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Reef Edge: Feshwater Coral Kills

REEF EDGE

Scientific letters or notes describing observations or data

Recent freshwater reef kill event in Kāne'ohe Bay, Hawai'i

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Freshwater 'kills' are rare events caused by lowered salinity during severe runoff and storm floods (Coles and Jokiel 1992) that modify the structure of reef communities. Coral reef communities within Kāne'ohe Bay are shallow (>50% of the bay is less than 3.3 m deep) and therefore extremely vulnerable to increased freshwater effluent due to the formation of a persistent freshwater surface layer that causes reduced salinities near these coral reef organisms (Banner 1968; Jokiel et al. 1993). Reduction of salinity to 15 - 20$^0/_{00}$ for 24 hours or longer results in extensive mortality in these shallow water communities (Coles and Jokiel 1992; Jokiel et al. 1993). Data on the frequency and intensity of freshwater kills are important in the understanding of long-term trends in coral reef ecology, while long-term monitoring programs need to continue over many decades (e.g. Rodgers et al. 2014) in order to capture their impacts.

Extensive freshwater 'kills' due to flood events with associated low salinity were documented in Kāne'ohe Bay during May 1965 (Banner 1968), January 1988 (Jokiel et al. 1993), and most recently, though less severely, during flash floods in July 2014 – indicating a frequency of re-occurrence of approximately 25 years. During the 1965 flood, the freshwater discharged into the bay in a 24 h period was calculated to be equivalent to a surface layer of 27 cm over the entire bay (Banner 1968). The resulting reduction in salinity in surface waters caused substantial mortality of coral reef organisms, with near total mortality of corals to a depth of 1-2 m in inshore regions. Twenty-three years later, a comparable storm flood resulted in similar destruction of the reef flat corals (Jokiel et al. 1993).

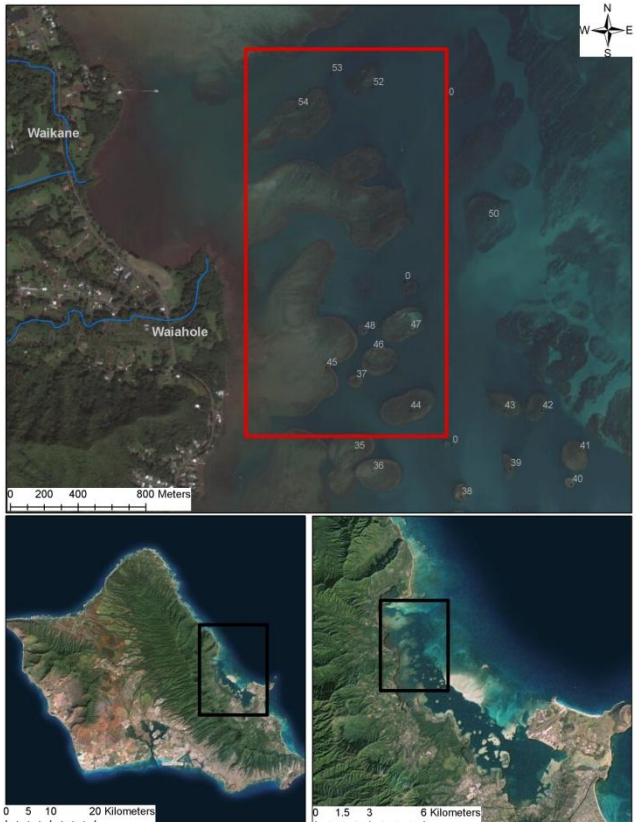

Figure 1. Map of Kāne'ohe Bay, a semi-enclosed estuarine coral reef ecosystem, located on the northeast coast of O'ahu, Hawai'i (21°, 28'N; 157° 48'W). The lower insets show the location of the Bay, and the red box in the main figure the area most heavily impacted.

The event of July 2014 was less severe than previous 'kills' and was localized to the northern leeward patch and fringing reefs in the bay (Fig. 1). Extensive mortality of corals and cryptic reef-dwellers (e.g. eels, crabs, shrimp) was observed following the storm (Fig. 2). A large percentage (50-90%) of the patch and fringing surveyed reefs was negatively affected. The reefs located close to the Wai'āhole and Waikāne stream mouths were the most adversely affected by the freshwater effluent. Within a 24 h period, 24 cm of rainfall was measured at the Wai'āhole rain gauge which increased the stream daily mean discharge by an order of a magnitude from 0.74 $m^3 s^{-1}$ to 24 $m^3 s^{-1}$ (USGS 2014). Fortuitously, thermographs and irradiance recorders had been deployed on the reef

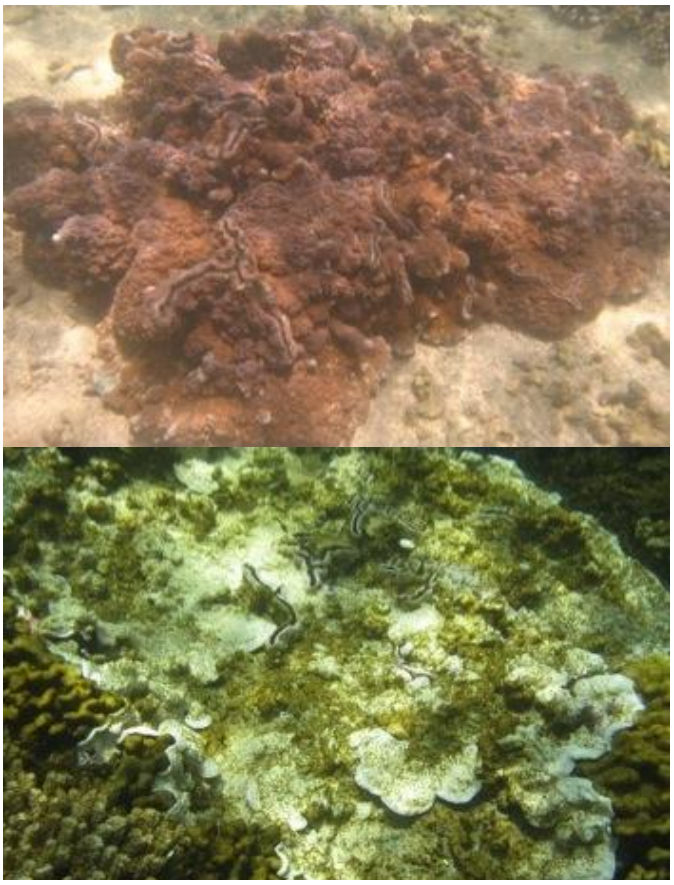

Figure 1. Above, a large bleached colony of the coral *Montipora patula,* with dead tissue sloughing (brownish green), compared to a similar healthy coral (below), located outside of the area of damage during the 19-20 July, 2014 storm event.

before the storm. Temperatures before the storm ranged from 27.4 - 29.2°C on the patch reefs with gauges (Fig. 2: reefs 44, 46, 47). The input of freshwater caused temperatures on the adjacent reef flat to decrease by 1°C and average irradiance levels to decrease by 55%; this compares with reports on the flood of 1988 that caused a temperature drop of 1 - 3°C and reduction of solar irradiance levels by 10-20% (Jokiel et al. 1993).

Acknowledgments
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Dimming sand halos in Dominica and the expansion of the invasive seagrass *Halophila stipulacea*.

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Coral reefs of Dominica are restricted to the island's narrow shelf. Most of its 31 reefs and reef complexes are clustered in two areas, one in the North and one in the West (Fig. 1). Together they comprise 77 % of the total coral reef area of only 80.5 ha (Steiner 2015) and are exposed to chronic stressors such as storm-induced breakage, sediment resuspension and terrestrial run off due to their proximity to shore (Steiner 2003). Despite Dominica's comparatively modest infrastructural development and a low human population (slowly declining from a peak of close to 74,000 in the 1950s), deforestation, the use of coral lime in construction, and fishing pressure since the 18th century, are among the principal direct anthropogenic forces that have shaped the deterioration of coral reefs throughout the island (Steiner 2015). In addition, the four most recent coral bleaching episodes between 2003 and 2010 led to further substantial loss of live coral cover (Steiner 2015).