

Wet season fecal indicator bacteria distribution and source, Malibu, California



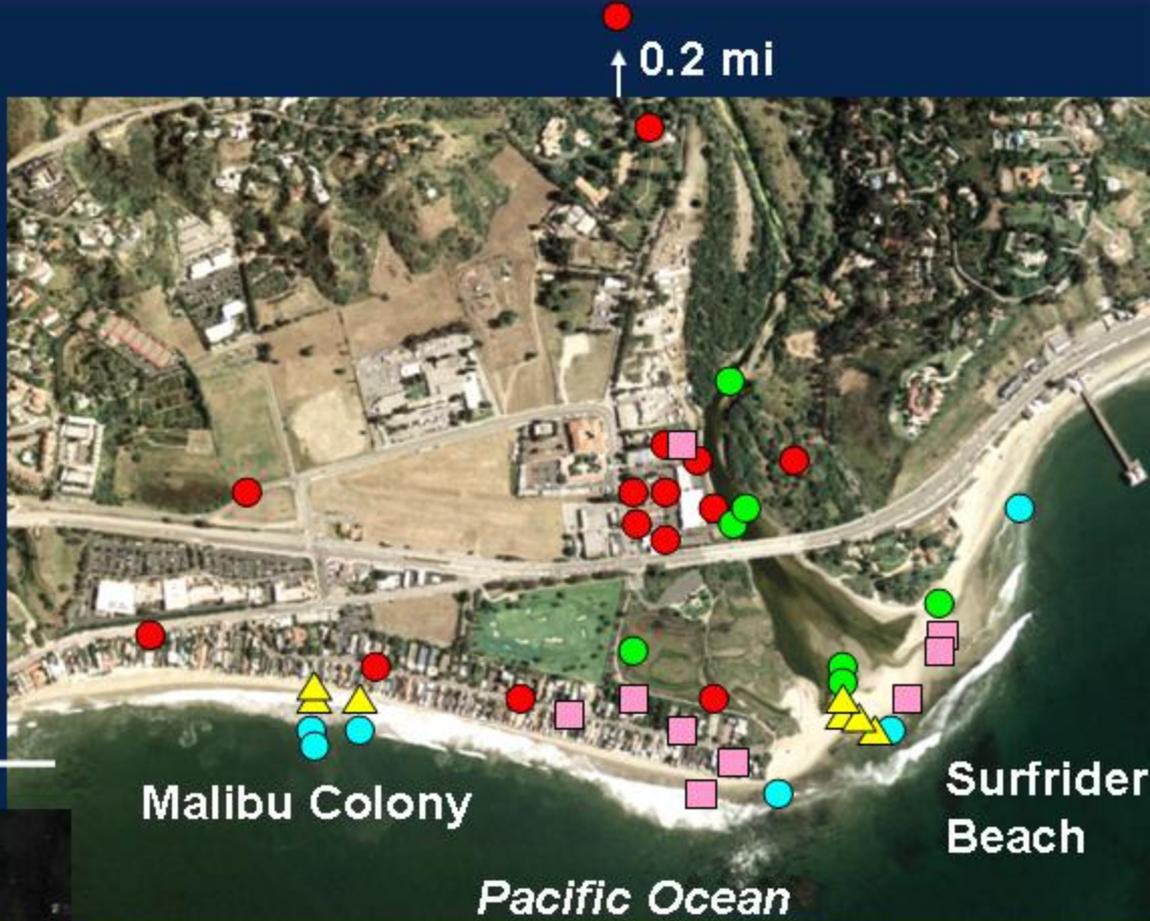
By: John Izbicki, Peter Swarzenski, and Carmen Burton

Cooperatively funded with the City of Malibu



Scope of work

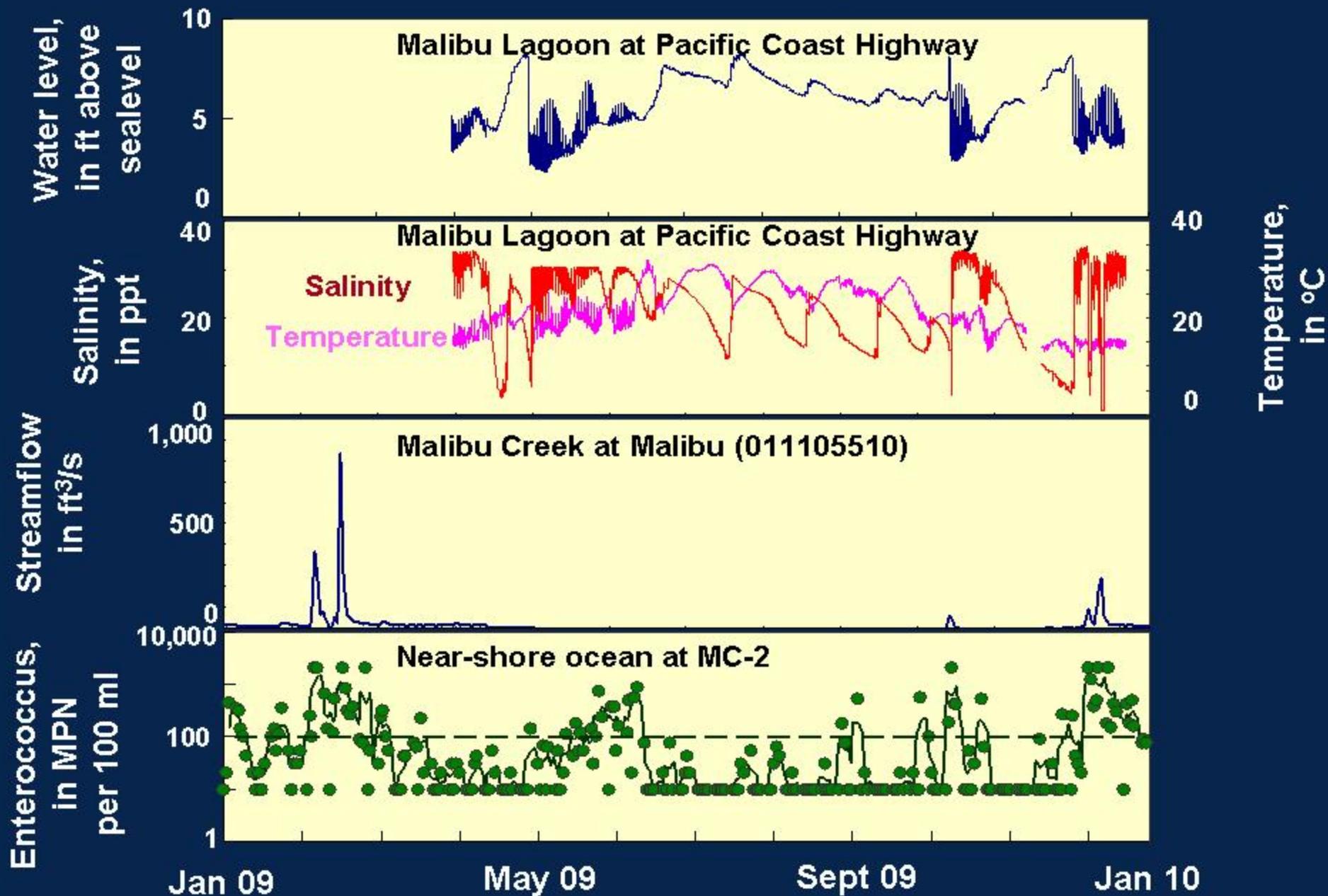
- Almost 500 samples collected during dry season (July 09) and wet season (April 10) sample periods
- Sample collection was done around the clock to capture tidally driven changes in FIB concentrations



- Wells
- ▲ Pieziometers
- Special samples
- Surface water
- Near-shore ocean

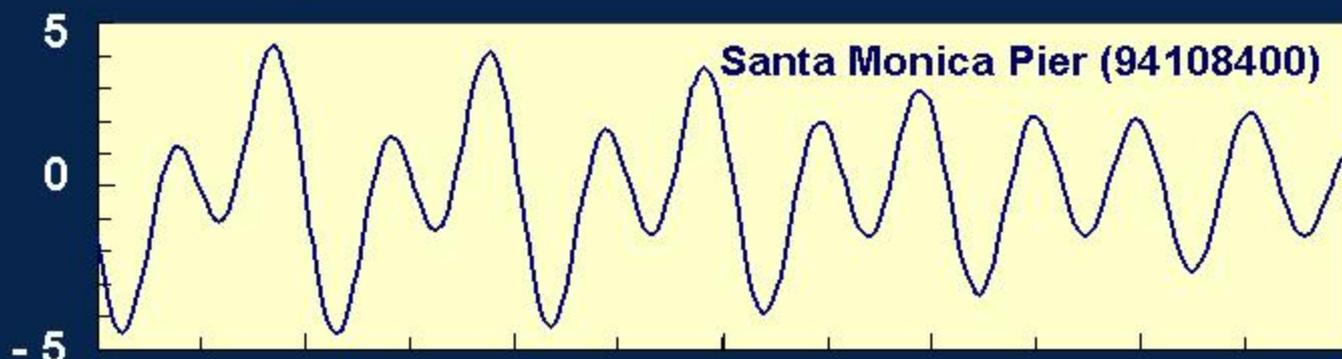


Fecal indicator bacteria at MC-2, near Malibu Calif.

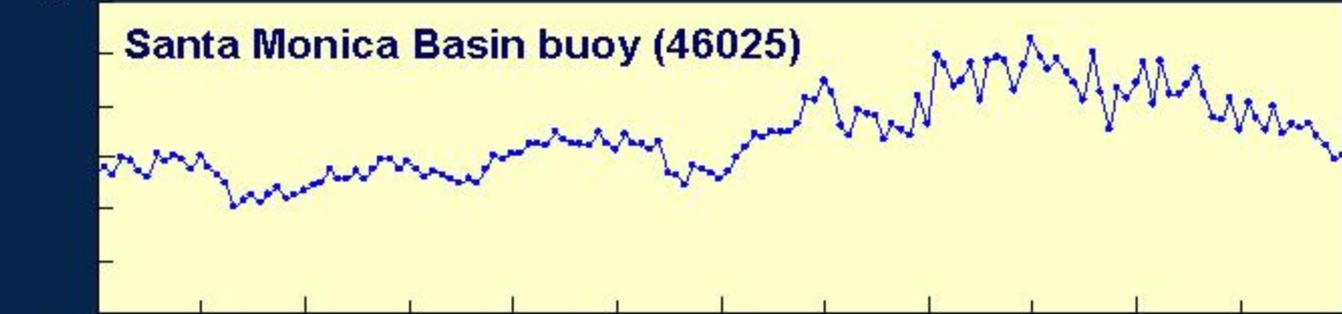


Tide, wave height, and streamflow data, Malibu, Calif.

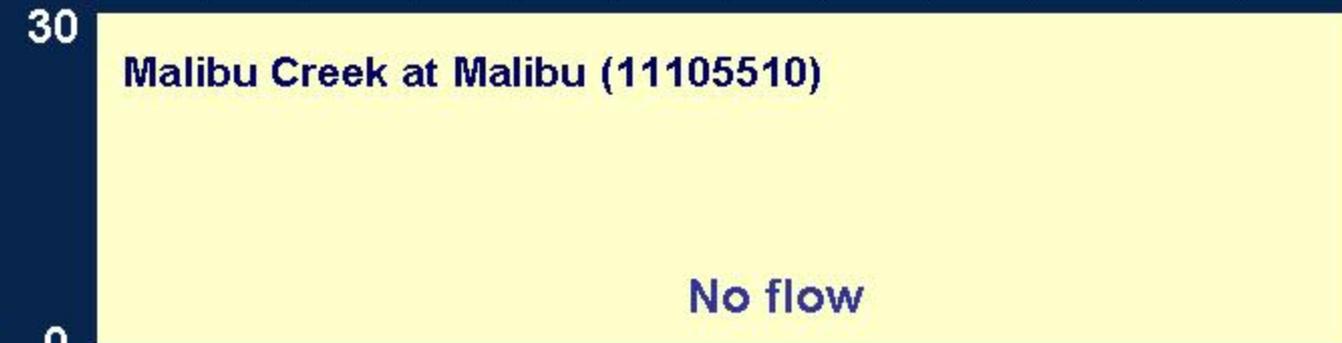
Predicted tide,
in feet above and
below sealevel



Streamflow,
in cubic feet
per second



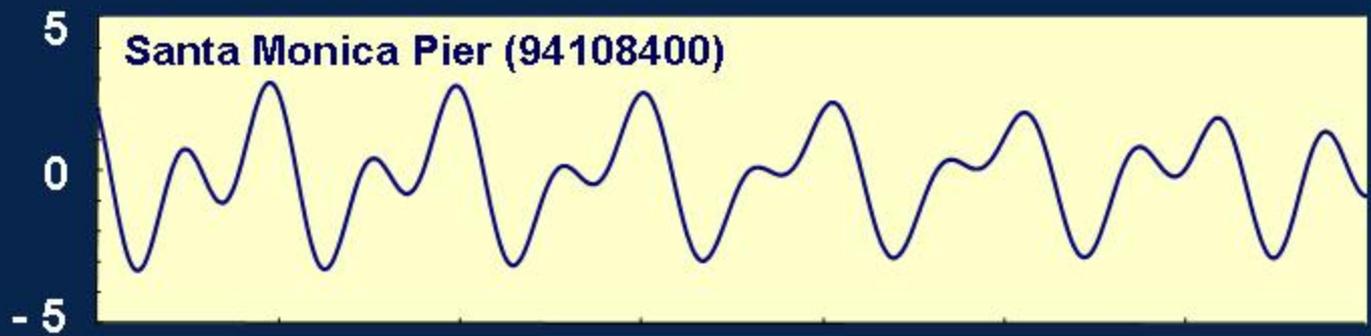
Wave height,
in feet



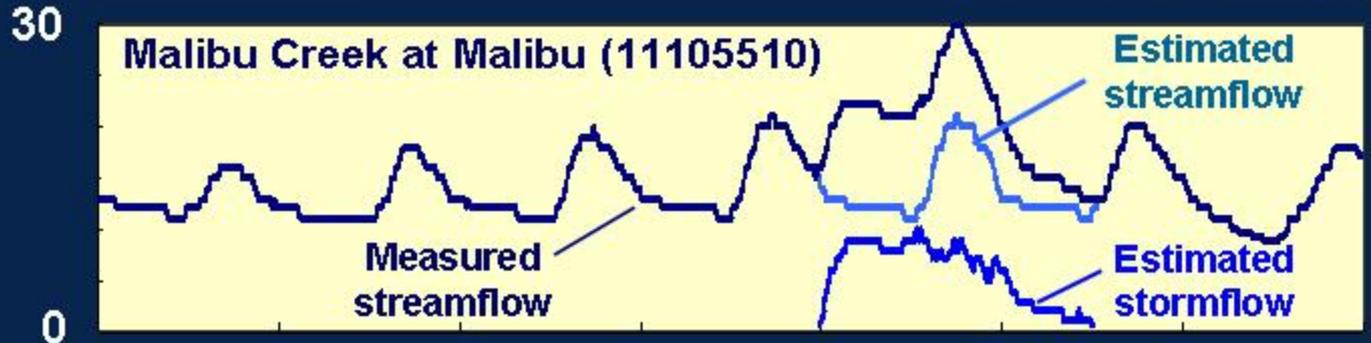
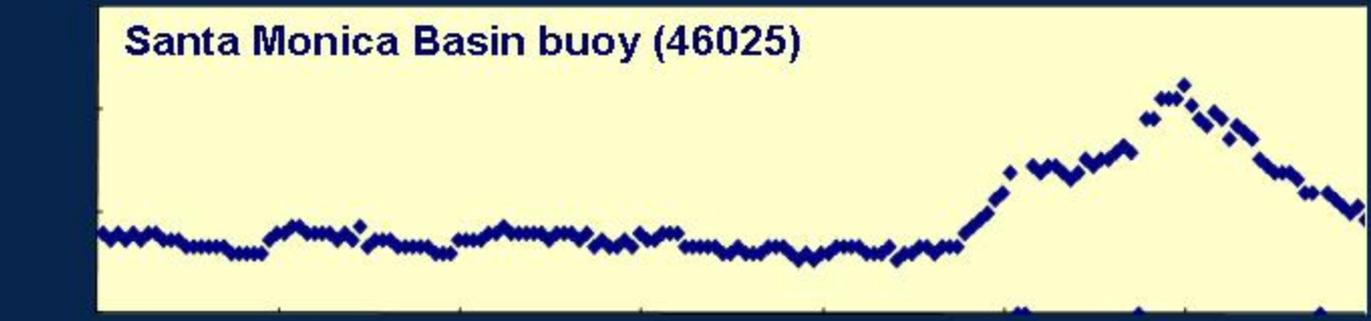
7/21/09 0:00hrs 7/23/09 0:00hrs 7/25/09 0:00hrs 7/27/09 0:00hrs

Tide, wave height, and streamflow data, Malibu, Calif.

Predicted tide,
in feet above and
below sealevel



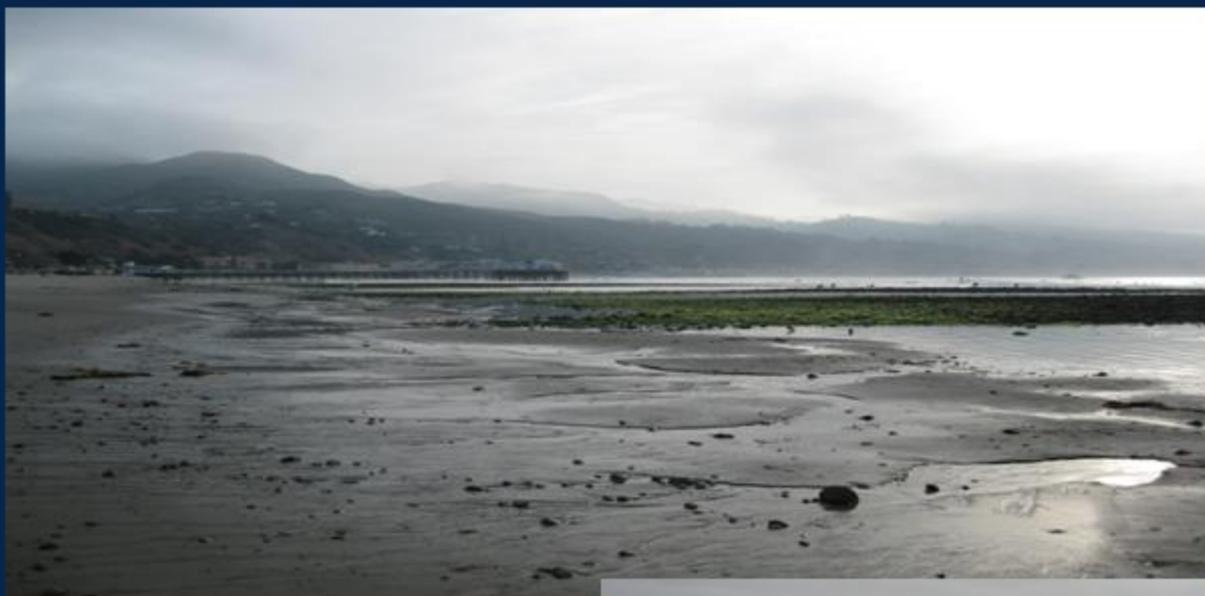
Streamflow,
in cubic feet
per second



Wave height,
in feet

4/16/10 0:00hrs 4/18/10 0:00hrs 4/20/10 0:00hrs 4/22/10 0:00hrs

Surfrider Beach, Malibu Calif.



July 2009

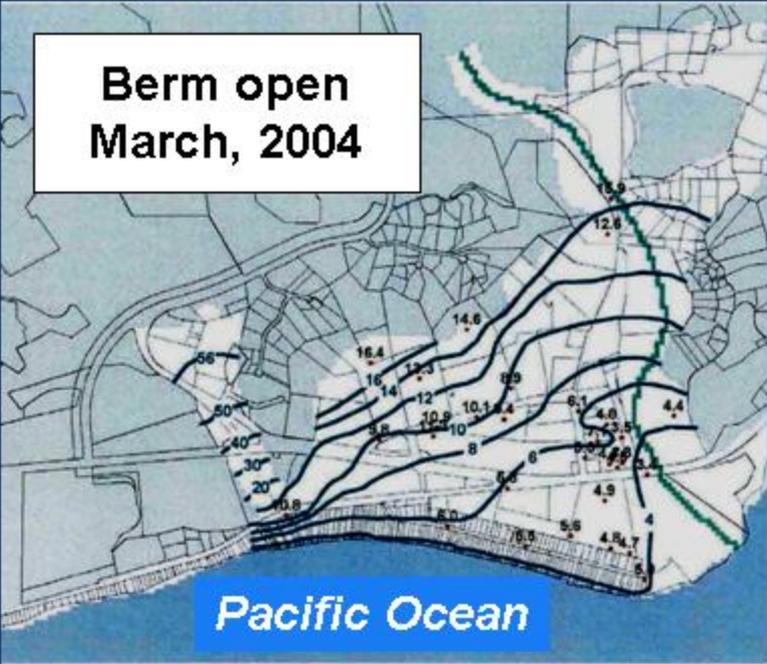
**Low tide, berm closed –
discharge through the berm**

April 2010

**Low tide, berm open –
discharge directly to
the ocean**



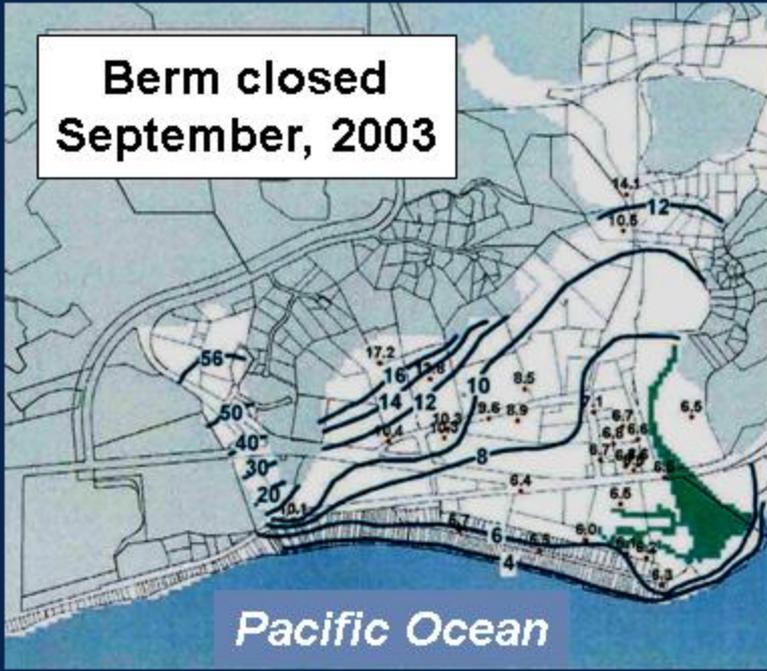
Groundwater levels in alluvial aquifer, Malibu Calif.



Greater groundwater discharge to lagoon

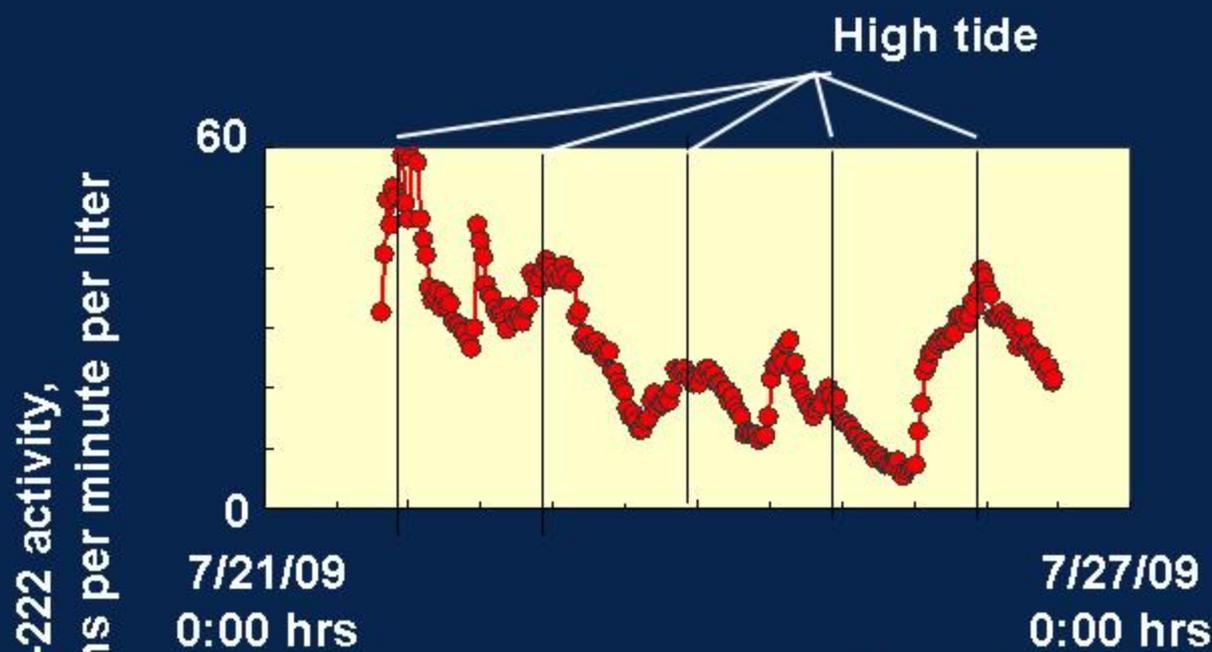
- Alluvium
- Consolidated rock

0 0.5 Miles

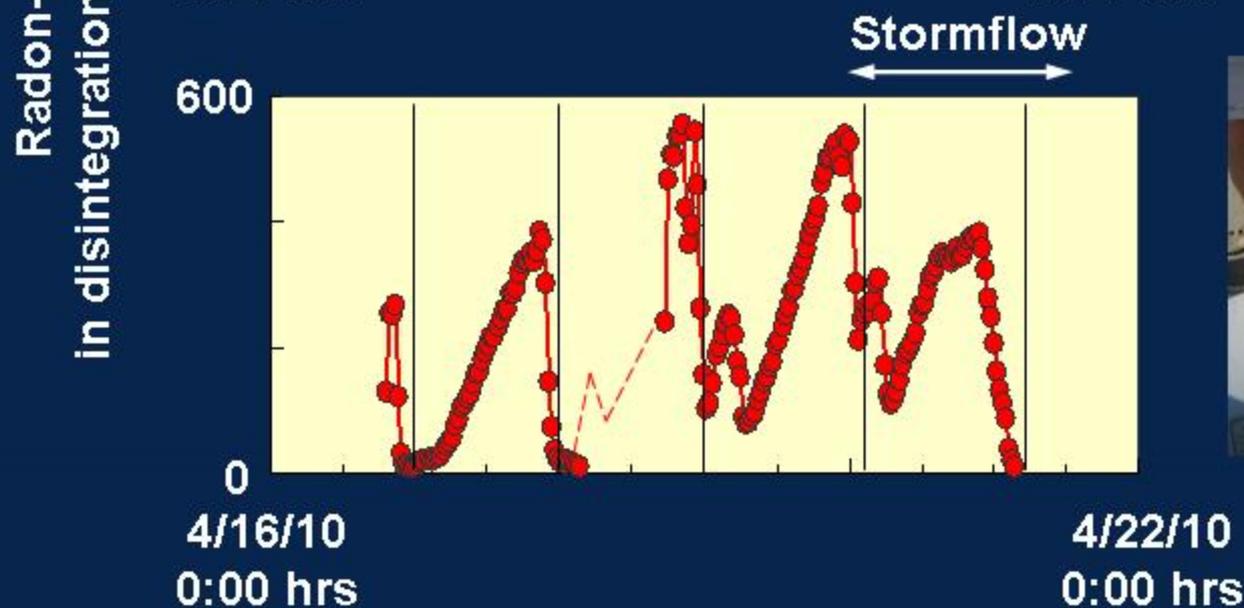


Greater groundwater discharge to ocean

Discharge of groundwater to Malibu Lagoon



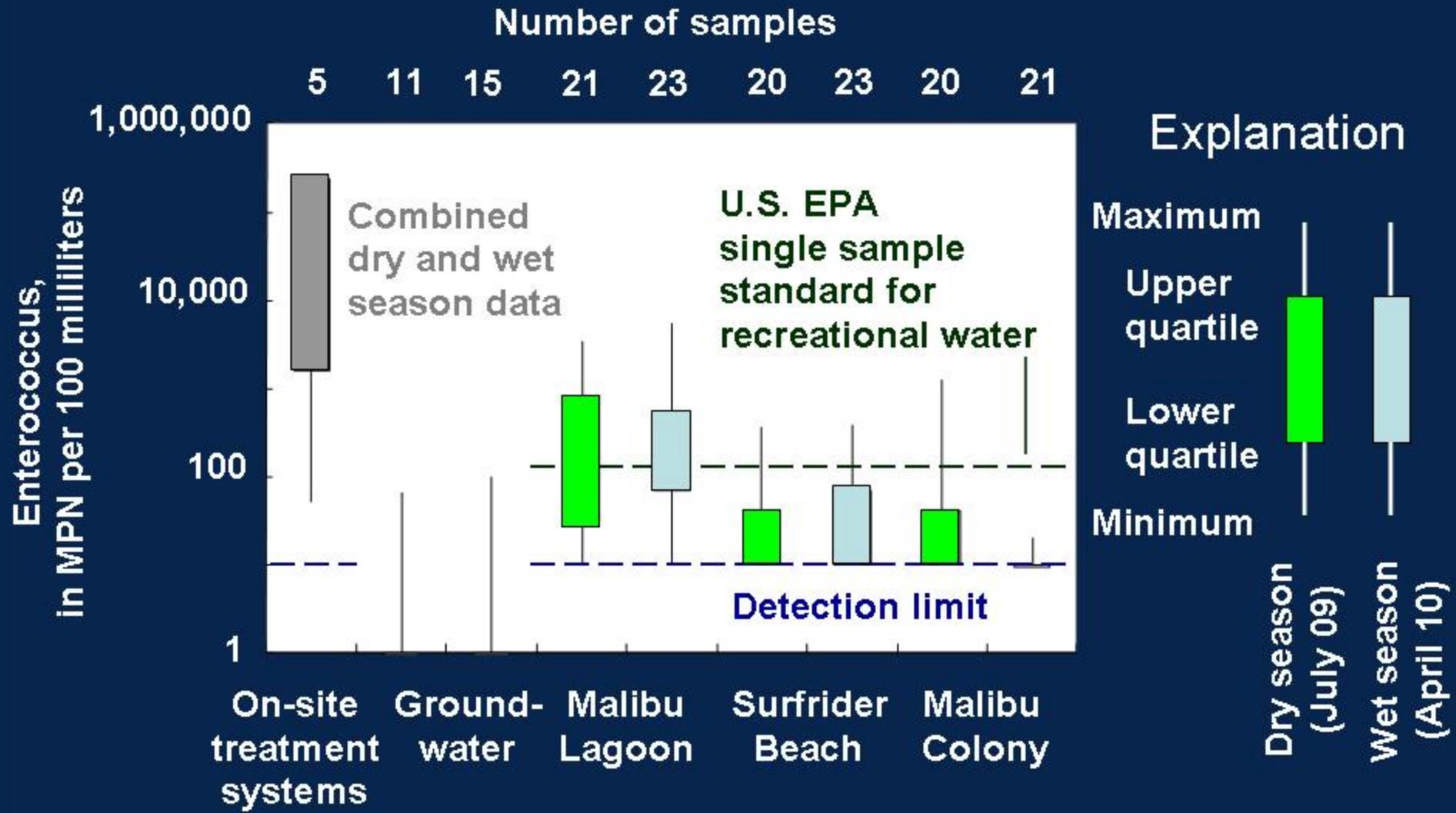
Deployment of Radon-222 measurement equipment



Rad-7 and air-exchanger

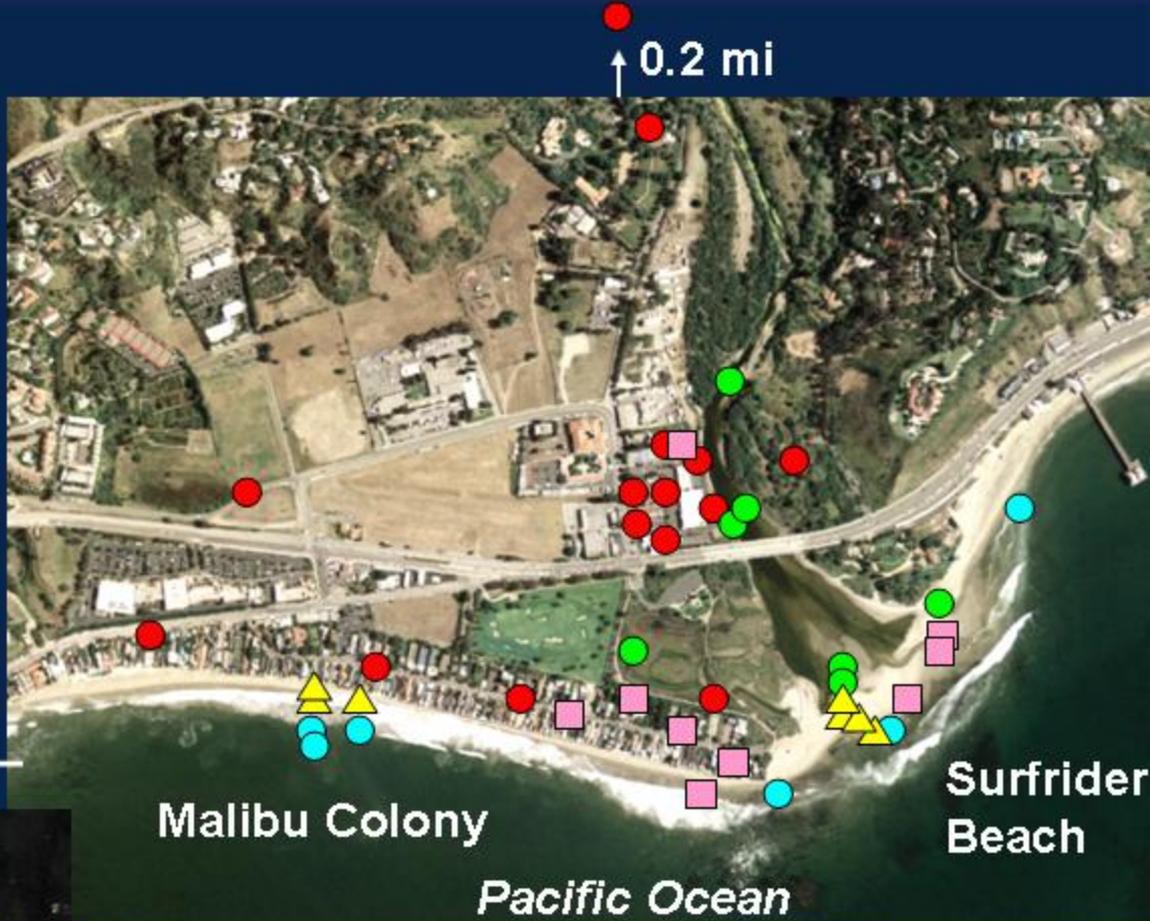


Fecal Indicator Bacteria Concentrations



Scope of work

- Almost 500 samples collected during dry season (July 09) and wet season (April 10) sample periods
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- Wells
- ▲ Pieziometers
- Special samples
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Instrumented oceanfront study sites



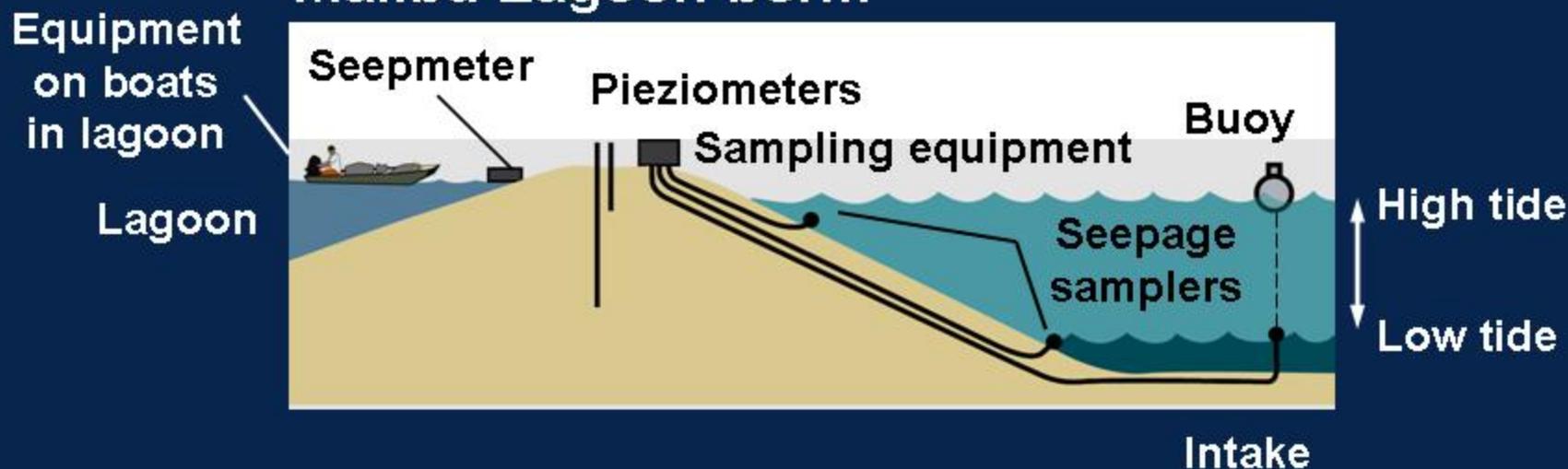
Malibu Lagoon berm



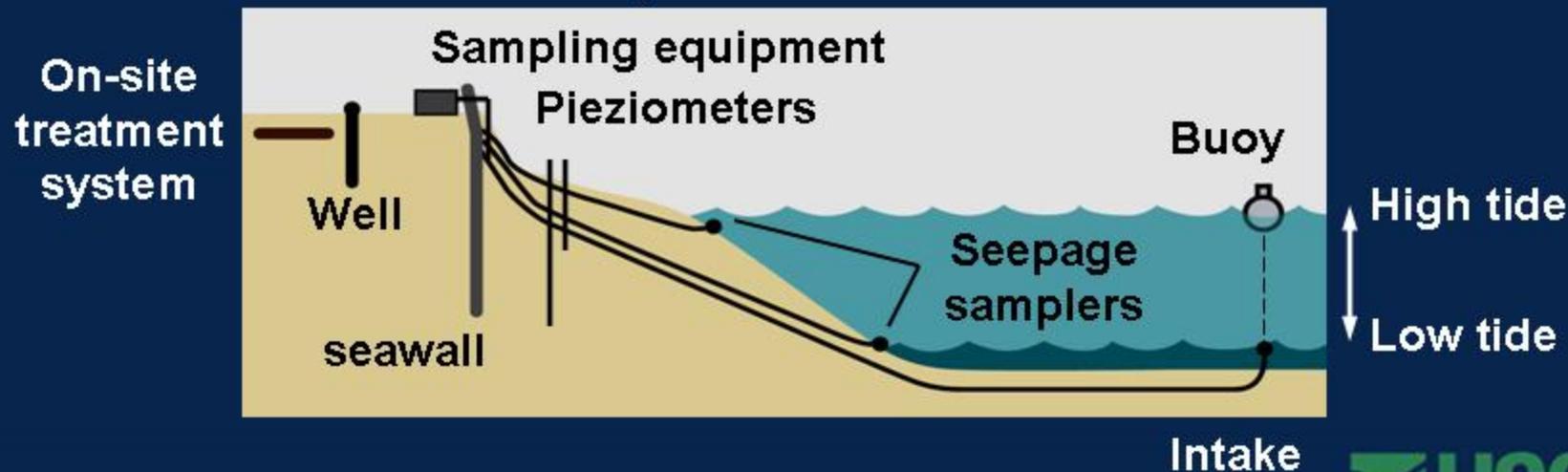
Malibu Colony

Generalized site instrumentation (not to scale)

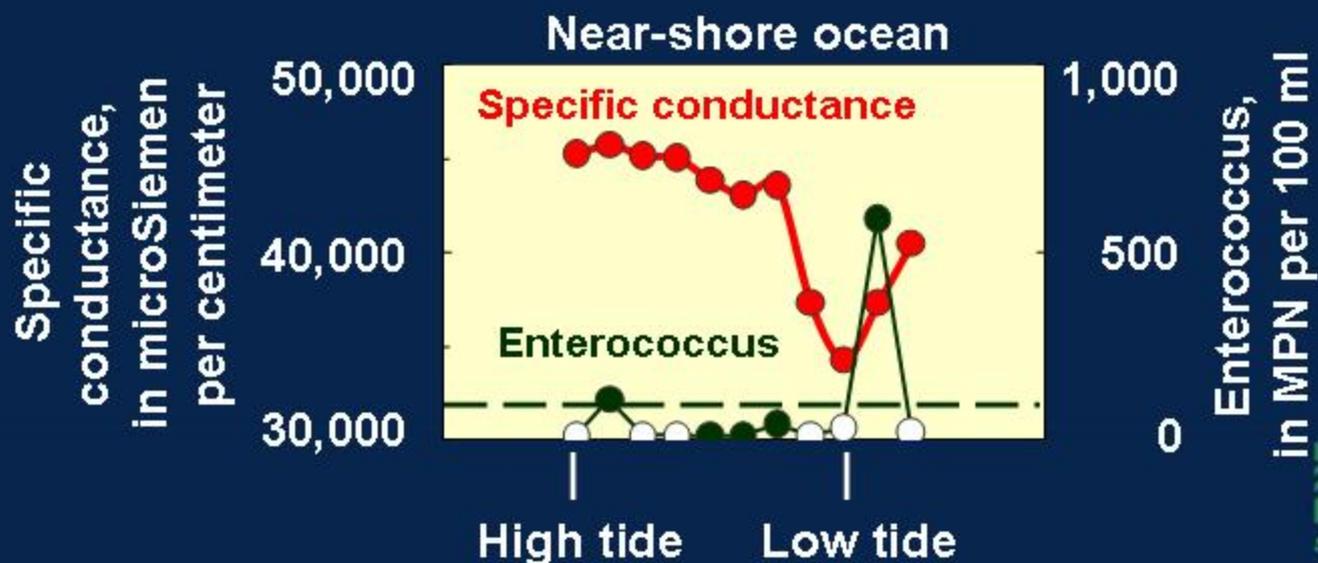
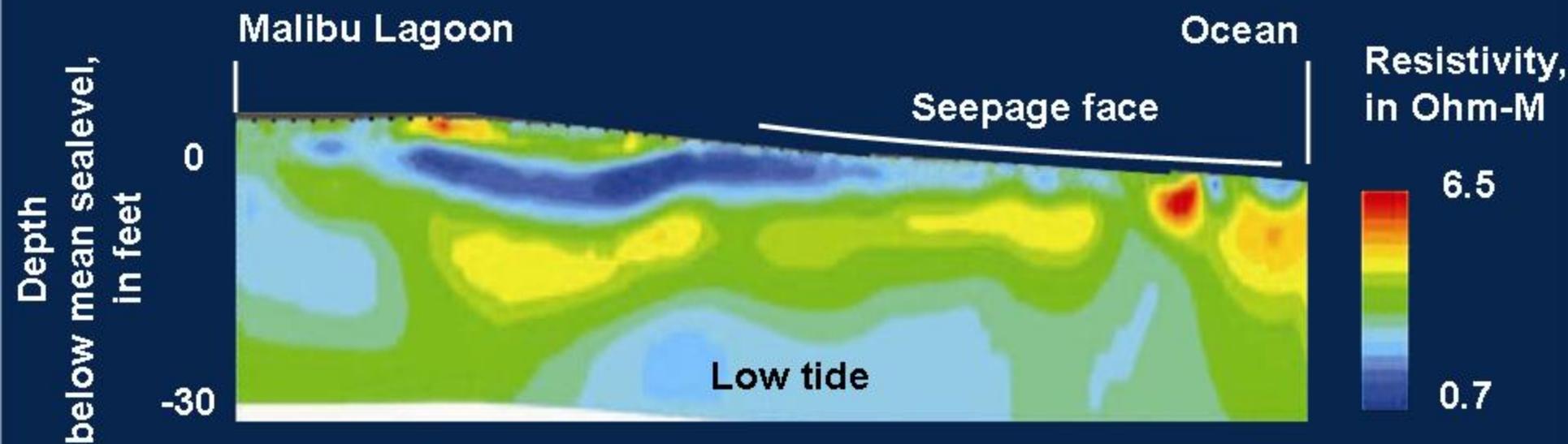
Malibu Lagoon berm



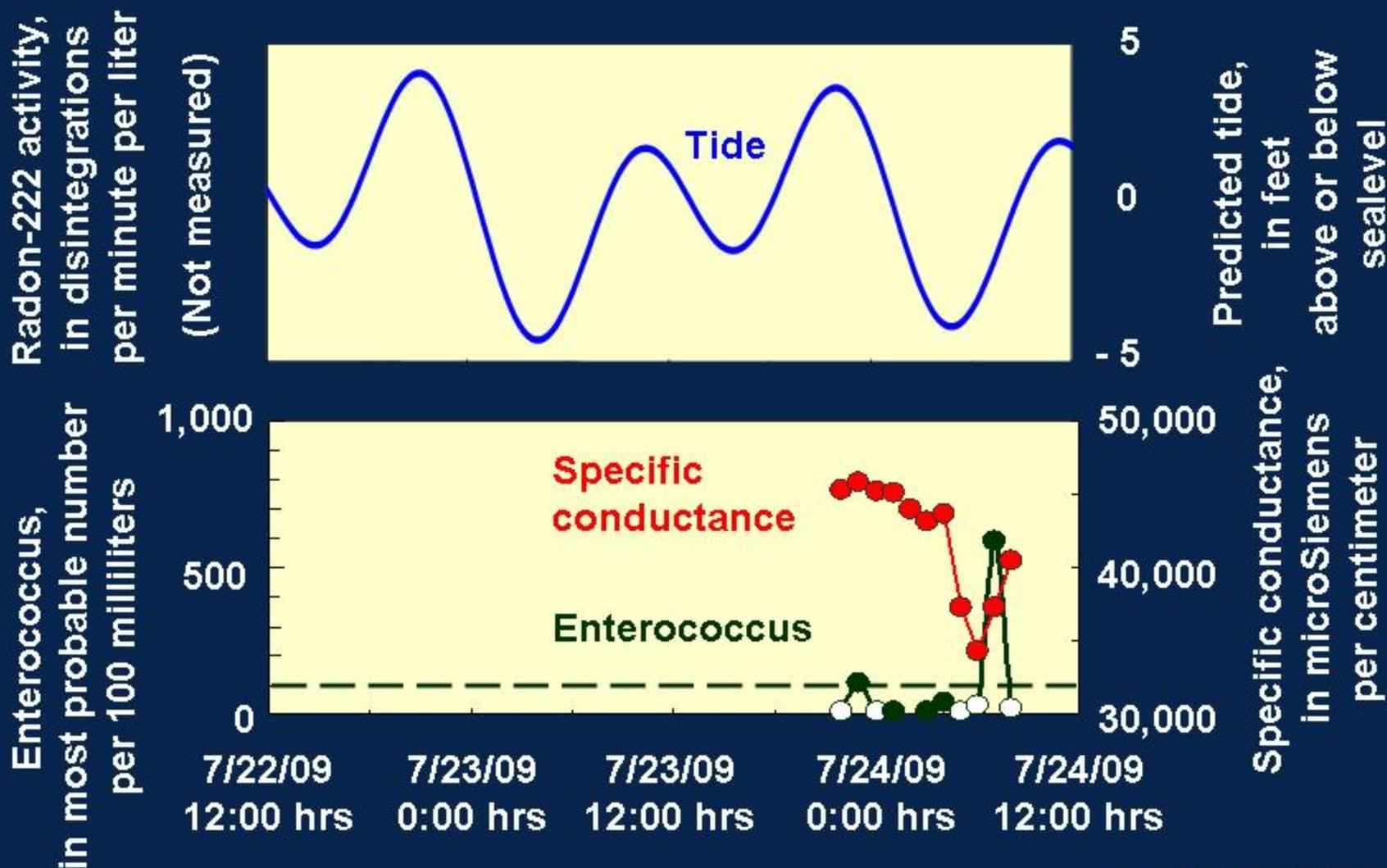
Malibu Colony



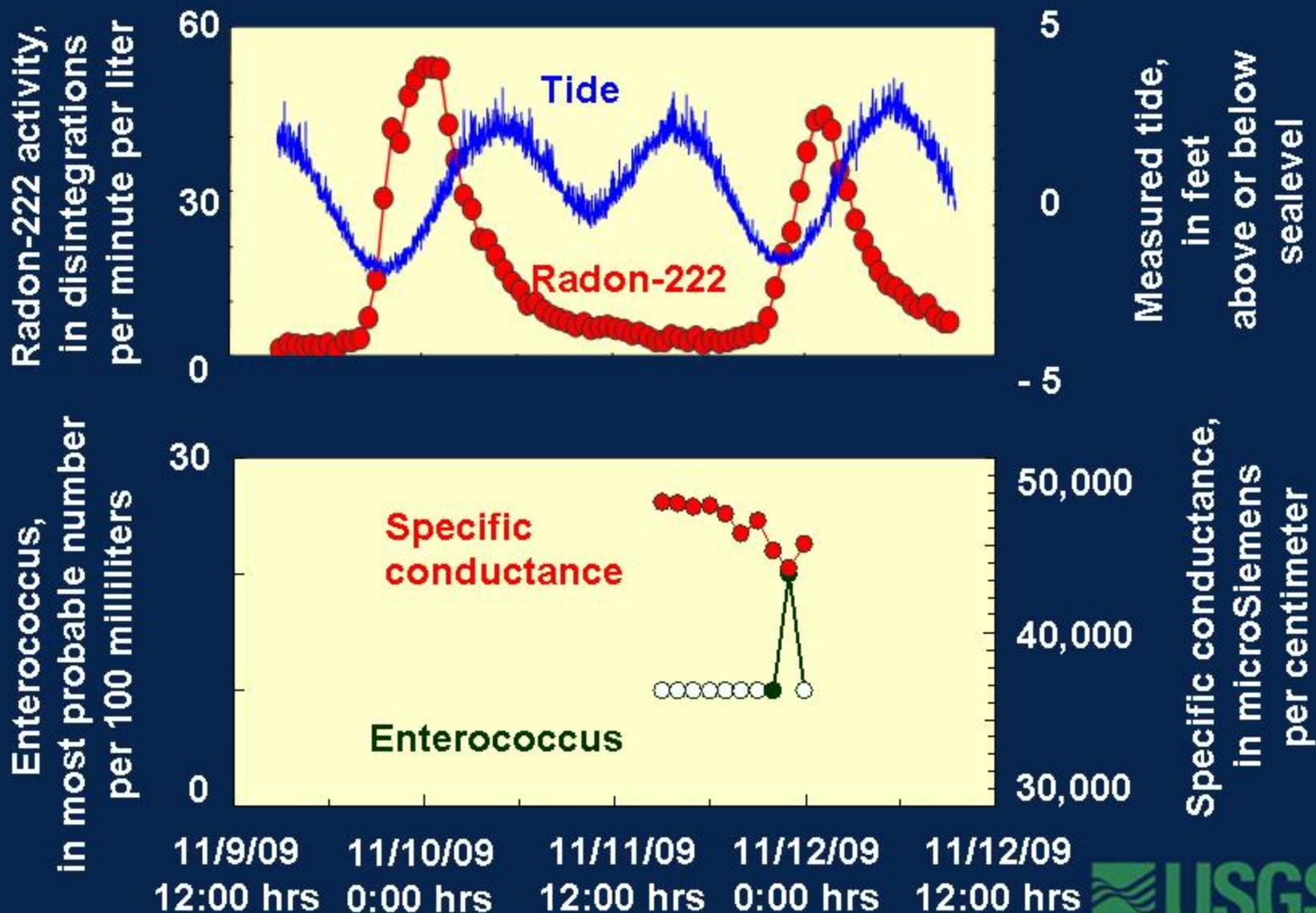
Discharge from Malibu Lagoon to the near-shore ocean



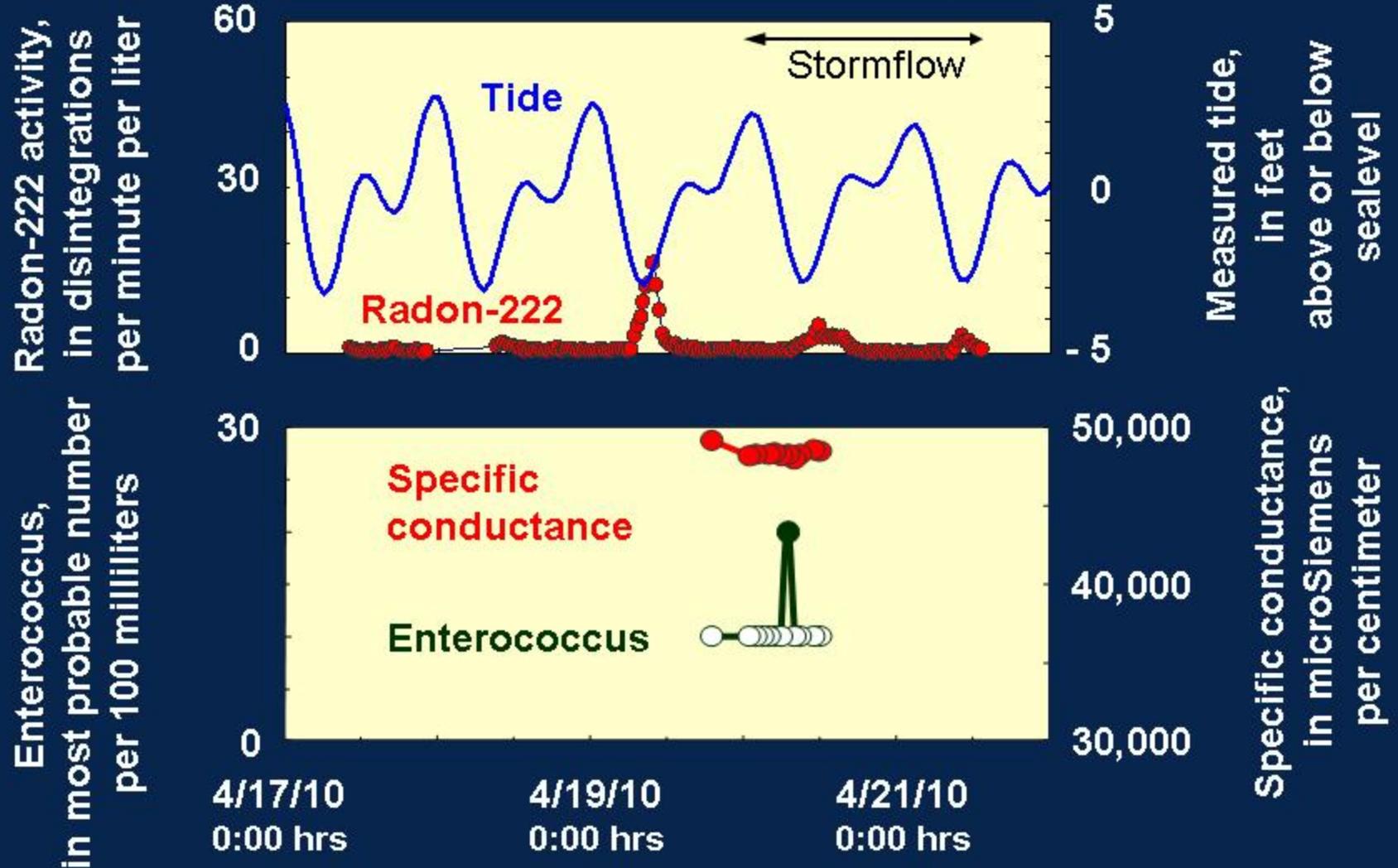
Tide, radon-222, bacteria, and specific conductance data near-shore ocean adjacent to Malibu Lagoon—berm closed



Tide, radon-222, bacteria, and specific conductance data near-shore ocean adjacent to Malibu Lagoon—berm closed

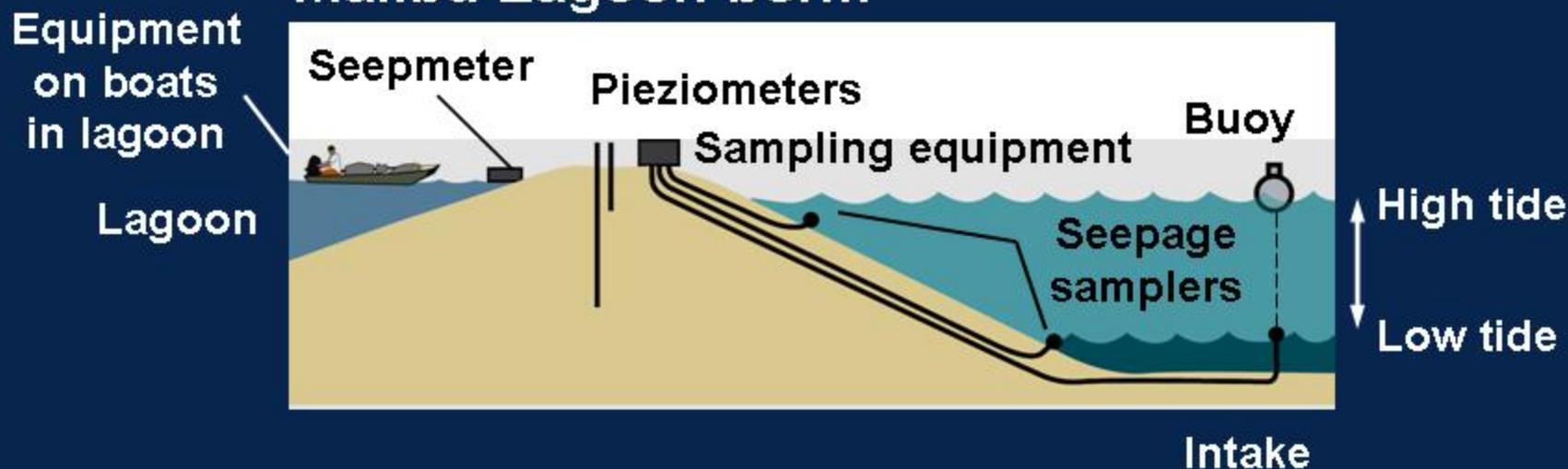


Tide, radon-222, bacteria, and specific conductance data near-shore ocean adjacent to Malibu Lagoon—berm open

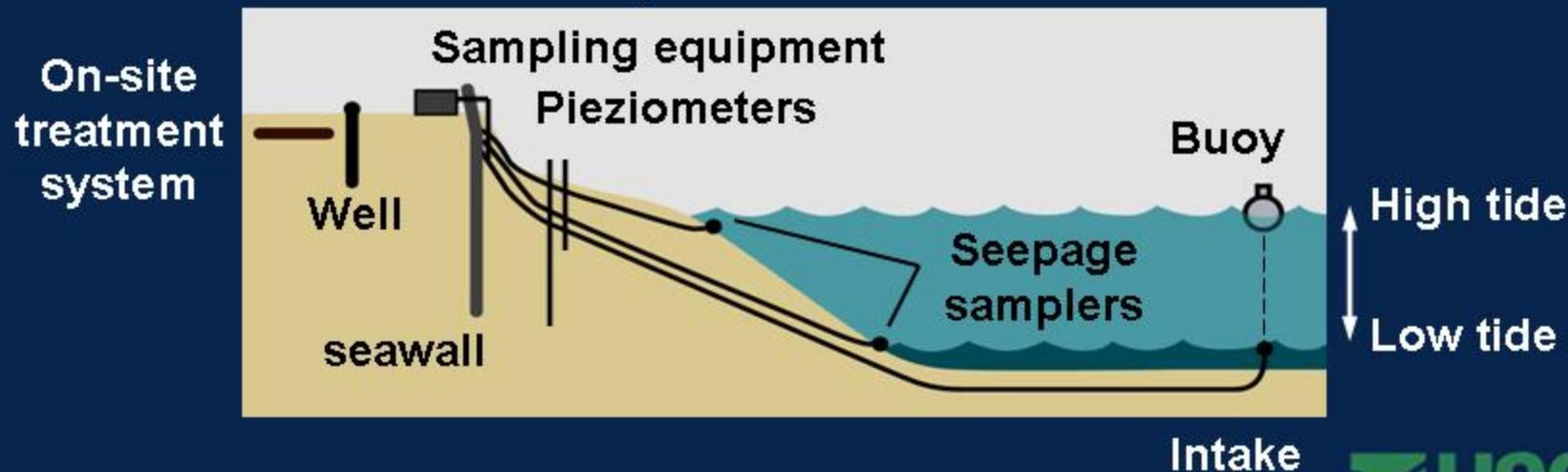


Generalized site instrumentation (not to scale)

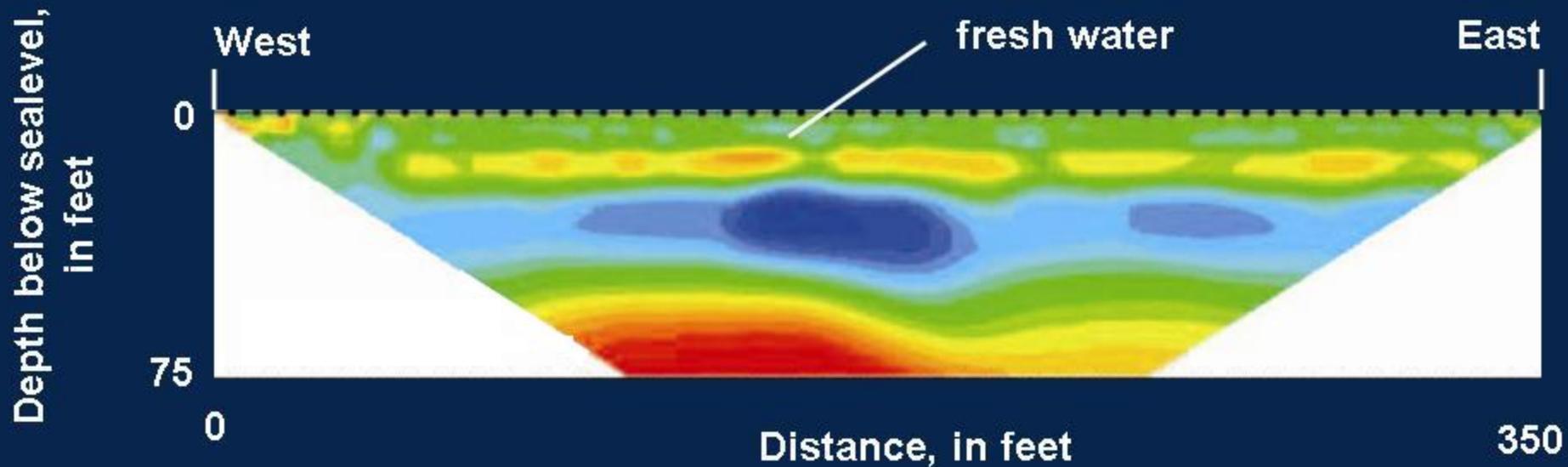
Malibu Lagoon berm



Malibu Colony

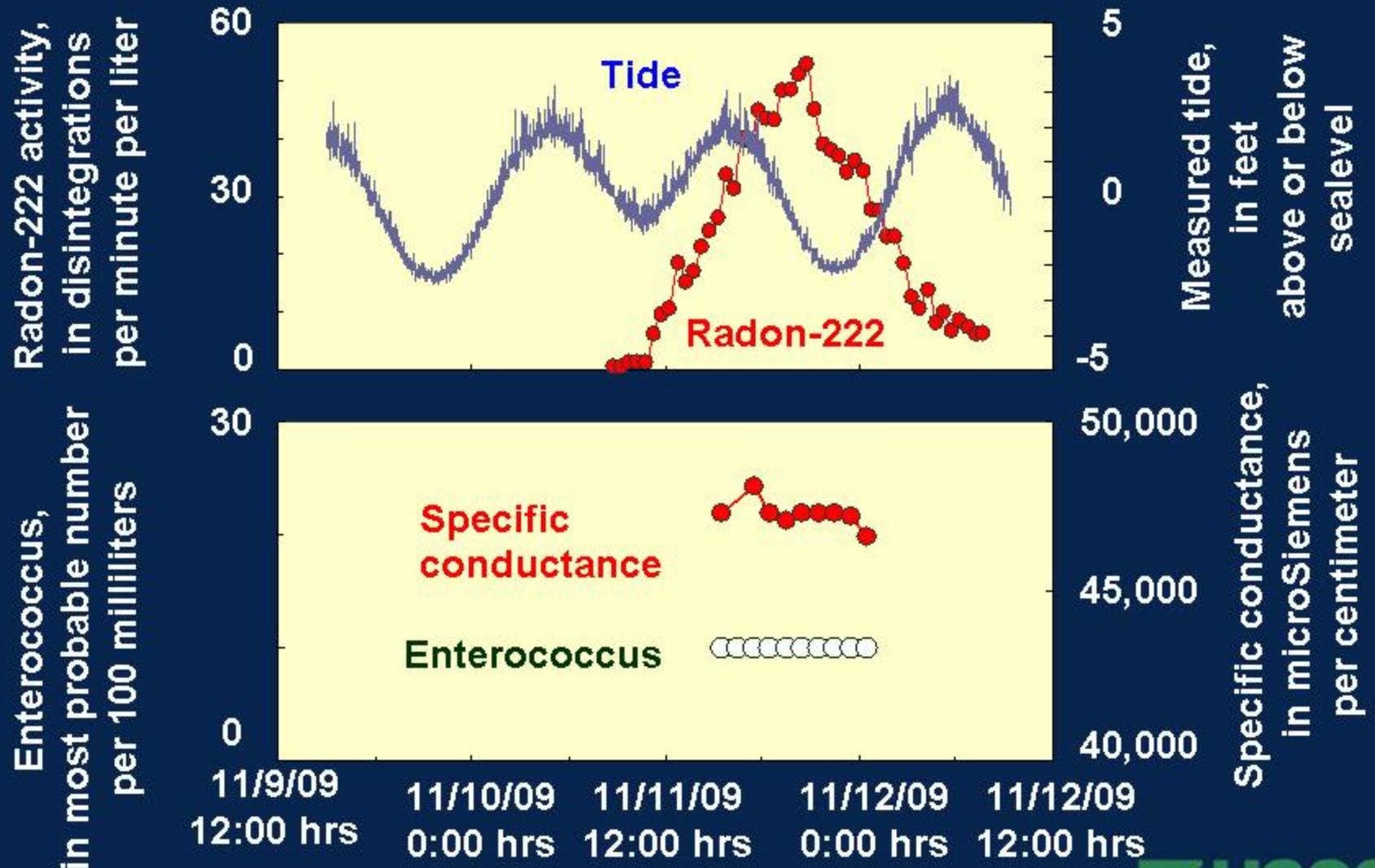


Water level and DC-Resistivity data at Malibu Colony beachfront

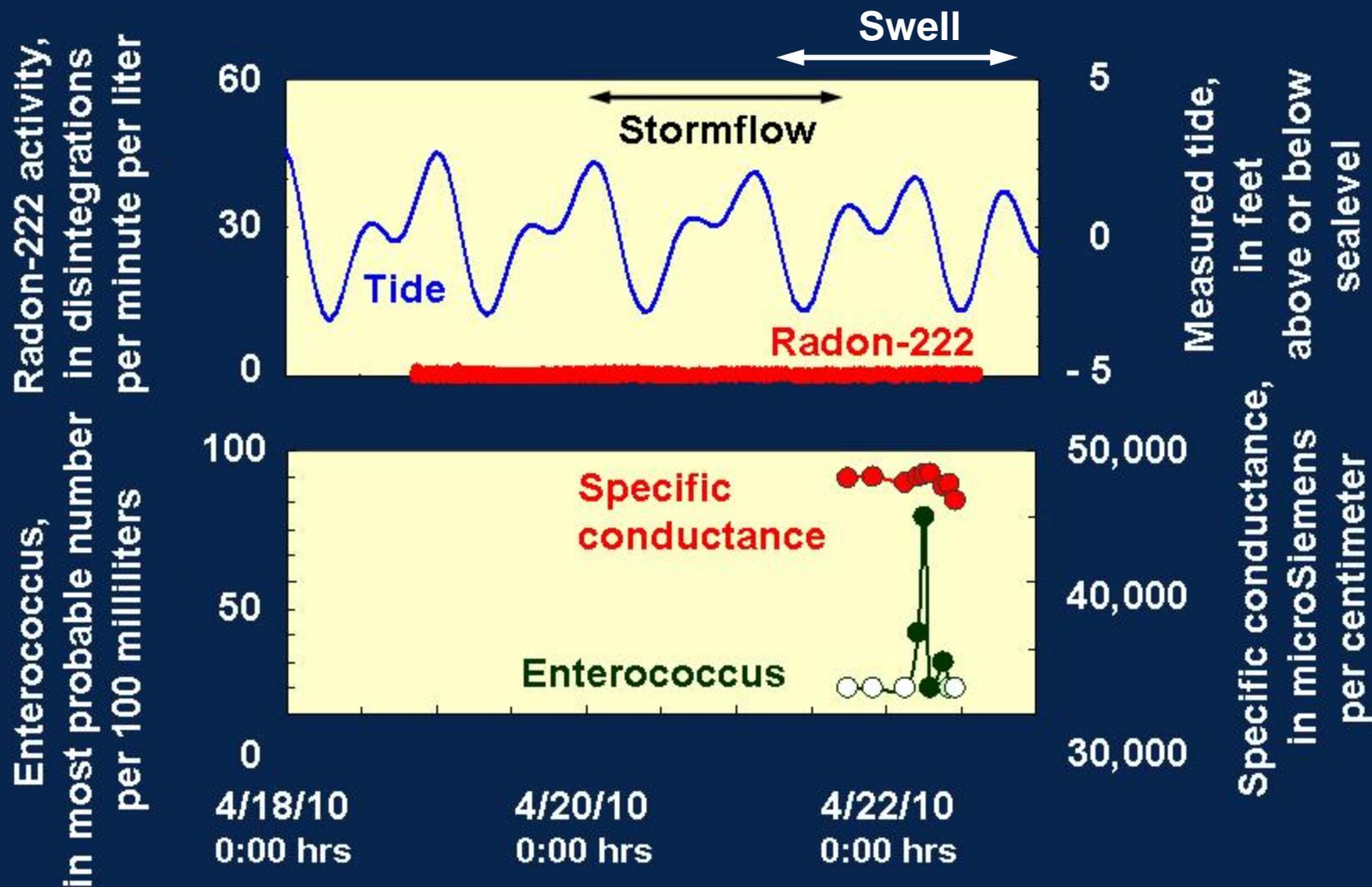


- Fresh groundwater discharging to ocean beneath the seawall

Tide, radon-222, bacteria, and specific conductance data near-shore ocean adjacent to Malibu Colony—berm closed



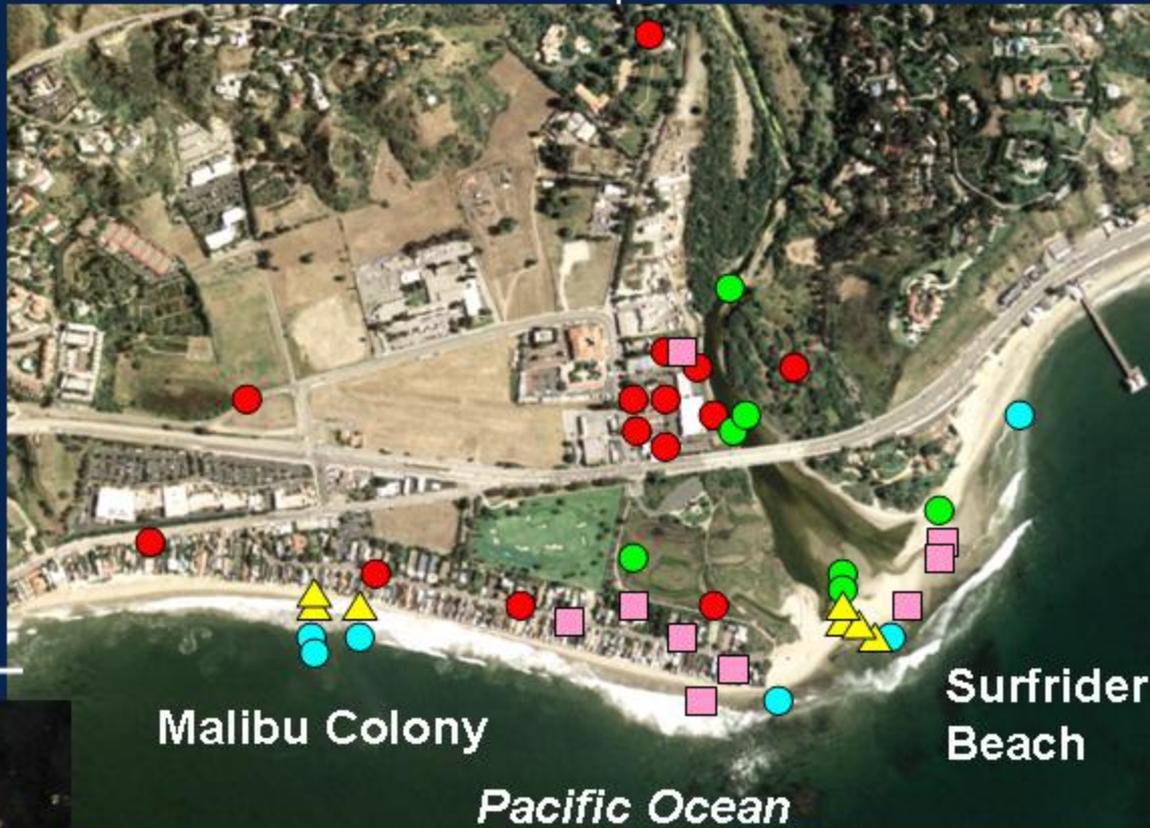
Tide, radon-222, bacteria, and specific conductance data near-shore ocean adjacent to Malibu Colony—berm open



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Puerco Beach



0 0.5 Miles

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Malibu Lagoon, Malibu Calif.

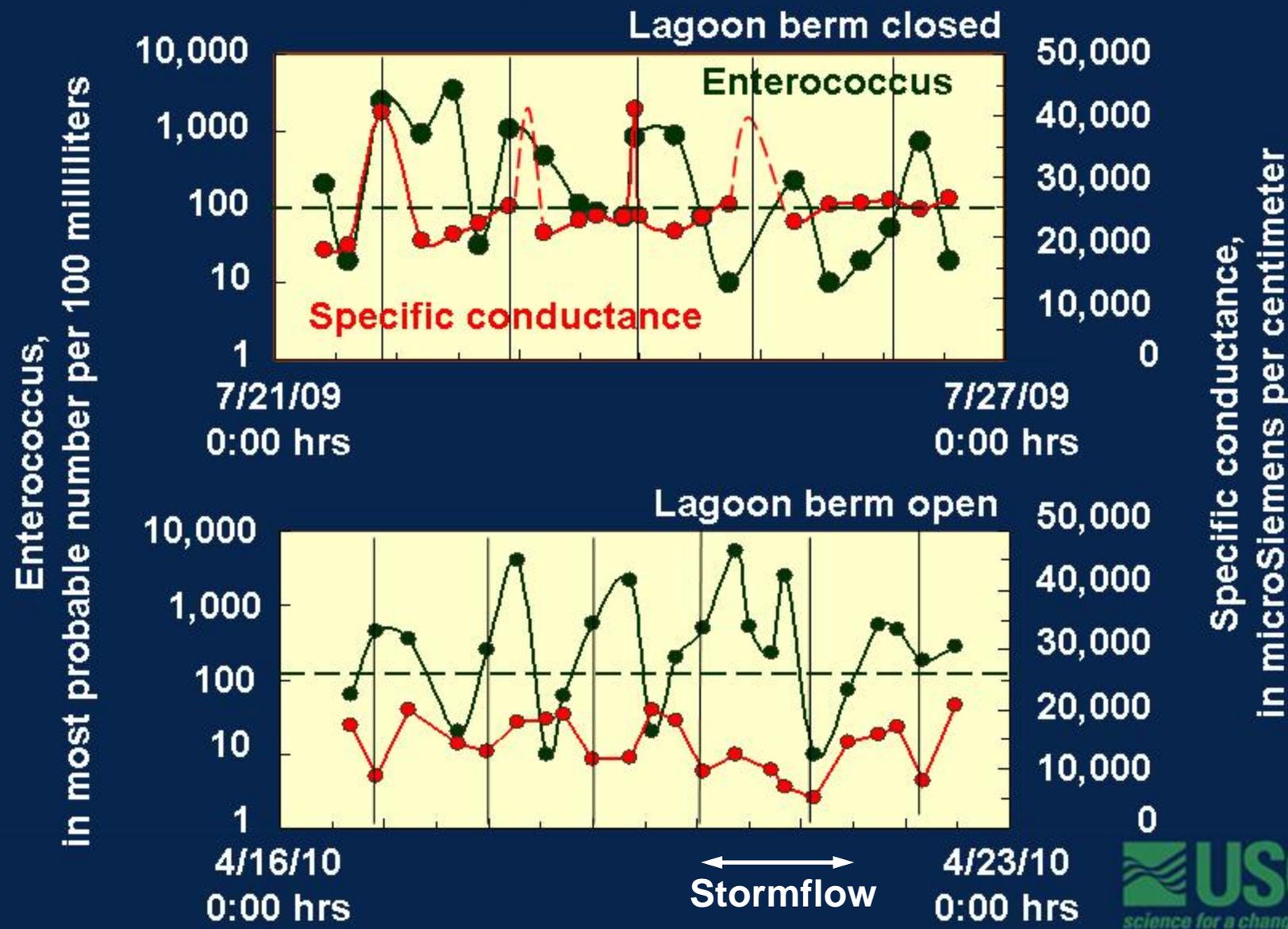


Dry season, July 2009—
berm closed,
lagoon water levels high

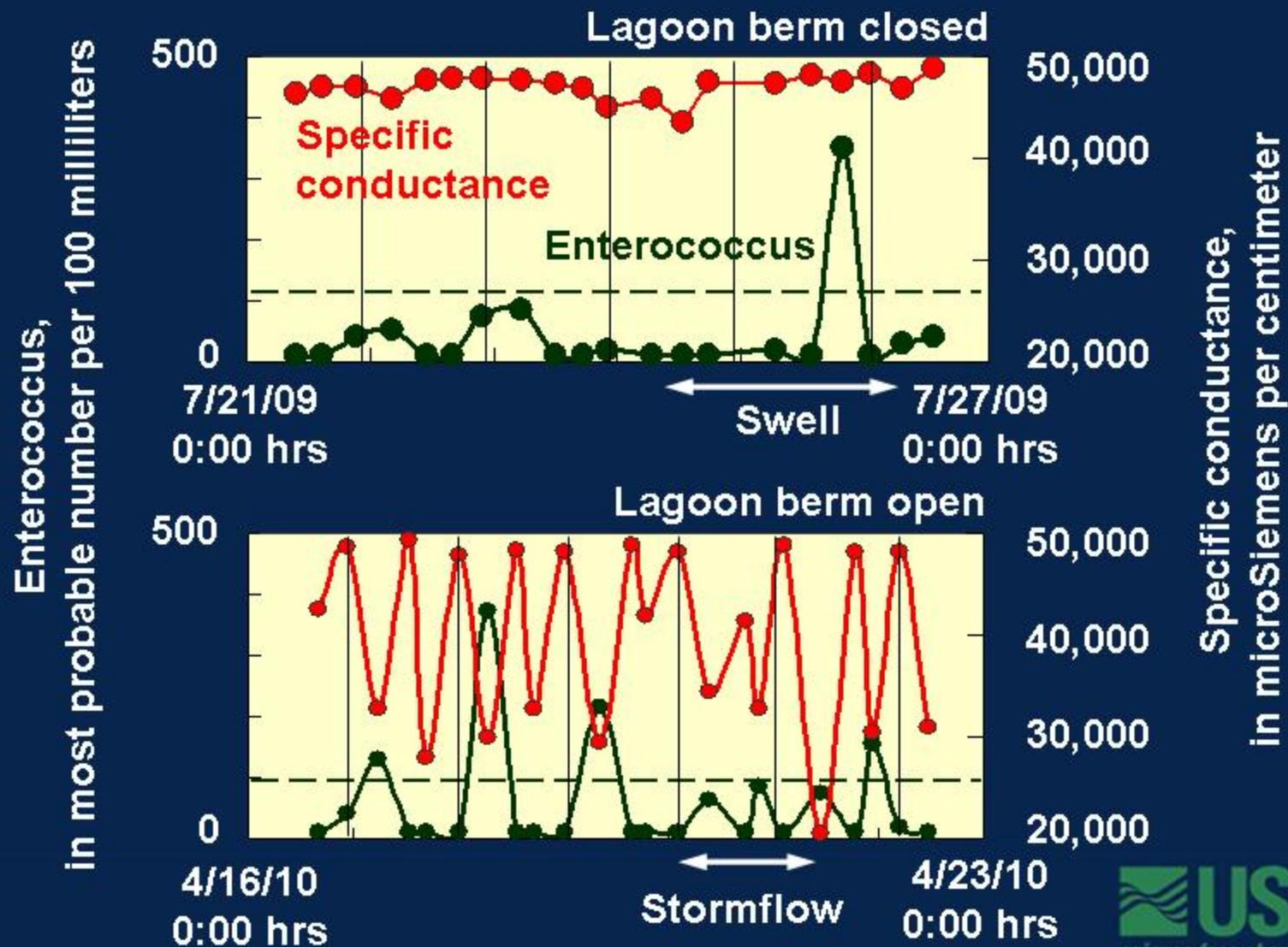


Wet season, April 2010—
berm open,
lagoon water levels vary with tides

Fecal indicator bacteria concentrations Malibu Lagoon, Malibu Calif.

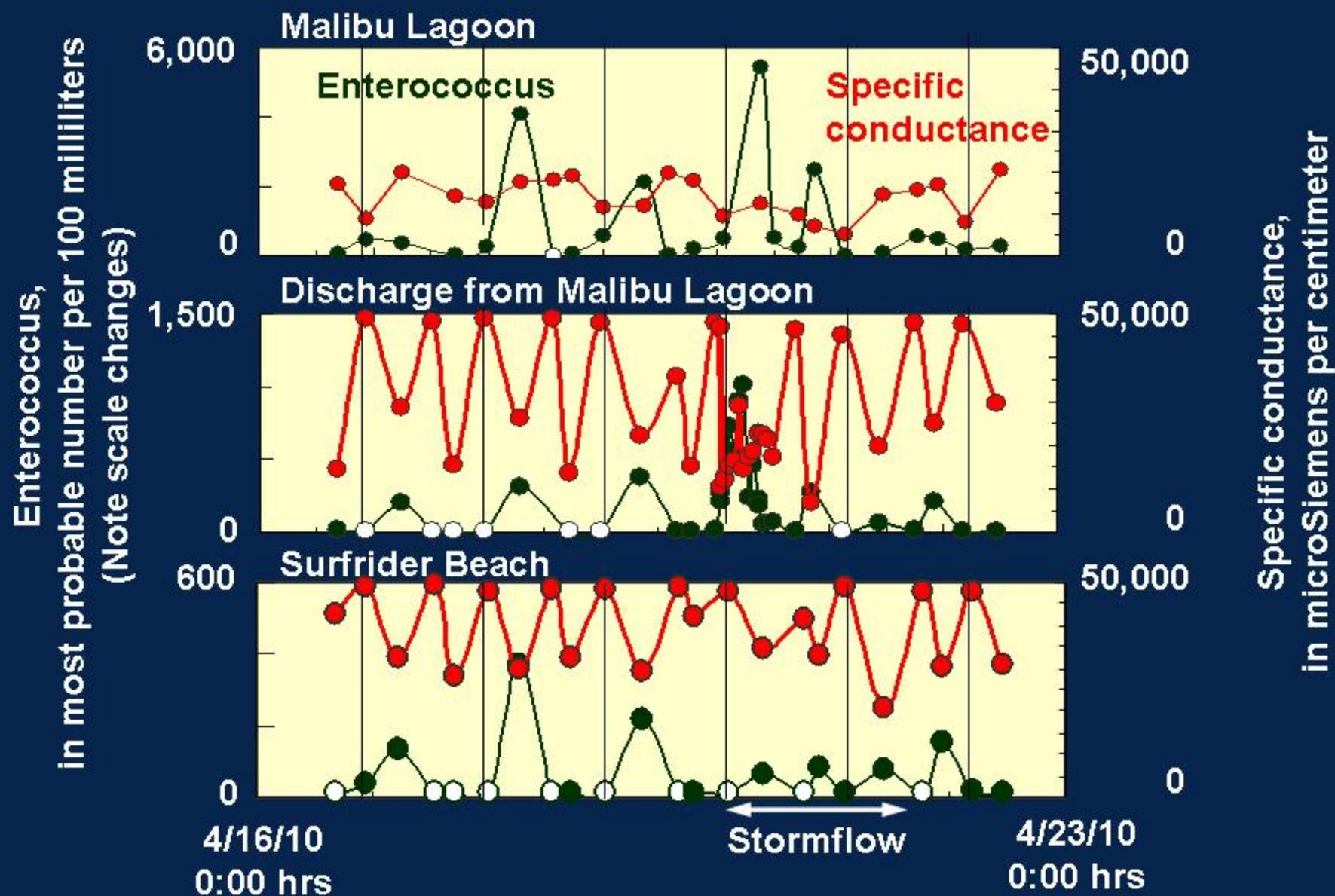


Fecal indicator bacteria concentrations Surfrider Beach, Malibu Calif.

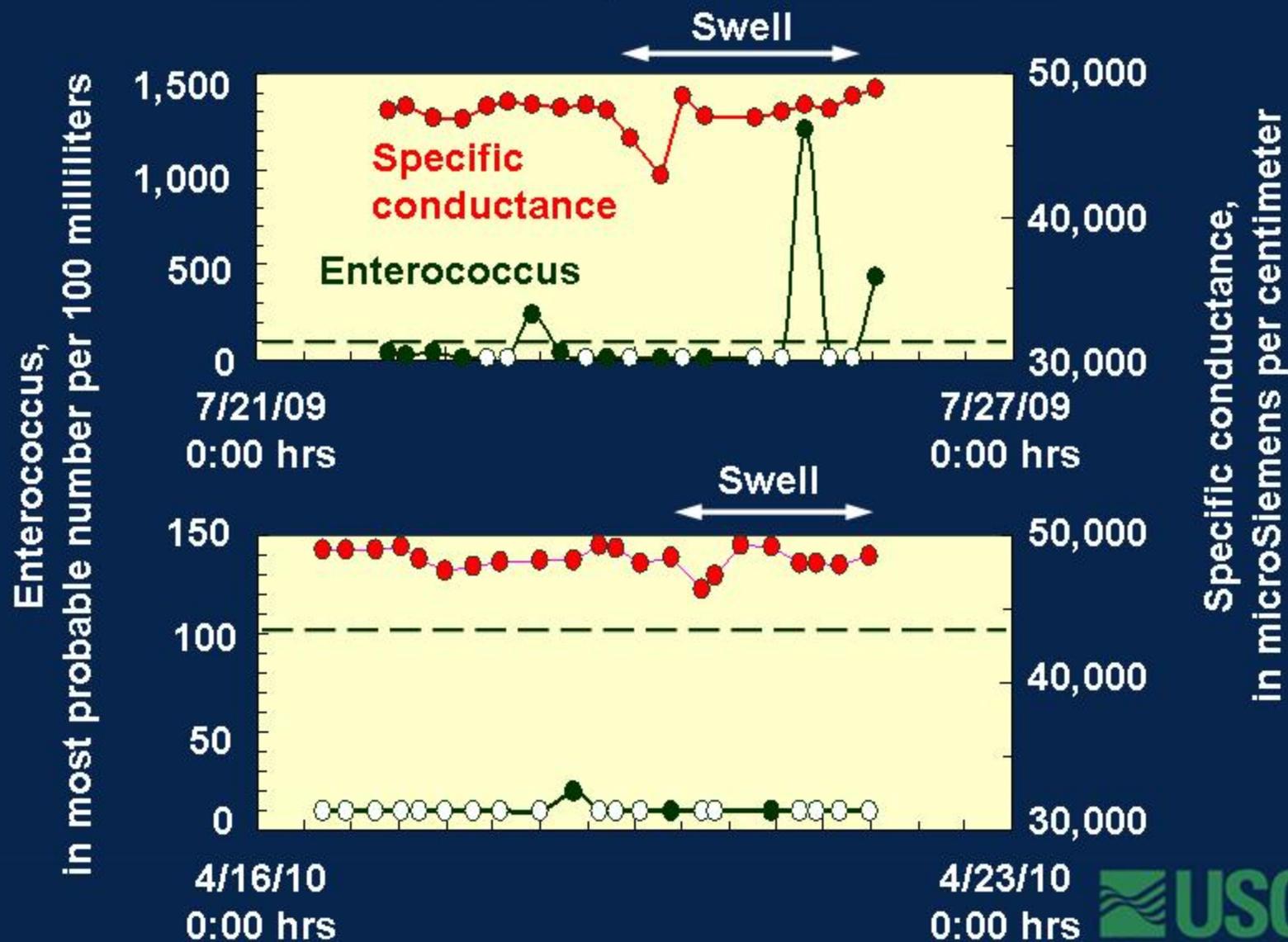


Fecal indicator bacteria concentrations

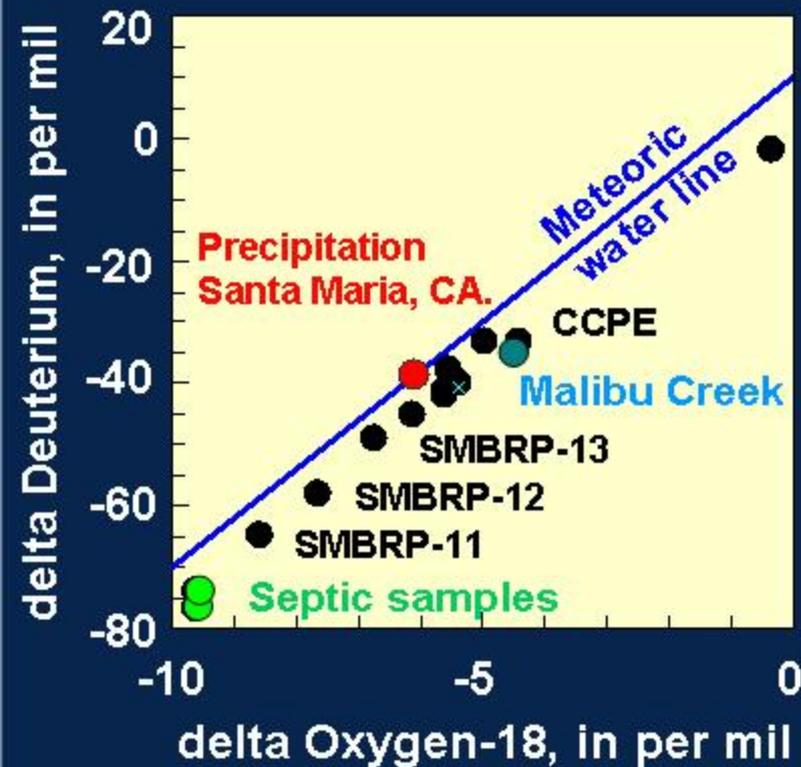
Malibu Lagoon and Surfrider Beachh, Malibu Calif.



Fecal indicator bacteria concentrations Malibu Colony, Malibu Calif.

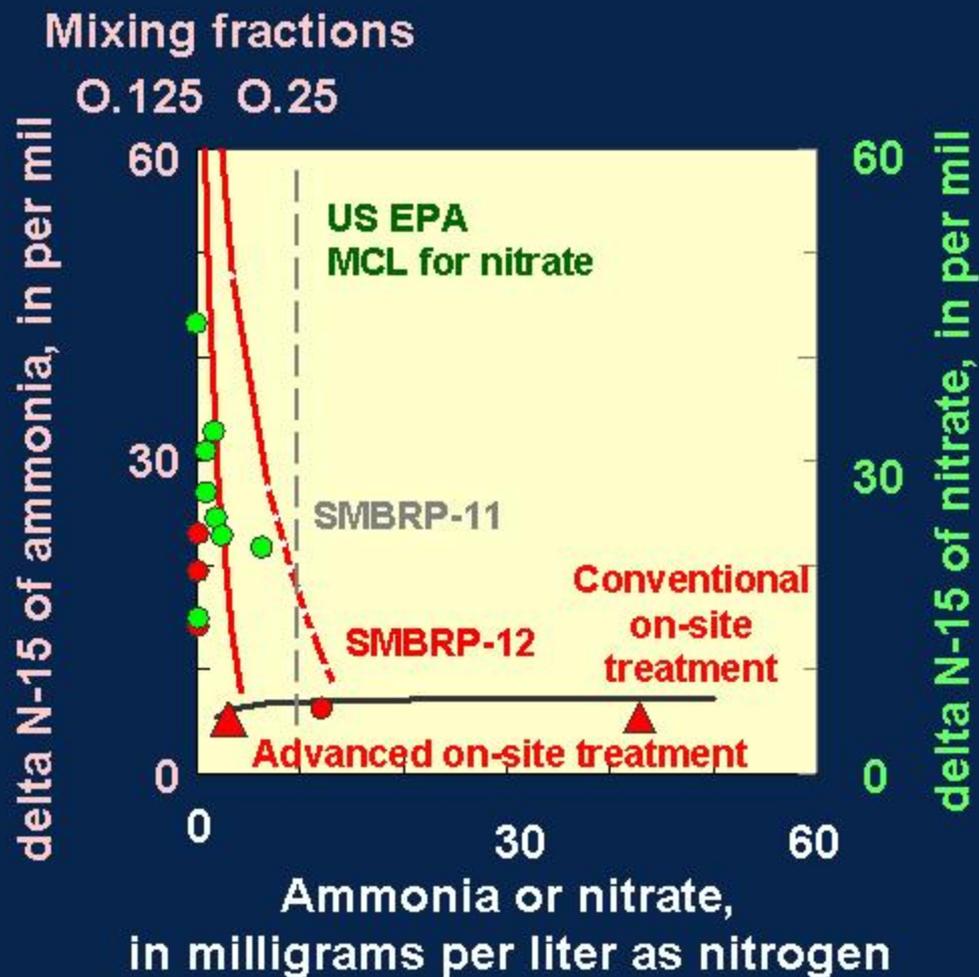


Dry season isotopic data, Malibu Calif.



Higher fraction of imported water in wells from Malibu Colony and a lower fraction in wells from the commercial area

Generally low nitrate and ammonia concentrations from mixing, denitrification, and source control



Other Analytical Data

Genetic data

- T-RFLP from UCSB
- Human-specific Bacteroides
- Phylochip

Phospholipid Fatty Acids

Chemical and isotopic data

- Major ions, minor ions, selected trace elements, nutrients
- delta Oxygen-18 and delta Deuterium
- delta Nitrogen-15 of ammonia and nitrate and delta oxygen-18 of nitrate
- Wastewater Indicators

Dissolved organic carbon and optical property data (UV absorbance and Excitation Emission)

SCCWRP data



Summary

Fecal indicator bacteria concentrations in groundwater are low

- Groundwater discharge to the ocean is higher in the dry season than in the wet season
- Groundwater discharge is not associated with increased FIB concentrations in near-shore ocean water during dry or wet seasons

Fecal indicator bacteria concentrations in Malibu Lagoon exceed standards for recreational water

- Fecal indicator bacteria in Malibu Lagoon are not associated with human-specific *Bacteroidales*
- Fecal indicator bacteria from Malibu Lagoon are associated with increased FIB concentrations in the near-shore ocean during the summer through discharge through the berm at the mouth of the lagoon and during the winter through direct discharge to the ocean

Sources of fecal indicator bacteria, Malibu Calif.



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