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GLOBAL MARINE POLLUTION

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doi:10.1006/rwos.2001.0501

Selected topics on pollution of the oceans are covered in detail by articles listed in the cross-references at the end. This brief overview is an introduction and guide to the appended list of Further Reading, which is designed to provide an entry to the historical and global context of these issues.

Until recently the size and mobility of the oceans encouraged the view that they could not be significantly affected by human activities. Fresh water lakes and rivers had been degraded for centuries by effluents, particularly sewage, but, although from the 1920s coastal oil pollution from shipping discharges was widespread (Pritchard, 1987), it was felt that in general the sea could safely dilute and disperse anything added to it. Erosion of this view began in the 1950s, when fallout from the testing of nuclear weapons in the atmosphere resulted in enhanced levels of artificial radionuclides throughout the world's oceans (Park *et al*., 1983). At about the same time, the effluent from a factory at Minamata in Japan caused illness and deaths from consumption of mercury-contaminated fish (Kutsuna, 1968), focusing global attention on the potential dangers of toxic metals. In the early 1960s, build-up in the marine environment of residues from synthetic organic pesticides poisoned top predators such as fish-eating birds (Tolba *et al*., 1992), and in 1967 the first wreck of a supertanker, the *Torrey Canyon*, highlighted the threat of oil from shipping accidents, as distinct from operational discharges (Eighth Report of the Royal Commission on Environmental Pollution, 1981).

It might therefore be said that the decades of the 1950s and 1960s saw the beginnings of marine pollution as a serious concern, and one that demanded widespread control. It attracted the efforts of national and international agencies, not least those of the United Nations. The fear of effects of radioactivity focused early attention, and initiated the establishment of the International Commission on Radiological Protection (ICRP) (Brackley, 1990), which produced a set of radiation protection standards, applicable not just to fallout from weapons testing but also to the increasingly more relevant issues of operational discharges from nuclear reactors and reprocessing plants, from disposal of low-level radioactive material from a variety of sources including research and medicine, and from accidents in industrial installations and nuclear-powered ships. Following Minamata, other metals, in particular cadmium and lead, joined mercury on the list of concerns. Since this, like radioactive wastes, was seen as a public health problem, immediate action was taken. Metals in seafoods were monitored and import regulations were put in place. As a result, metal toxicity in seafoods is no longer a major issue, and since most marine organisms are resilient to metals, this form of pollution affects ecosystems only when metals are in very high concentrations, such as where mine tailings reach the sea.

Synthetic organics, either as pesticides and antifoulants (notably tributyl tin (TBT); de Mora, 1996) or as industrial chemicals, are present in sea water, biota, and sediments, and affect the whole spectrum of marine life, from primary producers to mammals and birds. The more persistent and toxic compounds are now banned or restricted, but since many are resistant to degradation and tend to attach to particles, the seabed acts as a sink, from which they may be recirculated into the water column. Other synthetic compounds include plastics, and the increasing use of these has brought new problems to wildlife and amenities (Coe and Rogers, 1997).

Oil contaminates the marine environment mainly from shipping and offshore oil production activities (*Oil in the Sea*, 1985). Major incidents can release large quantities of oil over short periods, causing immense local damage; but in the longer term, more oil reaches the sea via operational discharges from ships. These and other threats to the ocean are controlled by the International Convention for the Prevention of Pollution from Ships (MARPOL, 73/78), administered by the International Maritime Organisation of the UN (IMO, 1991). Pollution is usually generated by population pressure, and the most ubiquitous item is sewage, which is derived from a variety of sources: as a direct discharge; as a component of urban waste water; or as sludge to be disposed of after treatment (Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP), 1982). Sewage in coastal waters is primarily a public health problem, exposing recreational users to pathogens from the local population. The dangers are widely recognized, and many countries have introduced protective legislation. At the global level, the London Dumping Convention controls, among other things, the disposal of sewage sludge. As well as introducing pathogens, sewage also contributes carbon and nutrients to the sea, adding to the substantial quantities of nutrients reaching the marine environment from agricultural runoff and industrial effluents. The resulting eutrophication is causing major ecosystem impacts around the world, resulting in excessive, and sometimes harmful, algal blooms (Brune *et al.*, 1997).

The need for a global approach to ocean affairs was formally brought to the attention of the United Nations in 1967, and over the next 15 years, while sectoral treaties and agreements were being introduced, negotiations for a comprehensive regime led in 1982 to the adoption of the UN Convention on the Law of the Sea (UNCLOS) (UNO, 1983). This provided a mechanism for the protection and management of marine resources. In the ensuing years, concepts such as sustainable development (*Our Common Future*, 1987) and the precautionary approach came to the fore and were endorsed in the Declaration of the Rio Summit (Grubb *et al.*, 1993), while proposals for Integrated Coastal Zone Management (ICZM) are being widely explored nationally and advanced through the Intergovernmental Oceanographic Commission (IOC, 1998).

Early ideas of pollution were focused on chemical inputs, but following the GESAMP definition (Pravdic, 1981) pollution is now seen in a much wider context, bringing in any human activity that damages habitats and amenities and interferes with other users of the sea. Thus, manipulation of terrestrial hydrological cycles, and other hinterland activities including alterations in agriculture, or afforestation, can profoundly influence estuarine regimes. In particular, it is now recognized that excessive fishing can do more widespread damage to marine ecosystems than does most chemical pollution (ICES, 2000).

Over the years, assessments of pollution effects have altered the priority of concerns, which today is very different from that of the 1950s. Thanks to the rigorous control of radioactivity and metals, these are not now major worries. Also, decades of experience with oil spills has shown that, after the initial damage, oil degrades and the natural resilience of communities leads to their recovery. Today the effects of sewage, eutrophication, and harmful algal blooms top the list of pollution concerns, along with the physical destruction of habitats by coastal construction. These impacts are on the shallow waters and the shelf, associated with continental inputs and activities. The open ocean, although subject to contamination from the atmosphere and from vessels in shipping lanes, is relatively less polluted (UNEP).

See also

Anti-fouling Materials. Anthropogenic Trace Elements in the Ocean. Atmospheric Input of Pollutants. Chlorinated Hydrocarbons. Eutrophication. Exotic Species, Introduction of. International Organizations. Marine Policy Overview. Metal Pollution. Oil Pollution. Phytoplankton Blooms. Pollution Control. Pollution: Effects on Marine Communities. Pollution, Solids. Radioactive Wastes. Thermal Discharges and Pollution. Viral and Bacterial Contamination of Beaches.

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GRABS FOR SHELF BENTHIC SAMPLING

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doi:10.1006/rwos.2001.0391

Introduction

The sedimentary environment is theoretically one of the easiest to sample quantitatively and one of the most convenient ways to secure such samples is by means of grabs. Grab samplers are used for both faunal samples, when the grab contents are retained in their entirety and then sieved to remove the biota from the sediment, and for chemical/physical samples when a subsample is usually taken from the surface of the sediment obtained. In both cases the sampling program is reliant on the grab sampler taking consistent and relatively undisturbed sediment samples.

Conventional Grab Samplers

The forerunner of the grab samplers used today is the Petersen grab, designed by C.G.J. Petersen to conduct benthic faunal investigations in Danish fiords in the early part of the twentieth century. It consisted of two quadrant buckets that were held in an open position and lowered to the seabed (**Figure 1**). On the bottom, the relaxing of the tension on the lowering warp released the buckets and subsequent hauling caused them to close before they left the bottom. The instrument is still used today but is seriously limited in its range of usefulness, working efficiently only in very soft mud.

Petersen's grab formed the basis for the design of many that came after. One enduring example is the van Veen grab, a sampler that is in common use today (**Figure 2**). The main improvement over Petersen's design is the provision of long arms attached to the buckets to provide additional leverage to the closing action. The arms also provided a means by

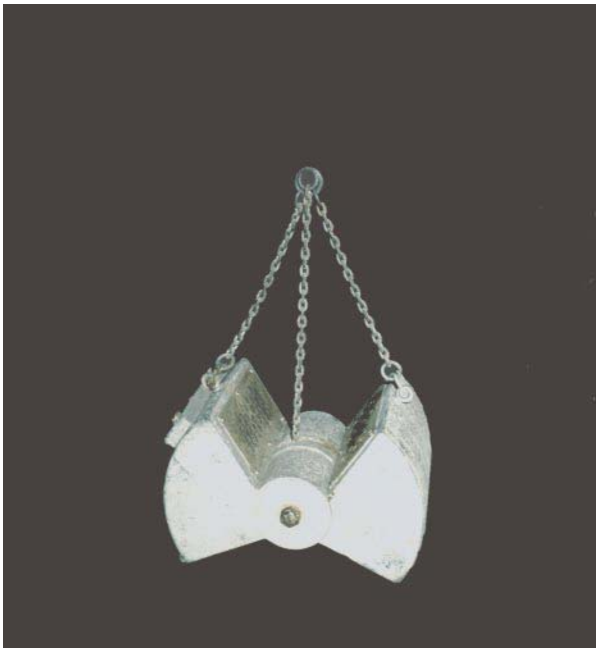

Figure 1 Petersen grab.