Water quality, ground water plumes and nutrients in benthic algae in Maunalua Bay

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The ecologic/biotic response component of our SGD project with Peter Swarzenski, Gordon Tribble, Sarah Akin, Sarah Rosa

Principal take home message:
Initial results show terrestrial-derived nutrient across reef flat.
Algae uptakes terrestrial derived N.
Now need to source N.
Distinct change in reef flat color (cover?) at Kahala
Hypotheses:

1. Difference in nutrient input along the coast results in different biotic response

2. Chronic input either surface runoff or groundwater discharge (along with net circulation) leads to distinct biotic response
Representative Photographs of Reef Flat Algae

Dense turf, lettuce algae

Diverse sp., 100% cover

Thick, 100% cover
Methods: Paired Studies across reef flat at our SGD sites (plus Waialae Golf Course)

Surface water properties:
- Salinity, Temp, pH, Diss. Oxygen, turbidity (YSI 6920V2 Multiparameter)
- Nutrient Concentrations

Benthic algae:
- Stable isotopes ($\delta^{13}C$, $\delta^{15}N$, C:N)

SGD-Plume Mapping:
Volume/Flux Calculations
Results: Fresh-brackish plumes alongshore from SGD

Marine value ~35

Salinity across-shore

Depressed marine salinities out to 50-100 m

Offshore spring at BP

Nov. 13, 2008
Results: Fresh-brackish plumes
High DIN concentration

18x greater NOx in SGD plume

Salinity vs. NO\textsubscript{x} across-shore (BP)

Nov. 13, 2008
Benthic Algae: Isotope analyses ($\delta^{15}N$)

18x greater NOx in SGD plume

$\delta^{15}N$ (Hypnea sp.) characteristic of terrestrial source across most of reef flat

Typical Sources:
- Fertilizers (-4 to +4 per mil)
- Sewage (+10 to +20 per mil)
- Soil (+2 to +4)

Black Point

Nov. 13, 2008
Results: Fresh-brackish plumes
High concentration of **All** nutrients

Very similar pattern to what we find at:
Maui/Molokai (Grossman et al. 2008; Street et al. 2008)
Kona (Knee et al. 2008)

Nutrient Concentrations (Black Point)

- NOx
- PO4
- NH4
- SiO2

Nov. 13, 2008
SGD-Plume Volume (high tide)

1. SGD along shore

How Extensive?
How Persistent?
1. SGD pushes seaward affecting ~3 acres
Each day (2 tide cycles) inputs ~1 MGal of SGD at this one site alone

SGD often 10-100 times greater total N-concentration than seawater

1. SGD pushes seaward affecting ~3 acres
2. Displaces seawater, depresses salinity across 90% of volume
3. Volume change = 2,000 m³ (~0.5 MGal)
Many SGD Points along Maunalua Bay

Assuming same rate at each of these 7 sites = ~7 MGal/day of SGD along Maunalua Bay

Eric and Peter integrating SGD flux and nutrient concentrations to estimate nutrient loads
Conclusions/Future Directions

Mapping physical properties of nearshore waters reveals SGD-plumes extensive across reef flat and high SGD fluxes; Need to determine spatial and temporal variability in extent.

SGD-plumes have high nutrient concentration across reef flat; Need to determine spatial and temporal variability and fate.

Benthic algae contain $^{15}$N characteristic of terrestrial source; Further work needed to determine source of nutrient loading, we hope to fingerprint sources of dissolved and particulate nutrients (with Dan Hoover, now with USGS).