Theme Session A on
Marine Litter (co-sponsored by PICES)

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It is now well recognised that marine litter, mainly plastic, can pose a serious environmental threat to marine organisms as well as a series of economic and social problems. Plastics accumulate in our seas and oceans because they don't readily biodegrade, unlike many other organic substances. However due to the effects of weathering, sunlight and wave action they do fragment in the environment into smaller and smaller fragments, better known as microplastics (<5 mm and typically in the micrometer range). ICES is starting to embrace the emerging pollution problems associated with marine litter as the effects encompass a wide variety of impacts across various marine environments. For example, marine litter can kill or harm marine life through entanglement or ingestion and thus put an even higher strain on those systems already under stress from overfishing and other anthropogenic influences. Ingested microplastics may pose additional health risks to marine organisms and ecosystems and can accumulate up the marine food chain and potentially pose a risk to human consumers of fish and shellfish products. Currently within the ICES community there are no directed surveys specifically for marine litter but rather programs take advantage of existing fisheries cruises to understand their fate and distribution.

This first ever ICES theme session on marine litter comprised 15 contributions: 7 oral and 8 posters. We received a variety of contributions on marine litter ranging from monitoring activities, laboratory exposure studies to issues related to plastic as a (transport) medium for (invasive) species and POPs. The contributions can be grouped in a number of categories which are summarized below.

Several contributions reported preliminary results of chronic laboratory experiments in which various marine organisms were exposed to fluorescent microplastics. Feeding experiments with copepods indicated that microplastic exposure significantly decreases algal feeding in copepods and may potentially affect fecundity and egg hatching success of the copepod (A:03). This suggests that microplastics may potentially affect secondary producers. Ingestion of microplastics by sea bass larvae had no effect on mortality but induced a 25% significant decrease in growth rate (A:15). Further, it was suggested that microplastics can affect reproduction capacities of oysters (*C. gigas*) (A:05). Lastly, a detailed physiological study of microplastics ingestion, uptake and clearance into the common shore crab (*Carcinus maenas*) was investigated by trophic transfer from the blue mussel (*Mytilus edulis*) and through direct exposure in the water. The results show that microplastics were rapidly distributed across body tissues. Interestingly, in addition to the amount of plastics within the stomach, microplastics were also being taken up in to the gill surface (A:04). All authors indicated that further research is needed to identify the ecological importance of their findings.

Photo: Microplastic sampling with a manta trawl.
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With respect to monitoring activities, one contribution (A:07) reported on the work of the technical subgroup on marine litter under the MSFD Good Environmental Status group. One of the descriptors (D10) of the MSFD is related to marine litter. Monitoring protocols have been developed by this group for use within the monitoring programs of the EU Member States and the Regional Sea Conventions of the European Seas and comprise protocols for beach litter monitoring, floating macro-litter observation, benthic trawl net surveys, benthic litter surveys and marine litter ingestion by seabirds and marine turtles. For the monitoring of micro-litter, different protocols according to the different monitoring matrices were proposed. Scope of the follow-up work is to provide recommendations for monitoring strategies and harmonized protocols for the monitoring of marine litter at the EU level. Other contributions reported results on the distribution and abundance of macro-litter and microplastics in different monitoring matrices (water, bottom, biota and sediment) for various marine regions. One study using a continuous sampling method indicated that plastic particles are widespread in the surface layer of the Northeast Atlantic Ocean (A:04). Two contributions from Greece reported on the distribution and abundance of marine litter from trawl fishing/bottom trawl surveys, carried out on the deep bottoms of the Eastern Mediterranean (A:06; A:18). These bottom trawl surveys were based on a significant data set from the MEDITS surveys conducted between 1995–2008. Litter was recorded in more than 85% of examined hauls on shelf and slope, with plastic items most frequently collected (shelf: > 66%, slope: ~80%), followed by metallic (>45%) and glass/ceramic objects (> 23%). A significant increasing trend of annual density was shown only for metallic and glass/ceramic items on the slope of the eastern Ionian Sea. The density of litter in the whole study area was 109 litter items/km2 and highest concentrations were found along navigation routes (A:04). An Irish field study showed that 13 % of individuals of commercially important fish and shellfish species caught in Irish waters contained microplastics in the intestinal tract (A:13). A Danish study presented the results of microplastic particle concentrations in sediments at several areas in Danish coastal and open waters in the North Sea, Skagerrak, Kattegat, Belt Sea and Baltic Sea. In some samples more than a hundred particles consisting of fibres, flakes, spherules, and/or granules were identified per 100 g sediment, and in sediments from open waters, indicating that sediments may act as sinks for microplastics (A: 16). In general, more research is needed to develop suitable indica-

tors for litter monitoring and to clarify the sources and the observed litter distribution patterns in the various marine regions. Harmonisation of protocols for use under the MSFD is considered to be a priority.

Photo: Japan tsunami marine debris washed into the Pacific Ocean

Plastics also create habitats for micro-organisms and other species, allowing would-be invasive species to hitch rides to new areas of the ocean. This was well illustrated by an analysis of the potential risk of aquatic invasive species posed by Japan tsunami debris to North American coastal waters (A:01). In a contribution by the UK macro litter data collected during fish bottom trawling showed no trends for the 20 sites routinely visited over a 15-year period (A:11). In addition, observations were made on the presence of colonising organisms on marine litter illustrating that it provides increased habitat for marine organisms. One contribution provided preliminary information regarding plastic pellets and biofilm development (A:10). Bioplast (biodegradable) pellets showed more signs of degradation and higher abundances of bacteria and diatoms than polystyrene pellets which may make Bioplast pellets more attractive to larger organisms as food. Plastic fragments may also act as a vector for the transfer of plastic adsorbed organic contaminants to marine organisms through the ingestion of plastic which is mistaken as food. First results were reported from controlled laboratory experiments that aimed to investigate the accumulation of PCB loaded microplastics after ingestion to benthic marine organisms (A:14).

It can be concluded that the session was highly successful in bringing together environmental scientists from various corners of the ICES community, PICES and the Mediterranean Sea. Most studies are still in their preliminary phases indicating the novelty of the marine litter research. More results can be expected in the near future coming from national and international initiatives, e.g. the EU-funded FP7 CLEANSEA (A:12). These could include damage of marine litter to people, property, and livelihood and inferred economic costs and the role of marine litter as an additional stressor on marine ecosystems. Overall the contributions clearly highlight that marine litter poses a significant threat to the marine environment, a threat that likely is increasing. Because of its complexity, marine litter can be seen as the perfect ICES example of an anthropogenic pressure which can easily be monitored on the back of existing ICES stock assessment surveys to determine potential influences on fish stocks and biodiversity. Research into the marine litter problem and identification of practical solutions will require a multidisciplinary approach and makes it a novel and challenging niche for ICES research and advice and opens the door to collaborations with other national and international organizations.