

SPATIAL AND TEMPORAL VARIABILITY IN BIODIVERSITY IN RESPONSE TO SEWAGE SLUDGE DISCHARGE OFF THE MEDITERRANEAN COAST OF ISRAEL

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Benthic assemblages have provided the most widely used parameters for assessing effects of waste discharges on the marine environment. The benthic invertebrate assemblage is considered an indicator of environmental quality because its components are relatively immobile and long-lived; thus they reflect the cumulative effects of exposure to environmental pollutants.

The Dan Region Wastewater project treats the sewage of the 1.3 million inhabitants of the Tel Aviv metropolitan area. Marine discharge of 14,000 m³/day of sewage sludge begun in 1987. The outfall is 5 km offshore at water 37 m deep. A baseline survey of the area conducted in 1978 revealed no aberrant conditions. The benthic fauna was diverse and abundant and indicated the disposal area was unpolluted at the advent of dumping.

During Spring 1992, the environmental ministry initiated an improved monitoring program to measure the environmental effects of sludge discharge at the site. Twenty stations along two lines intersecting at the outfall were established, at distances of 50, 100, 200, 500 and 1000 m from the outfall, and triplicate 0.062 m² box core samples were taken at each in May and November 1992, October 1993 and May 1994. The samples were washed aboard ship through 0.5 mm screen and preserved in 10% buffered formalin. In the laboratory the samples were washed, preserved in 70% ethanol and stained with Rose Bengal. Organisms were identified and counted. The data have been analysed with the aim of distinguishing different associations of organisms and to examine any gradients through the data.

Sediments in the vicinity of the sewage sludge outfall were nearly devoid of benthic macrofauna, suggesting that accumulating sludge particles have a deleterious effect on the fauna. Further away from the most organically enriched area the assemblage was composed of few pollution tolerant species, including extremely abundant populations of one or two opportunistic species. Beyond the enriched zone assemblages gradually approach the composition of the assemblage in the unpolluted environment and abundance values decline. The benthic assemblages found were dominated by polychaetes and bivalves, with a relative absence of crustaceans. Although the fauna at the sludge disposal site has shown significant degradation indicating modification of bottom environmental quality at and around the outfall, the size of the area affected fluctuated. In spring of 1992, samples collected 50 m from the outfall contained large numbers of capitellid polychaetes and little else, and those collected 100 m from the outfall contained large numbers of the bivalves *Abra alba* and *Corbula gibba*. In fall of 1992 and again in 1993, samples collected within an area delimited by the stations 1000 m north, 200 m east, 500 m south and 100 m west of the outfall, were nearly devoid of life. In spring of 1994, samples collected within 200 m of the outfall were extremely poor.

Available wave data indicate that at 37 m depth, near-bed currents capable of transporting fine sand occur only during particularly stormy winters. During fierce winter storms, wave induced motions near the sea bed rework the surface of the sediments, resuspending and widely dispersing the fine organic particles, sweeping the site clean of dumped material. Undisturbed accumulation of sludge takes place through the quiescent periods of the year. The winter of 1992 was stormy, thus by May 1992 the vicinity of the outfall was only little affected by sludge accumulation. The winter of 1994 was mild and indeed the fauna revealed the effects of increased organic loading. By fall these effects are exacerbated. The dispersive characteristics of the outfall site have prevented the perennial accumulation of organic substances. However, it appears that current rates of disposal have somewhat exceeded the dispersive capacity of the area, placing the fauna under stress and promoting the growth of pollution tolerant species. These changes are limited to a small area, but they suggest that further increases in sludge disposal may lead to more extensive, indicative and readily-identifiable effects.