Can Off-Shore Outfall Pipes Disperse Nutrients and Bacteria From Stormwater Runoff?

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Abstract

Recent research has shown that nutrients, mainly nitrate and phosphate, can behave as pollutants to fresh and marine waters if present in large enough quantities. Nitrogen and phosphate-based nutrients are often the limiting factors of primary production in fresh and marine waters; as such, general increases in their levels can spur phytoplankton production and cause algal blooms, some of them toxic. When the organisms in these blooms begin to die, the rapid decomposition of such large mass leads to highly depleted oxygen levels in the water column. As the frequency of algal blooms, particularly Harmful Algal Blooms (HABs), has risen in the past two decades, it is important to monitor nutrient levels in coastal waters and examine the relationship between increased algal blooms and nutrient loading from stormwater discharge pipes from a stormwater discharge pipe rough 16 feet above the ocean. The stormwater discharge pipes at Myrtle Beach SC have been shown to have chronic nutrient levels of contaminants away from the surf zone. High nutrient levels were expected in this runoff due to the adjacent mangrove forest and coastal grasses. A nutrient assessment of this new discharge system did show elevated bacterial counts as well as higher-than-normal concentrations of chlorophyll. This means that although the pipe is restricting water outfalls, it is also possibly contributing to algal bloom formation. Furthermore, it appears that some of this diverted water is “blocking” its way back to the surf zone and causing a possible contamination hazard for people or animals in the area.

Introduction

Along the Grand Strand of South Carolina (from NC-SC state line to Winyah Bay), stormwater flows into pipes that discharge into the beach boulders. Approximately 250 pipes are currently in place from Cherry Grove to Garden City. Some stormwater also flows through a natural salt marsh southwest of the Myrtle Beach, SC. Stormwater sampling was conducted from 4/14/04 and 4/20/04 following a significant rain event (1.7 in) on 4/13/04. Pre-rain sampling was performed at 3/17, 4/5, 4/14, 4/15, 4/16, 4/17, 4/18, 4/19, and 4/20. The sampling sites included Yaupon and adjacent sub-basins as a significant source of nutrients to the surf zone. Yaupon indicates that excess water can be flushed into the surf zone but then quickly decline due to the toxic effect of saline waters.

Numerical Eutrophication Criteria

The following water quality analytes were averaged for each sampling event:

- Total Nitrogen (ppm N)
- Nitrate + Nitrite (ppm N)
- Chlorophyll a (mg/L)
- Turbidity (NTU)
- Solids (mg/L)
- Phosphate (mg/L)
- Dissolved Oxygen (mg/L)
- pH

The area is subjected to hurricanes that deposit large amounts of contaminants into the area. The nutrient concentrations were determined using methods developed by Parsons et al. (1984).

Sampling Design

Sampling Sites:

- Yaupon Drainage Sub-Basin (Figure 2.1) - serves discharge pipe (2)
- Surf Zone adjacent to drainage basin (3)
- Springmaid Pier (12.5 km south of drainage sub-basin) (4)
- Second Avenue North (5.8 km north of drainage sub-basin) (The pipes were chosen as sampling sites because they lead into the ocean approximately 250 m from the discharge pipe (335 m) and should reflect the effects of storm-areas flow of stormwater discharge pipe).

The sampling site in the surf zone adjacent to the drainage basin reflects the impact of pollution washed back onto the beach by incoming waves and serves as a measure of potential impacts on the outer zone.

Results

- Chlorophyll a concentrations were low in drainage basins and declined after rain event.
- Evidence for bloom within one day after rain was seen at all the ocean sites. Chlorophyll a to Phaeophytin ratio (4.0 to 5.5) peaked two to three days after end of rain.
- Concentrations in ocean during bloom exceeded EPA draft nutrient criteria.
- Concentrations in ocean to be low and immediately after rain event exceeded US EPA draft nutrient criteria.
- DO concentrations increased through day 3, after which there was a general decline.
- This is further evidence for bloom formation during days 2 & 3 following rain event.
- In the basin, overall increase in DO over the entire sampling period indicated phosphorus following their increase in the surf zone. Although chlorophyll concentrations did not return to pre-rain levels.
- A sample from the drainage sub-basin was underestimated, suggesting presence of oxygen-demanding substances the bloom.
- All ocean sites reached supersaturation by the third day after the rain event, suggesting the occurrence of a phytoplankton bloom.
- By end of sampling period, all sites were understated, suggesting day off and remineralization of bloom biota.

Conclusions

- It is likely that the new outlet pipe designed to carry stormwater away from the surf zone is at least partially responsible for the algal blooms found in this study.
- Algal blooms could also be supported by discharges from adjacent swales (Myrtle and Withers)
- Data from another rain event (1.7” on 5/24) showed similar plankton bloom on same time scale (1 day) after end of rain.
- This suggests a reproducible phenomenon.
- The amount of freshwater (0 psu) introduced into the nearshore was not enough to significantly lower the salinity (33.5 psu).
- Bacterial counts also did not rise very high in the surf zone. Due to the storm event, they were not as high as expected for offshore sites.

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