



## The Science of the Marine Litter Issue

Below is a series of verbatim extracts of an article which discusses the issue of marine litter in the 21<sup>st</sup> Century. The article tackles the specific issues, impacts and solutions of this environmental challenge. The quoted texts below discuss the general issue of marine litter, its ecological impacts and the socio-economic impacts of marine debris around the world.

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### Citation:

Committee on the Effectiveness of International and National Measures to Prevent and Reduce Marine Debris and Its Impacts, National Research Council, Ocean Studies Board, Division on Earth and Life Sciences, Tackling Marine Debris in the 21<sup>st</sup> Centuryq *National Research Council of the National Academies* (Washington, D.C.: The National Academies Press, 2008), 1-166.

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The following text is an extract from the article:

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### The Issue

Marine debris presents a significant environmental challenge, far more diverse and less tractable than most other environmental issues. Marine debris, especially plastic debris is now ubiquitous in the oceans and along coasts. It is found in the middle of the oceans (Matsumura and Nasu, 1997), on remote uninhabited tropical atolls (Donahue et al., 2001; McDerimid and McMullen, 2004; Morishige et al., 2007), and on

Arctic and sub-Antarctic islands (Gregory and Ryan, 1997). Despite heightened awareness of the problem and ongoing remediation efforts, studies suggest that, overall, marine debris in the environment has not been reduced (Miller and Jones, 2003; Barnes, 2005; Sheavly, 2007; Yamashita and Tanimura, 2007).<sup>1</sup>

Marine debris items range from 4 to more than 48 thousand items per km of shoreline, while weight of the items range from 31 grams per km to more than 3.8 metric tons per km. Plastic materials dominate coastal marine debris in number, volume, and weight at all debris sizes examined to date, particularly on beaches and areas near population centers (e.g. Ribic et al., 1997; Sheavly, 2007).<sup>2</sup>

## The Impact

Not all debris is equally harmful, and not all organisms or regions are equally vulnerable. To prudently use scarce or limited resources in mitigation efforts, it is important to fully understand the impacts of marine debris on the environment and on human uses.<sup>3</sup>

### Ingestion

Ingested marine debris is quite common in samples of dead and captured seabirds and turtles – The large variation in the prevalence of indigested debris does not appear to correlate with any particular taxa, region, or time period.<sup>4</sup>

The known effects of ingestion of marine debris by birds include reducing the absorption of nutrients in the gut, reducing the amount of space for food in the gizzard and stomach, uptake of toxic substances that comprise the debris or have been absorbed onto the debris, ulceration of tissue, and mechanical blockage of the digestive processes (Azzarello and Van Vleet, 1987; Fry et al., 1987; Ryan and Jackson, 1987; Ryan, 1988; Spear et al., 1995).<sup>5</sup>

Prevalence of debris ingestion among seabirds is suggestive of a broad and significant ecological impact, at least in some regions such as the North Pacific Ocean. However, a direct link between ingestion and mortality has been limited to incidental examinations of a small number of birds (Pierce et al., 2004).<sup>6</sup>

In addition to the possible direct physical effects of marine debris, there is concern that plastics, particularly microplastics, are able to absorb, concentrate, and deliver toxic compounds to

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<sup>1</sup> Page 22 of *Tackling Marine Debris in the 21<sup>st</sup> Century*

<sup>2</sup> Page 22 of *Tackling Marine Debris in the 21<sup>st</sup> Century*

<sup>3</sup> Page 25 of *Tackling Marine Debris in the 21<sup>st</sup> Century*

<sup>4</sup> Page 25 of *Tackling Marine Debris in the 21<sup>st</sup> Century*

<sup>5</sup> Page 25 of *Tackling Marine Debris in the 21<sup>st</sup> Century*

<sup>6</sup> Page 25 of *Tackling Marine Debris in the 21<sup>st</sup> Century*

organisms. Microplastics are the very small (approximately  $\leq 5$  mm) plastic debris items; sources include pre-production plastic resin pellets used in the manufacture of plastic items (Gregory, 1977, 1978; Shiber, 1979, 1982, 1987; Redford et al., 1997; Moore et al. 2001b), tiny bead scrubbers used in washing products (Zitko and Hanlon, 1991; Gregory 1996), abrasive plastic beads used to clean ships (Reddy et al., 2006), and ever-smaller fragments resulting from the mechanical and photodegradation (oxidation) of larger plastic debris (Andrady, 1990; George, 1995).<sup>7</sup>

The small size of microplastic marine debris allows it to be ingested by a wide range of organisms. Microplastics particles as small as 20  $\mu$ m can be ingested by invertebrates, including lugworms, barnacles, and amphipods (Thompson et al., 2004) and protochordates, such as salps (Moore et al., 2001a). The ingestion of plastic particles by seabirds and marine mammals is also widely reported (Fry et al., 1987; Moser and Lee, 1992; Laist, 1997; Robards et al., 1997).<sup>8</sup>

### Entanglement

The effect of entanglement in marine debris on organisms ranges from restricting the movement of affected individuals to direct physical harm and mortality.<sup>9</sup>

Prevalence of entanglement (number of cases per population) was generally less than one percent; however, entangled animals may die at sea unobserved or otherwise fail to return to land after entanglement, confounding both entanglement rates and subsequent fate of entangled animals (Laist, 1997). Entanglements typically involved debris encircling the neck or appendages, most commonly by plastic packing straps, followed by rope and line and net fragments (Laist, 1997; Henderson, 2001). Once entangled mortality rates differ among species from more than 80 percent for Antarctic fur seals, 44 percent for Australian sea lions, and 57 percent for entangled New Zealand fur seals (Croxall et al., 1990; Page et al., 2004).<sup>10</sup>

### Socio-Economic Impacts

Marine debris can also reduce indirect socio-economic benefits (use values, option values and non-use values) or increase direct or indirect costs (National Research Council, 2004). Direct benefits include the value of commercial, sport, subsistence, and other cultural harvests, marine transportation, and the benefits that beachgoers, boaters and divers derive from recreating at the seashore and on marine waters.

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<sup>7</sup> Page 26 of *Trackling Marine Debris in the 21<sup>st</sup> Century*

<sup>8</sup> Page 26 of *Trackling Marine Debris in the 21<sup>st</sup> Century*

<sup>9</sup> Page 27 of *Trackling Marine Debris in the 21<sup>st</sup> Century*

<sup>10</sup> Page 27 of *Trackling Marine Debris in the 21<sup>st</sup> Century*

(Smith and Palmquist, 1994; Kaoru et al., 1995; Kirkley and McConnell, 1997; Smith et al., 1997).<sup>11</sup>

Ways in which marine debris can reduce direct socio-economic benefits include reductions in:

- Sustainable harvests or catch-per-unit effort of valued fish and shellfish due to ghost fishing (Kirkley and McConnell, 1997; National Research Council, 1999);
- Actual and contingent benefits of coastal recreation due to the presence of litter and other marine debris, including hazardous materials that present human health dangers; and
- Net benefits for commercial and recreational boaters from fouling of propellers and jet intakes as well as damage to hulls (Kirkley and McConnell, 1997).<sup>12</sup>

Offra and Brown (1999) and Swanson et al, (1991) estimated that New Jersey lost between \$379 million and \$3.6 billion in tourism and other revenue as a result of debris washing ashore in 1988.<sup>13</sup>

Socioeconomic studies not only help define impacts, but can also assist with mitigation by improving the understanding of the actions that lead to debris generation. Human behaviour is the ultimate cause of marine debris and understanding of factors that lead to marine debris generation must ultimately be addressed to achieve prevention.<sup>14</sup>

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<sup>11</sup> Page 29 and 30 of *Tackling Marine Debris in the 21<sup>st</sup> Century*

<sup>12</sup> Page 30 of *Tackling Marine Debris in the 21<sup>st</sup> Century*

<sup>13</sup> Page 30 of *Tackling Marine Debris in the 21<sup>st</sup> Century*

<sup>14</sup> Page 30 of *Tackling Marine Debris in the 21<sup>st</sup> Century*