was the AVERAGE amount of litter in stomachs of humans around the southern North Sea, ambient levels of litter would certainly be considered harmful and immediate action would be taken.
Photo: Jan van Franeker, IMARES

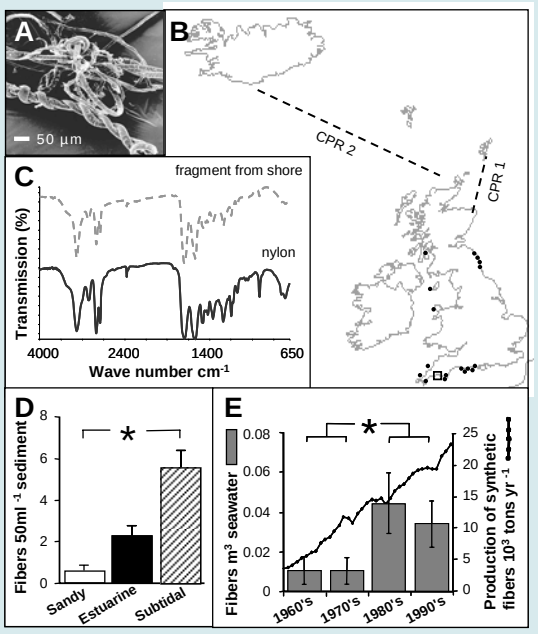

Figure 4. (**A**) Fragment of microscopic plastic from shoreline. (**B**) Sampling locations in North-East Atlantic, showing Routes (CPR 1 and 2) sampled by Continuous Plankton Recorder (CPR) since 1960 and used to assess changes in the abundance of microplastics in the water column (see Fig. 4E). Shores around the UK where similar fragments were found (•) and the location of sites near Plymouth (□) used to compare the abundance of microscopic plastic among habitats (see Fig. 4D). (**C**) Example showing how FT-IR spectroscopy was used to identify fragments from the shoreline and the water column. Here an unknown fragment is identified as nylon. (**D**) There were significant differences in abundance of microplastics between sandy beaches and subtidal habitats (ANOVA, * = P < 0.01), but abundance was consistent among sites within habitat type. **(E)** Accumulation of microscopic plastic in CPR samples revealed a significant increase in abundance when comparing the 1960's and 1970's to the 1980's and 1990's (ANOVA, * = P < 0.05). Approximate figures for global production of synthetic fibres overlain for comparison. *Reproduced from Thompson et al. (2004), with permission.*

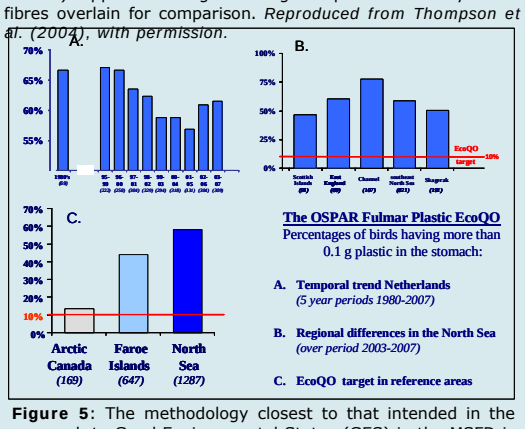

Figure 5: The methodology closest to that intended in the approach to Good Environmental Status (GES) in the MSFD is the Ecological Quality Objective (EcoQO) approach of OSPAR for the North Sea. For the EcoQO on marine litter, OSPAR uses abundance of plastics in the stomach of a seabird, the Northern Fulmar. OSPAR has provisionally defined it's objective for acceptable Ecological Quality concerning litter in the North Sea as "There should be less than 10% of Northern Fulmars having 0.1 gram or more plastic in the stomach in samples of 50-100 beach-washed fulmars from each of 5 different regions of the North Sea over a period of at least 5 years"

Key attributes of the proposed descriptor

Description and subcomponents, why the attribute is important

The group recommends the overriding objective to be a measurable and significant decrease in comparison with the initial baseline in the total amount of marine litter by 2020 using the following criteria and methodologies for the evaluation of the state of good environmental status.

• **Amount, source and composition of litter washed ashore and/or deposited on coastlines**. The attribute will indirectly measure inputs, impacts on aesthetic values, the presence of toxic compounds and socio-economical damage.

• **Amount and composition of litter in the water column - including floating and suspended litter - and accumulation on the sea floor.** The attribute will measure litter dynamics and potential interactions with marine life. Accumulation areas will be located.

• **Amount and composition of litter ingested by marine animals**. The attribute measures time-trends and spatial variation in inputs of litter and its impact on marine life.

• **Amount, distribution and composition of microparticles (mainly microplastics).** The attribute will measure quantities, types, degradation processes and potential sources of contaminants (Figure 4).

Monitoring results combined with research on social, economic and ecological harm will lead to improved knowledge of critical thresholds.

Important classes of indicators related to the attribute to cover properties and linkages to pressures - examples and methodological standards:

Evaluation of quantities and composition of litter (amount on the coastline, the sea floor, in the water column and on the waters surface), the amount ingested by animals and entanglement rates are the best links to pressures.

Methodological standards in Europe are currently available for the assessment of:

•Litter on coastlines: In the OSPAR, HELCOM and Black sea regions, standards for the Beach Litter Survey have been developed which can, if necessary, be adjusted, harmonized and applied to other regions.

•Litter at sea. Pilot projects indicated that litter on the sea floor could be measured along side international biological trawling surveys (e.g. IBTS) or dedicated dive or photographic transects. Impact of "ghost" nets will be considered in fishing areas. Litter in the water column can be measured by using (plankton) nets or filtered water samples. Floating litter can be assessed at large scale by aerial surveys.

•Biomonitoring (Figure 5): In the OSPAR system of Ecological Quality Objectives (EcoQO) for the North Sea, amounts of plastics in Fulmar stomachs are already used as the EcoQO to assess temporal trends, regional differences and compliance with a set target for acceptable ecological quality in the North Sea area. Such monitoring can be applied in other areas by either fulmars or similar species with adjusted targets, and may also include entanglement rates of representative species.

•Particle abundance, especially microplastics can be assessed in the water column by concentrating the particles from water or by washing low-density particles from sediment samples.

Methods for aggregating the indicators (indices) within the descriptor to achieve an overall assessment.

OSPAR QSR 2010 and HELCOM based regional approaches which link pressures and activities to the quality of ecosystem components will be considered for implementation and extension to other areas.

Emergent messages about monitoring and research

An initial evaluation is needed by all member states on the current state of research in their region/subregion to give a scientific and technical basis for monitoring, define knowledge gaps and priority areas for research. Harmonisation will require coordination by relevant representatives from each member state; this will lead to common and comparable monitoring approaches, recommendations and guidelines to assess GES on a regional/European scale. Research will need to include the improvement of knowledge concerning impacts on marine life, degradation processes at sea, the study of litter-related microparticles, the study of chemicals associated with litter, the factors influencing the distribution and densities of litter at sea (human factors, hydrodynamics, geomorphology etc.), the normalisation of methods and the determination of thresholds. The assessment and monitoring of socio-economic harm will also need to be addressed.