Effects of Wastewater Effluent on Macrobenthic Infaunal Communities at Christies Beach, South Australia

Maylene G K Loo
Department of Environmental Biology
The University of Adelaide

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Abstract

The effects of an outfall discharging secondarily treated wastewater effluent into the southeast region of Gulf St Vincent, South Australia, were evaluated. The environmental assessment involved the sampling of macrobenthic infaunal communities, which were then analysed by a variety of methods ranging from multivariate (classification and ordination) to univariate (number of species, abundance, diversity and evenness) and distributional/graphical (log normal and ABC comparison) techniques.

The multivariate analyses of community structure indicated that the Christies Beach Wastewater Treatment Plant effluent outfall had induced changes to the macrobenthic infaunal communities. Whereas there were significant spatial and temporal variations at both the outfall and control sites, differences between the compositions of the macrobenthic infaunal communities at the outfall site and the control site were still evident. Furthermore, the expected gradient response with increasing distance from the outfall was also observed. Differences were consistent with an increased organic and nutrient loading on the benthos resulting from discharge from the Christies Beach Wastewater Treatment Plant.

In measuring community stress, the Abundance-Biomass Comparisons (ABC) showed intermediate to moderately disturbed conditions for stations in close proximity to the outfall. These stations appeared to have communities increasingly dominated numerically by very small opportunistic species (especially spionid polychaetes). Similarly, the neutral model analysis indicated disturbed conditions with reduced diversity for stations close to the outfall. Although plots of abundance of individuals among taxa (log-normal plots) showed that both the outfall and control sites had uneven distribution of abundance groups, interpreted as being indicative of the effects of moderate organic enrichment, the outfall site had more abundance groups, suggesting the possibility of higher organic enrichment at the outfall site. Furthermore, indicator abundance groups at the outfall site had taxa such as capitellid polychaetes, which were responsive to organic enrichment while taxa that characterised the control site (e.g. gammaridean amphipods) were more pollution sensitive. The changes in the various community descriptors (e.g. abundance and diversity) along a gradient of organic enrichment were generally observed to follow models such as the Pearson-Rosenberg model.
The results of this research were also compared with work on other macrobenthic communities in Gulf St Vincent, to address the problem of a single control site. In addition, a more detailed analysis of the infauna data, addressed temporal (inter-annual differences) and spatial variability (resolution of the gradient response) at the outfall site. These detailed analyses showed that the single control site (Meana) was typical of shallow water gulf sites along the metropolitan coast and therefore an appropriate basis for the comparisons in this study. The comparison within the outfall site in terms of spatial resolution of the gradient response and inter-annual variability indicated that regardless of the variability, the macrobenthic infaunal communities appeared to change with increasing distance from the discharge point.

Benthic respirometry was used to quantify the rate of total sediment oxygen consumption at the outfall site and at two control sites. The results showed that the mean rate at the southern control site was lower than the outfall site and the northern control site. However, there were no differences between the northern control site and the outfall site. These differences in rates were probably due to the supply of organic carbon to the sediment from the effluent discharged at the outfall site and a stormwater drain at the northern control site, while there were no such discharges in the immediate vicinity of the southern control site.

Overall, the results of this study supported the hypothesis that the Christies Beach effluent outfall has induced significant and persistent changes to the structure of the macrobenthic infaunal communities, which increased in severity in relation to the proximity to the outfall. Furthermore, the temporal patterns of community structure indicated that, over and above the seasonal variations, communities at the outfall site were still different from communities at the control site and appeared to relate primarily to distance from the discharge point. These differences were consistent with the environmental effects one would expect from an effluent discharge.