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Quantities, composition, and sources of beach debris in Korea from the results of nationwide monitoring

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ABSTRACT

This study assessed the levels of marine debris pollution and identified its main sources in Korea. The surveys were bimonthly conducted by NGO leaders and volunteers on 20 beaches from March 2008 to November 2009. The quantities of marine debris were estimated at 480.9 (±267.7) count · 100 m^{-1} for number, 86.5 (±78.6) kg · 100 m^{-1} for weight, and 0.48 (±0.38) m^3 · 100 m^{-1} for volume. The level of marine debris pollution on the Korean beaches was comparable to that in the coastal areas of the North Atlantic ocean and South Africa. Plastics and styrofoam occupied the majority of debris composition in terms of number (66.7%) and volume (62.3%). The main sources of debris were fishing activities including commercial fisheries and marine aquaculture (51.3%). Especially styrofoam buoy from aquaculture was the biggest contributor to marine debris pollution on these beaches.

1. Introduction

Marine debris has become a global marine environmental problem that involves multiple stakeholders in many different countries. It is defined as "any manufactured or processed solid waste material that enters the marine environment from any source" (Coe and Rogers, 1997). Marine debris causes problems beyond creating an eyesore for tourists. It is a source of serious damage to marine lives, ecosystems, fisheries, and navigational safety. Transfer of chemicals to marine biota has also been recorded recently (Barnes, 2002; Derraik, 2002; Donohue et al., 2001; Hall, 2000; Hong et al., 2013; Rochman et al., 2013).

Numerous efforts have been made worldwide to comprehend the magnitude and extent of the marine debris problem (OSPAR, 2007; Ribic et al., 2010). The majority of research has revealed the abundance, composition, geographical distribution, or occasional sources of marine debris, showing highly temporal or spatial variation even along a beach or during a single day (Eriksson et al., 2013; Kako et al., 2010a; Smith and Markic, 2013; Velander and Mocogni, 1999). The quantitative or qualitative data have been used to understand the influence of wind, ocean or tidal currents, proximity to human population, and diverse human activities on marine debris pollution (Edyvane et al., 2004; Ribic et al., 2010; Williams et al., 2003).

The Korean government has responded to the marine debris issue since the late 1990s by investing in retrieval programs and research projects. Revision of the Marine Environment Management Act in 2008 provided the legal basis for managing marine debris. These efforts, however, have resulted in limited success because there is no reliable scientific information and data at the national level on the sources, types, spatiotemporal distribution, and impacts of marine debris. Government programs have focused mostly on the retrieval of floating or deposited fishing gear from near-shore coastal waters, fishing grounds, and deep sea beds with government or private vessels. Marine debris research has provided technical solutions only for the collection and treatment of floating and sunken debris (Jung et al., 2010). Even though the removal programs and technical approaches have contributed to some extent to mitigating marine debris pollution, the current marine debris management regime in Korea is insufficient for meeting the future challenges that Korean society faces regarding protection and sustainable use of the local marine ecosystem. This study was aimed at assessing the level of beach debris pollution as well as identifying management priorities for beach debris in Korea. To achieve the aim, we surveyed the quantities, composition, and sources of beach debris through regular, nationwide monitoring for 2 years (2008–2009).

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2. Method

2.1. Study area

A total of 20 beaches were monitored along the eastern, western, and southern coasts of Korea (Fig. 1). The beaches selected were composed of sand or pebbles, had moderate to low slopes, and were of sufficient size to encompass 100-m survey lines. Accessibility to sites for regular monitoring and debris removal after surveys was also considered in the site selection. Beaches with other routine cleanup activities and that were located within or close to protected areas were excluded.

The three coasts of Korea have very distinct characteristics in morphology and marine economic activities. The east coast of Korea has a relatively straight coastline bordered by a narrow strip of the continental shelf in the East Sea. No major rivers drain this steep coastal watershed. Well-developed sandy shores attract tourists during the summer, and fishery using gill nets and trawls dominates the fishery sector in the region. In contrast, complex coastlines with inlets, bays, estuaries, and islands characterize the west and south coasts of Korea. The west coast has extensive tidal flats created by high tidal range and sediment supply from big rivers that drain into the Yellow Sea. Encompassing over 60% of the islands in Korea and many inlets and bays, the south coast is the most complex coast, in which the total length of coastline is approximately 28 times that of a straight line (KHOA, 2012). Along the west and south coasts, local economies benefit from intensive tourism, commercial fishing, marine aquaculture, and shipping. More than 70% of aquaculture production in Korea in 2011 (MIFAFF, 2012) was from the south coast area, which

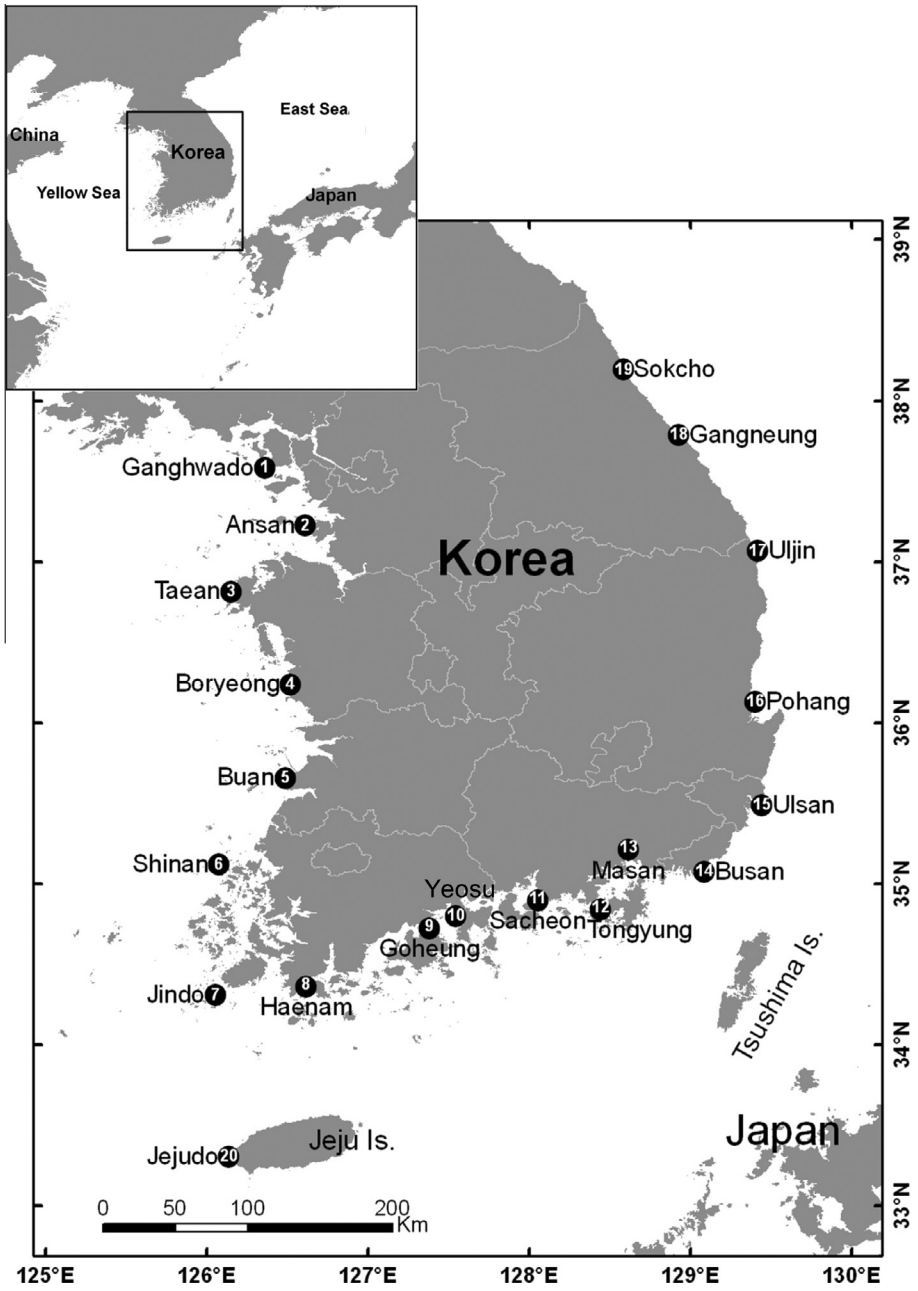

Fig. 1. Location of beach debris monitoring sites in Korea during the period 2008–2009.