ABSTRACT

A STUDY OF THE GROUNDWATER NUTRIENT FLUXES TO THE SMALL, TROPICAL EMBAYMENT, DISCOVERY BAY, JAMAICA

Debbie-Ann Denise Shantie Gordon-Smith

Over the last decade, the reasons for the degradation of the coral reef at Discovery Bay, Jamaica and other reefs worldwide have been a topic of much debate. During the 1980's, the reef at Discovery Bay experienced a phase-shift from coral-dominance to macroalgal-dominance. Researchers have proposed a number of natural and anthropogenic factors that could have led to the decline. However, there is still much disagreement as to the reasons for the phase-shift on this reef.

The role of elevated nutrient concentrations in the decline of the reef at Discovery Bay is not fully understood due to the paucity of available chemical data. The problem in Discovery Bay is complex because there are no permanent surface flows to the bay and the major source of freshwater is submarine groundwater discharge. Studies have investigated the nutrient concentrations in the bay but the conclusions of

these studies have not been consistent. Also, the nutrient loadings to the bay are unknown because the groundwater discharge to the bay has not been quantified.

The significance of the submarine groundwater discharge and its associated nutrient fluxes into Discovery Bay were investigated in this study. The groundwater flow into the shallow western section of the bay was determined by a salt-balance. The groundwater discharge from submarine vents and seepage through sand was determined using direct measurements of flow. The groundwater discharge into the western section was calculated at 4.8 – 13 x 10^4 m^3 d^{-1} using the salt-balance method. This estimate was significantly higher than the total groundwater discharge into the bay from vents and seepage of 13 – 67 x 10^3 m^3 d^{-1}. The submarine vent flow was not affected by seasonal (rainfall-related) changes and accounted for about 70% of the total groundwater discharge during dry periods. After periods of heavy rainfall, the seepage rates increased ten-fold and accounted for about 80% of the total discharge.

The nutrient concentrations in the western section and at vent and seepage sites in the bay were measured. There were significant salinity stratifications within the western section of the bay. In the western section and at the vent sites, the total oxidised nitrogen, total dissolved nitrogen, soluble reactive phosphorus and total dissolved phosphorus

concentrations correlated with salinity while the ammonium concentrations did not. Chlorophyll a concentrations were highly variable but the levels suggested oligotrophic to mesotrophic conditions in the bay. The seepage nutrient concentrations were highly variable. During the sampling period, the concentrations of TOxN and SRP, the major nitrogen and phosphorus species in the groundwater, (estimated from dilution curves) ranged from 52 to 135 μM and 0.33 to 1.3 μM, respectively.

The groundwater nitrogen and phosphorus fluxes were calculated to be 0.72 – 1.4 kg N d^{-1} and 0.01 – 0.04 kg P d^{-1} during periods of low rainfall and 1.3 – 3.5 kg N d^{-1} and 0.01 – 0.19 kg P d^{-1} following periods of heavy rain. Increases in the fluxes during wet periods were sustained for several months. However, the nutrient fluxes to Discovery Bay (wet and dry periods) were trivial when compared to river and groundwater fluxes at other sites in Jamaica and around the world.