Sewage Pollution in Bermuda

Rachel Parsons (BIOS) Tim Noyes (BIOS Ross Jones (AIMS)	David Kendall and Elaine Watkinson Department of Health, Government of Bermuda

Department of Health

The Department of Health regularly monitors seawater quality at the beaches and other locations within Bermuda's inshore waters. They use the membrane filtration (MF) method according to the EPA Recreational Water Quality Criteria. This extensive dataset was used towards a publication (Jones et al. 2010 – see below) that included scientists from BIOS.

Seabright Sewage Outfall Study 2007 to 2010

Background: There is no national sewerage system in Bermuda and ~20 x 10^6 L of sewage is generated daily. This sewage is disposed of via marine outfalls, cess pits/septic tanks underneath houses and through waste disposal (injection) wells. The largest sewage outfall at Seabright receives effluent from Hamilton and surrounding areas (Photo 1). This effluent is only preliminary treated. The Seabright outfall is 784m from the entry to Hungary Bay, 700m from the eastern end of Grape Bay and 1600m from the eastern end of Elbow Bay; all popular bathing beaches.

In 2007, The MEP Lab joined with the Oceanic Microbial Observatory to look at the impact sewage had on the environment surrounding Seabright Sewage outfall. Dr. Ross Jones, formerly of BIOS and now at AIMS, was interested in the impact sewage has on the water quality and the coral reef environment. Alicia Shepard, a NSF funded REU student looked at the microbial composition of water samples as well as the coral surface microlayer (CSM) of *Porites Astreodes*. She found that the microbial abundance increased significantly in corals just west of the sewage outfall (Figure 1). Since the predominant flow at the outfall is in a westward direction, this was not surprising.

***Photo 1**: The Seabright Sewage outfall site showing the marker bouy, sewage slick and team sampling on board the R/V Stommel.*

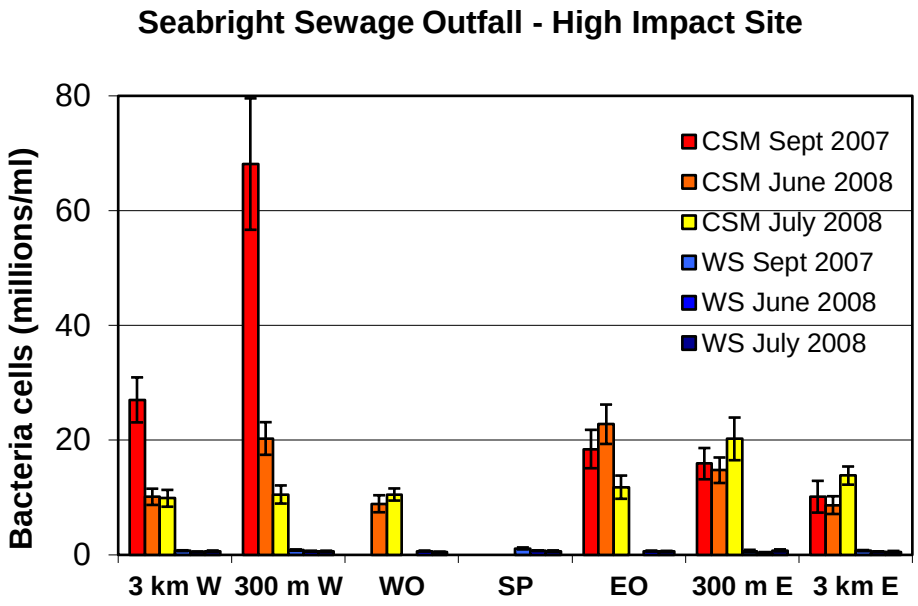

***Figure 1**: Bacteria counts in millions of cells per mililitre of seawater and coral surface microlayer (CSM) samples taken at sites around Seabright sewage outfall. The site 300m west of the outfall had the highest counts inn September 2007.*

The project was continued in 2008. Princeton intern, Maria Fasolino and Eckerd intern, Kerrie Collins joined the group. The Department of Health also assisted with measuring *E.coli* and *Enterococci*, fecal indicator bacteria species, in water samples from the sites. The method used is membrane filtration (MF) that requires these bacteria to grow on plates; a culturing method approved by the EPA and WHO. The MF data was included in

a publication on the health of coral reefs in Bermuda and in particular those coral reefs impacted by Black Band disease.

Jones, R, Johnson, R, **Noyes, T**. and **Parsons, R**. 2012 Spatial and temporal patterns of coral black band disease in relation to a major sewage outfall in Bermuda. Mar Ecol Prog Ser 462: 79-92.

In addition to MF as a method to indicate fecal contamination, Maria used fluorescent in-situ hybridization (FISH) to look at the bacterial community in water and CSM samples. She found E.coli in both water and CSM samples as far as 3 km east and west of the outfall. Kerrie was using polymerase chain reaction (PCR) to look at the presence or absence of the human strain of *Bacteroides* in water and CSM samples. The human strain of Bacteroides is an anaerobic bacteria that lives in the human gut. While it cannot be detected using the normal culturing techniques, it was be detected using molecular methods – PCR. We found *Bacteroides* in water and CSM samples as far as 3km east and west of the sewage outfall where we detected little *E.coli* or *Enterococci* in water samples. This suggests that the present sampling methods are not sensitive enough to determine fecal contamination in marine waters.

In 2010, we revisited Seabright. Dr. Jones had left BIOS so research specialist, Tim Noyes and myself planned another project. Mae Lortie from Connecticut College and Nathan van Bibber from Eckerd College joined the team. We decided to sample sediments as well as water and the CSM. Mae used fluorescent in-situ hybridization (FISH) to look at the bacterial community in water and CSM samples. She found E.coli in water, CSM and sediment samples from near the outfall. Nathan used PCR to look at the presence or absence of the human strain of *Bacteroides* in water, CSM and sediment samples. The Department of Health also assisted with measuring *E.coli* and *Enterococci*, fecal indicator bacteria species, in water samples from the sites. Mae returned to BIOS in 2011 to continue work on this project and was funded by Parsons. *E.coli, Enterococci* and the human strain of *Bacteroides* were found in water samples from Hungary Bay. The presence of the human strain of *Bacteroides* was also found in CSM and sediment samples near the sewage outfall. Since the wave action on the south shore of Bermuda helps to churn up the waters, corals and sediments also need to be included in any study on sewage contamination. Bacteria counts from high impact sites around Bermuda were compared and showed that water circulation plays a large role in bacterial abundance (Figure 2).

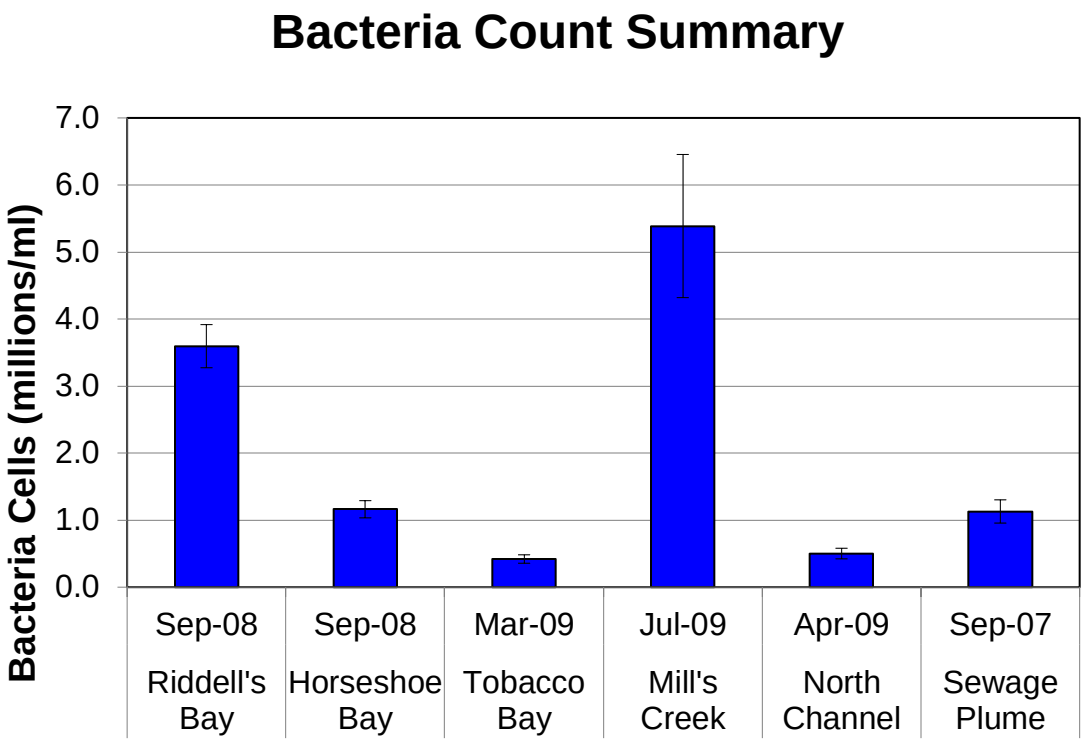

***Figure 2**: Bacteria counts in millions of cells per mililitre taken at six sites around Bermuda showing that Mill's Creek and Riddell's Bay have higher counts than the sewage plume.*