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Marine Groundwater Studies in Biscayne National Park, South Florida

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Submarine groundwater discharge (SGD) is spatially and temporally variable along a coastal margin where the influence of marine tides and onshore hydraulic gradients converge. There are numerous methods of monitoring and quantifying groundwater dynamics along a coastal margin. Three methods have been used to define the system in Biscayne National Park. Biscayne National Park (BNP), located south of Miami, Florida, encompasses 172,000 acres of which more than 95% is located in a marine environment containing mangrove, seagrass, and coral reef ecosystems. That waters in BNP consist of both marine and estuarine systems has made the use of Radon (^{222}Rn), seepage meters, and ground- and surface-water sampling key components in the study of groundwater/surface-water exchange.

The most common method used in delineating SGD is the placement of seepage meters at various locations along the coast. The USGS has acquired two electromagnetic seepage meters (ESM) that can be programmed to operate autonomously, have high sampling rates (1 per min), and can measure relatively low flows (<0.2 L/min). The instruments have been used in various environments ranging from estuaries in Tampa Bay and Biscayne Bay to salt ponds on Rhode Island and in the Florida Everglades. Groundwater discharge measured in Biscayne Bay at Cutler Ridge was on the order of 10 to 45 cm/d (mean=25.2 cm/d). These discharge values resemble values calculated from a groundwater/surface-water model for the same site. This technique, however, gives only point data, and results can be influenced by various forcing factors (e.g., wave action, tidal pumping, local hydraulic gradient). A second method, which shows promise, is the utilization of an instrument (RAD7) that continuously monitors ^{222}Rn (half life=3.8 days) in the water column. Whereas seepage meters only provide point data, continuous mapping of ^{222}Rn can be conducted from a boat running track lines normal or parallel to shore. In BNP, six RAD7s connected in series allowed for close discretization of samples (i.e., 5-min averages). Inference to ground water seeping into overlying waters can be made when ^{222}Rn is high in surface water. This assumption can be made because ^{222}Rn, an inert gas, is continuously produced in the subsurface. Concentrations of ^{222}Rn can be 10 times greater in the limestone aquifer underlying the bay. Average ^{222}Rn values in BNP surface and ground water were 3 dpm/L and 256 dpm/L, respectively.

Monitoring wells have also been employed in offshore coastal settings to identify both chemical constituents (nutrients, trace metals, organics, etc.) and pressure gradients that may prove to be useful in understanding offshore hydraulic gradients. Monitoring wells installed below the surface of Biscayne Bay and on the reef tract of BNP have been sampled five times during a period from August 2002 to March 2004. Data from these wells show that marine salinities are common in the mid-bay and offshore reef wells, but fluctuate somewhat along Elliott Key (east side of Biscayne Bay) and along the mainland (west side of Biscayne Bay). The nutrients analyzed in this study are ammonium, nitrates, nitrites, soluble reactive phosphorus, and soluble silicates. Ammonium, soluble reactive phosphorus and soluble silicates concentrations are elevated in ground water relative to surface water. However, based on other groundwater studies, these three nutrients are also elevated in nearby systems such as Florida Bay and the Florida Keys.