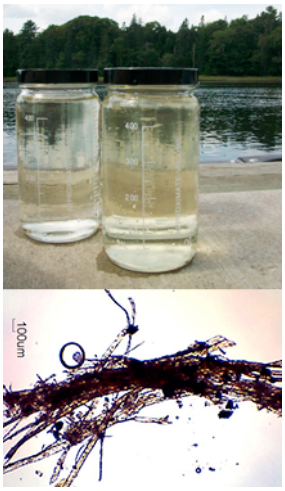
MERI Backgrounder

MICROPLASTICS

The use of plastic has been on the rise because of its durability and seemingly endless application and flexibility. Global production has increased from 1.5 million tons in 1950 to 230 million tons in 2009, increasing on average by 9% annually (PlasticsEurope, 2010). Plastic constitutes 10% of municipal waste worldwide as a consequence of the widespread use of plastics for throw-away goods, such as packaging, and other single-use products (Barnes et al., 2009). It is further estimated that approximately 10% of all plastic debris ends up in the ocean (Thompson, 2006).

Plastic Debris

The presence of plastic debris in the marine environment is well documented (Derraik, 2002). Heavier plastics like polyvinyl chloride (PVC) accumulate in bottom sediments while lighter plastics like polyethylene and polypropylene are distributed on the sea surface (Moret-Ferguson et al., 2010). Due to its buoyancy, plastic debris is widely dispersed in the open ocean (Ng and Obbard, 2006); however, currents, wind and upwelling lead to high concentrations near the centers of subtropical ocean gyres (Law et al., 2010). While cold marine water slows the degradation of larger pieces of plastics, debris on beaches is susceptible to abrasion by sand and rocks as well as photo-degradation by UV light, all of which cause a loss in the structural integrity of plastic. The debris becomes brittle and breaks into smaller pieces that are carried out to sea by wave and wind action (Cole et al., 2011).



Water samples collected in Blue Hill Bay are monitored for microplastics.

Microplastics Pollution

There are two classes of marine microplastics. *Primary* microplastics are small manufactured 'granules.' These granules are used, for example, in cosmetics like exfoliating face washes (Gregory, 1996) and in air blasting to remove rust and paint (Andrady, 2011). *Secondary* microplastics are the product of UV degradation of plastic debris as described above. When the structures of the larger pieces are broken down, they become more available for ingestion by small organisms (Cole et al., 2011). In addition, the added ingredients like plasticizers and BPA, which are used to make products more flexible or durable, disassociate from the plastic fragments and migrate into the environment (Sajiki and Yonekubo, 2003, Meeker et al., 2009).

Distributed by ocean currents (Ng and Obbard, 2006), microplastics persist either in the water column or in sediments from shorelines to the deep ocean floor (Law et al., 2010, Thompson et al., 2009) and are now found in most marine habitats around the world (Browne et al., 2007).

Coastal tourism, recreational and commercial fishing, boat yards, landfills, marinas and aquaculture are all potential direct inputs of microplastics into the ocean. Washing our clothes is another source of microplastics since much of the clothing people wear today is made from polyester, acrylic, rayon and various other synthetic textile materials. Thousands of tiny microfibers tear off our clothing with every wash and go down the drain during the rinse cycle (Browne, et al., 2011). Other common sources of plastics include manufacturing plants where resin pellets may be released into industrial drainage systems or spilled during shipping (EPA, 1992), offshore fisheries (Andrady, 2011), and dumping at sea

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(Pruter,1987).

Impacts of Microplastics on Marine Organisms

Microplastics are potentially harmful to marine organisms in several ways. When plastic polymers are broken down by heat or other mechanical processes, the resulting compound can be a toxic substance (Andrady, 2011). Additionally, chemical additives that are incorporated into the manufacture of plastics, including plasticizers, flame retardants, antioxidants and Bisphenol-A, may leach out of the plastic and into the water column or into the body of any organism that ingests it (Browne et al., 2007, Oehlmann et al., 2009, Teuten et al., 2009). Plastic has also been shown to adsorb and concentrate hydrophobic contaminants such as PAHs, PCBs, DDT, DDE and PBDEs from the marine environment (Rios et al., 2007, Teuten et al., 2009) with PCB and DDE concentrations on microplastic pellets several orders of magnitude higher than those of the surrounding seawater (Mato et al., 2001).

The pathway for many toxic chemicals into the marine food web may be partly through the ingestion of plastic fragments in the water or through smaller prey (Eriksson and Burton, 2003). Ingestion can affect all levels of the food chain -- from tiny zooplankton to filter feeders such as shellfish to mammals. Once ingested, the particles have the potential to move up the food chain and magnify via trophic transfer and bioaccumulation, risking marine mammal, large fish, bird and human health. Concerns have also been raised about the potential ecological impact of microplastics as substrates and vectors for the dispersal and introduction of exotic diseases and alien species (Leslie et al., 2011). MERI researchers have found that plastic is an ideal substrate for several invasive tunicate species originally from the Pacific Ocean, which now colonize Gulf of Maine waters.

Microplastics Project at MERI

During the summer of 2012, MERI researchers and a graduate intern from the Acadia Internship in Regional Conservation and Stewardship program, sponsored by the Quebec-Labrador Foundation, Schoodic Education and Research Center (SERC) and the University of Maine, explored methods for the collection, categorization and quantification of microplastics. The project assessed microplastic prevalence and tested methods for routine monitoring and surveying of microplastics. MERI plans to finalize sampling and lab techniques, get baseline data on the occurrence of microplastics in Blue Hill Bay, and develop materials for a public awareness campaign and a replicable education curriculum.

MERI will continue to promote plastic awareness through its education and outreach programs to raise public awareness of plastic pollution and emphasize the importance of removing plastics from beaches. In October, Dr. Kara Lavender Law, a foremost marine plastics researcher, will speak about microplastics research in the Atlantic as part of MERI's Ocean Environment Lecture Series. The microplastics project is expected to lead to other collaborative efforts with a broader scope for future field seasons. In addition, the Blue Hill environmental community has indicated a strong interest in reducing plastics use, and this project will help inform and inspire citizen action.

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