

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



Data U.S. Navy
Image © 2009 CyberCity 3D, Inc. / Team Vision Virtual
Image U.S. Geological Survey
Image © 2009 TerraMetrics

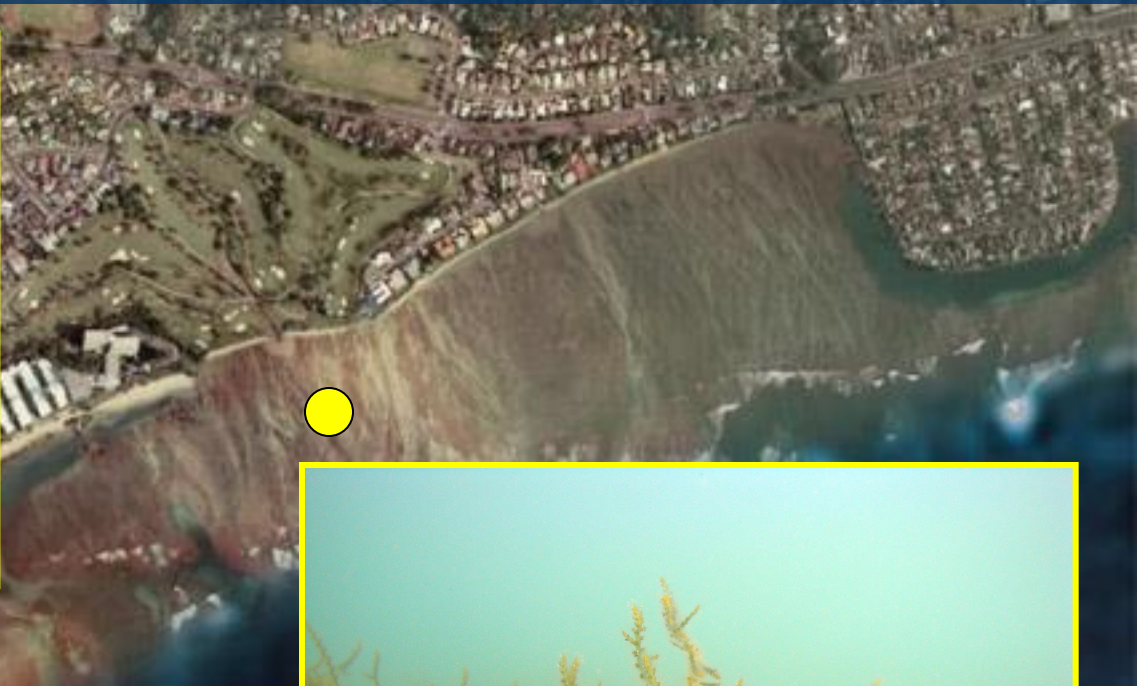
Hypotheses:



- 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**



Dense turf, lettuce algae



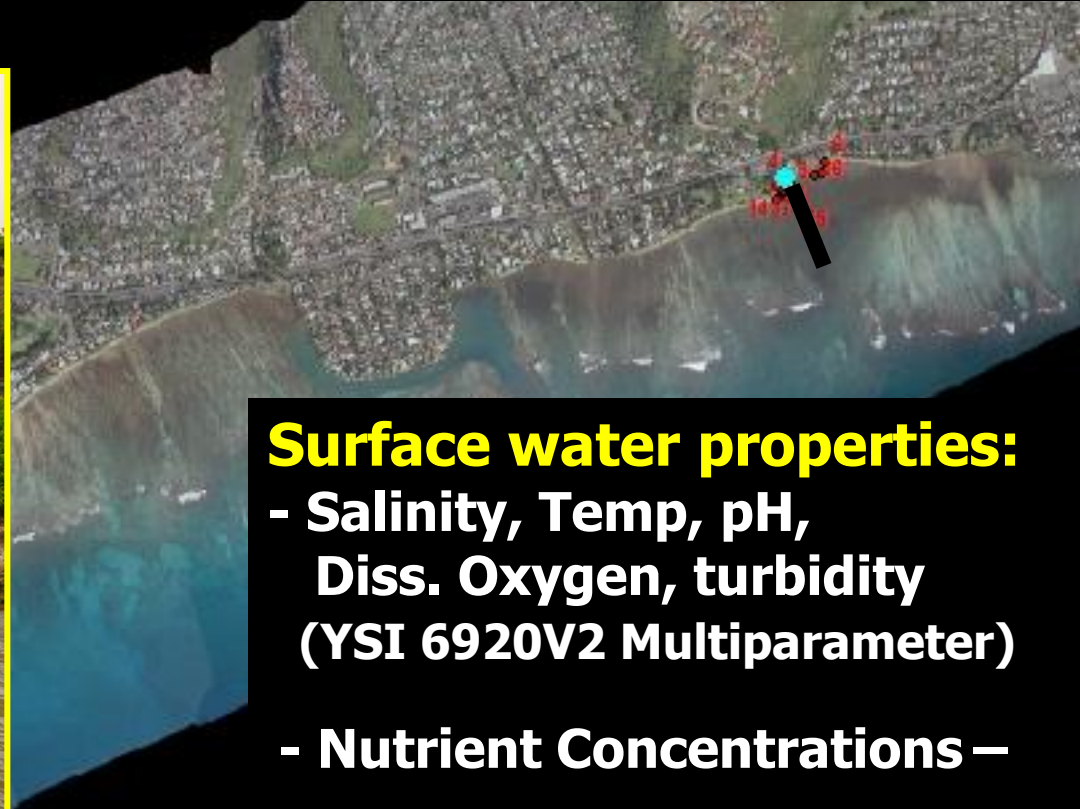
Thick, 100% cover



Diverse sp., 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 –

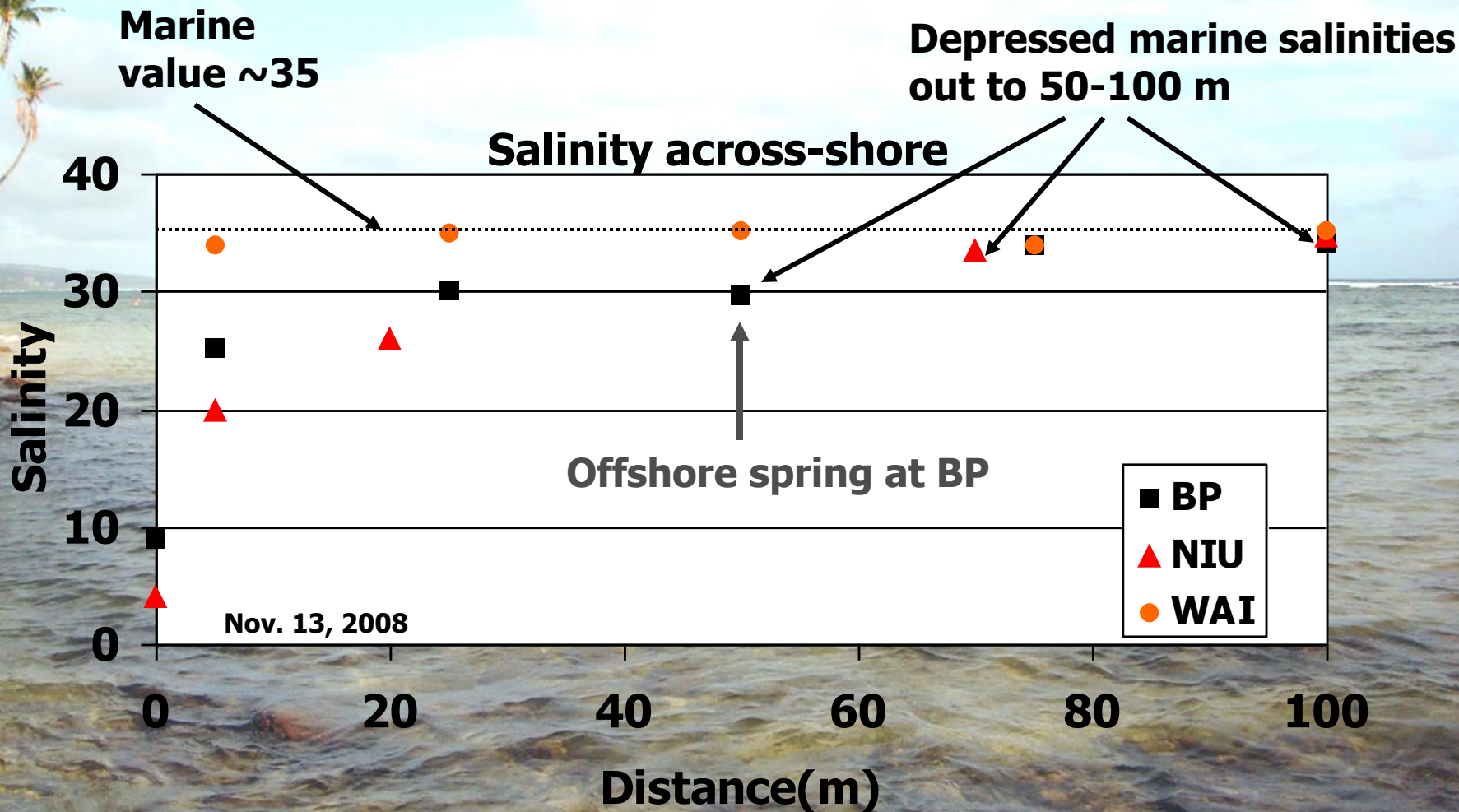
Benthic algae:

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

SGD-Plume Mapping:

Volume/Flux Calculations

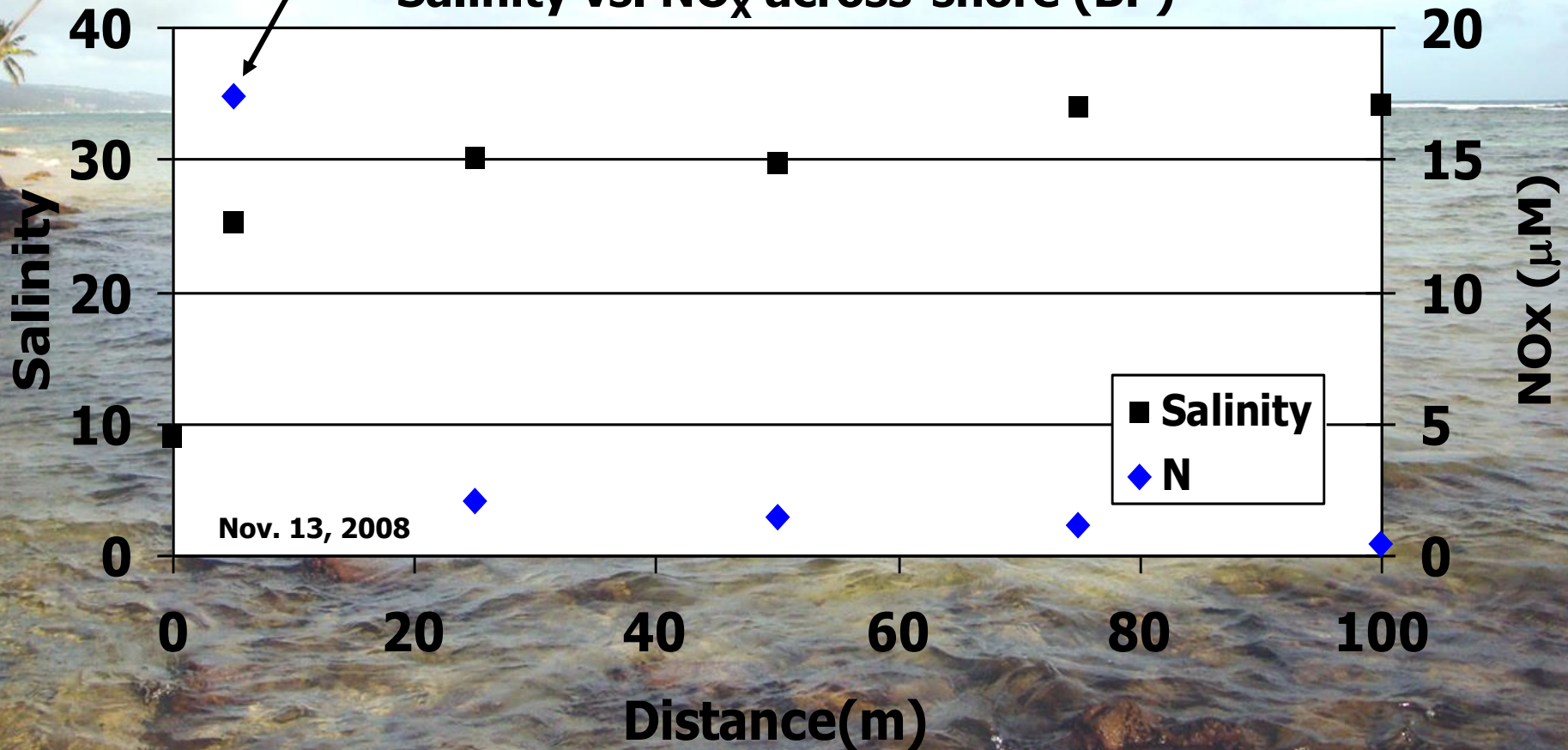
Results: Fresh-brackish plumes alongshore from SGD



Results: Fresh-brackish plumes High DIN concentration

18x greater NO_x
in SGD plume

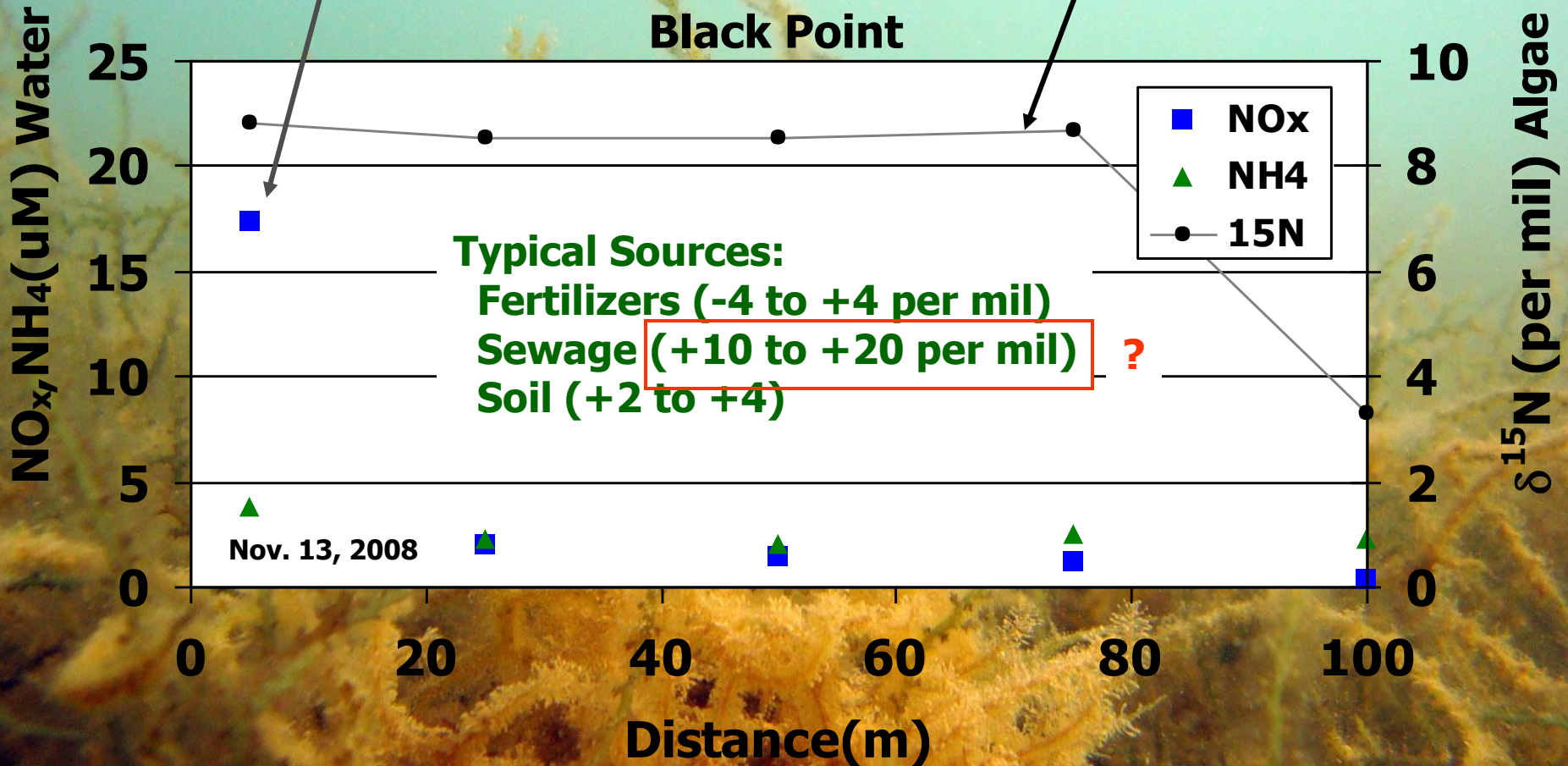
Salinity vs. NO_x across-shore (BP)



Benthic Algae: Isotope analyses ($\delta^{15}\text{N}$)

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

18x greater NO_x in SGD plume

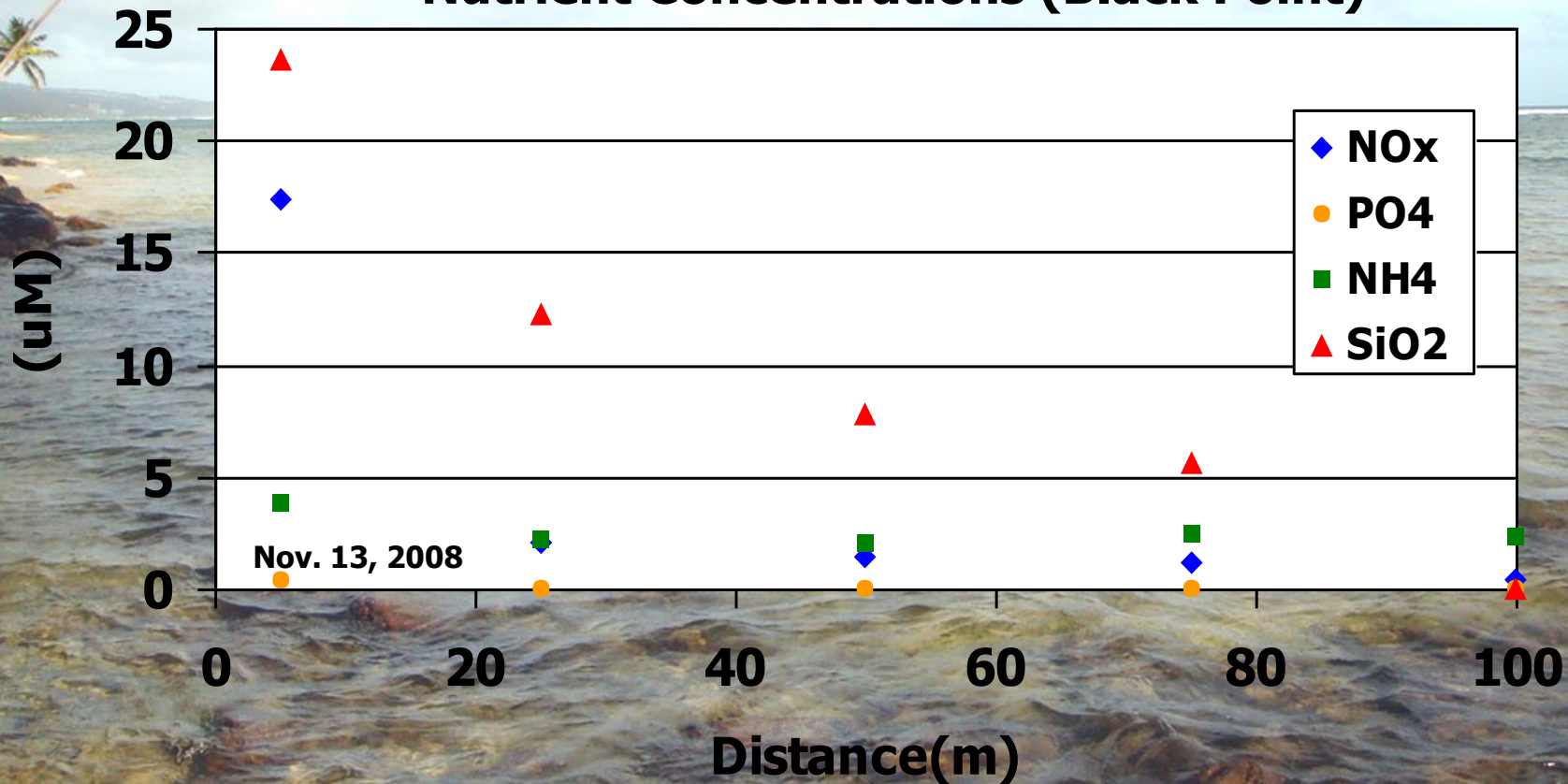


Results: Fresh-brackish plumes

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)

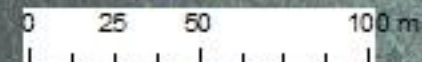
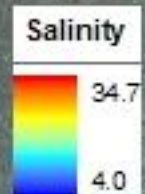
Nutrient Concentrations (Black Point)



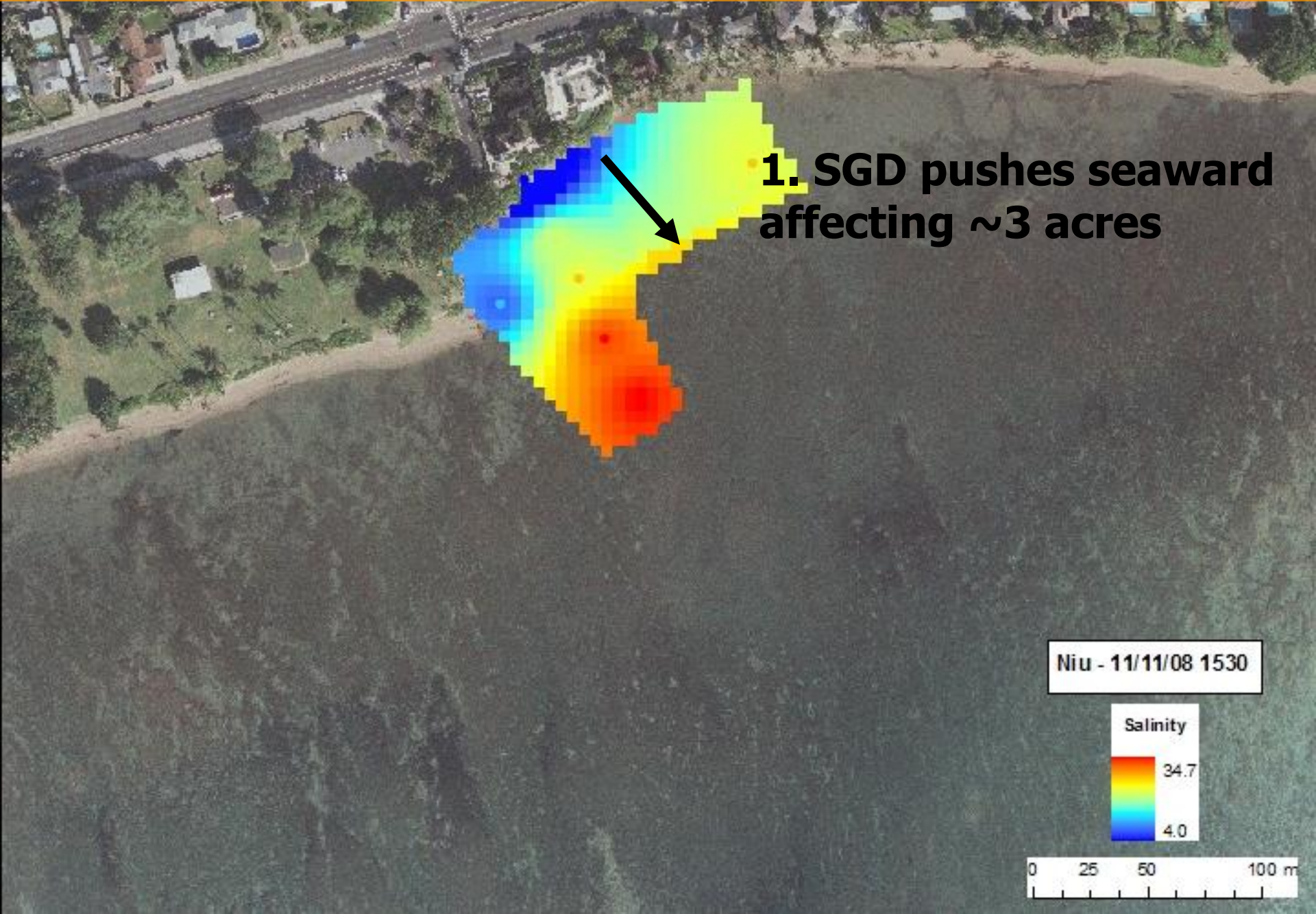
SGD-Plume Volume (high tide)

1. SGD along shore

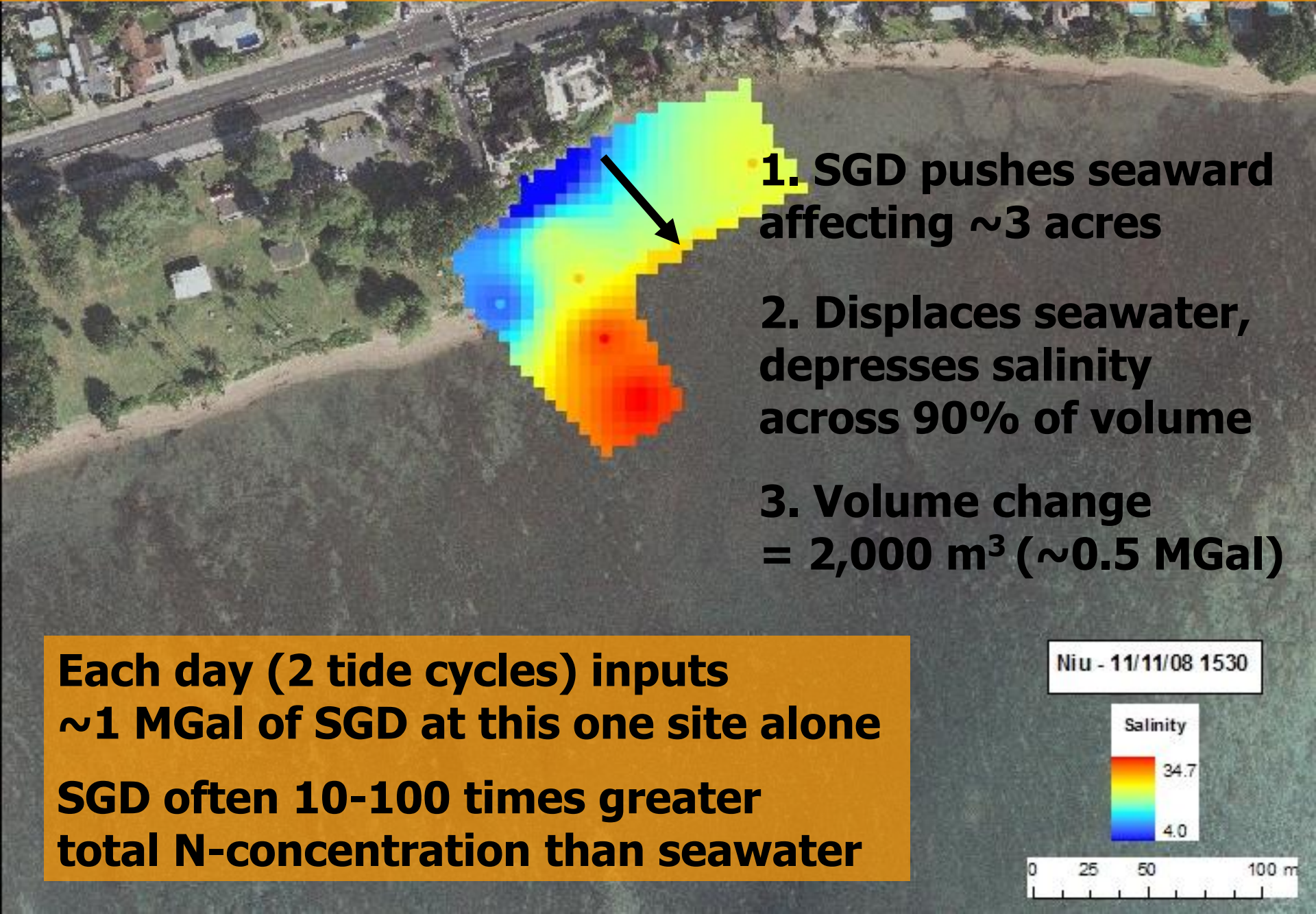
How Extensive?
How Persistent?



SGD-Plume Volume (low tide)



SGD-Flux Estimates



1. SGD pushes seaward affecting ~ 3 acres

2. Displaces seawater, depresses salinity across 90% of volume

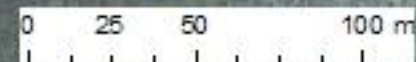
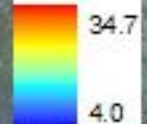
3. Volume change = $2,000 \text{ m}^3$ ($\sim 0.5 \text{ MGal}$)

Each day (2 tide cycles) inputs $\sim 1 \text{ MGal}$ of SGD at this one site alone

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

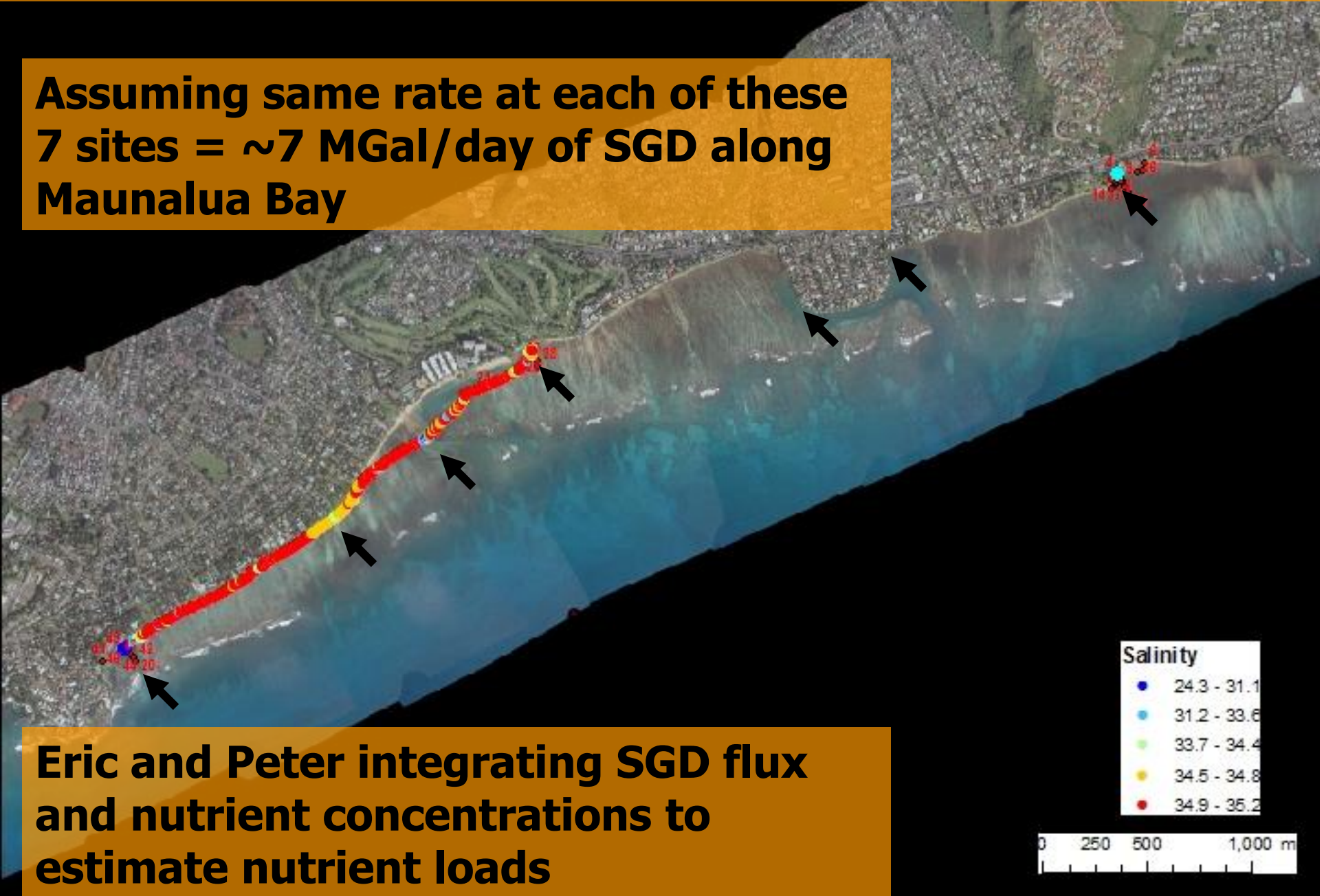
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Salinity



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)