Water Quality: Examples from the Big Island



Tracy Wiegner
Marine Science Department
University of Hawaii at Hilo

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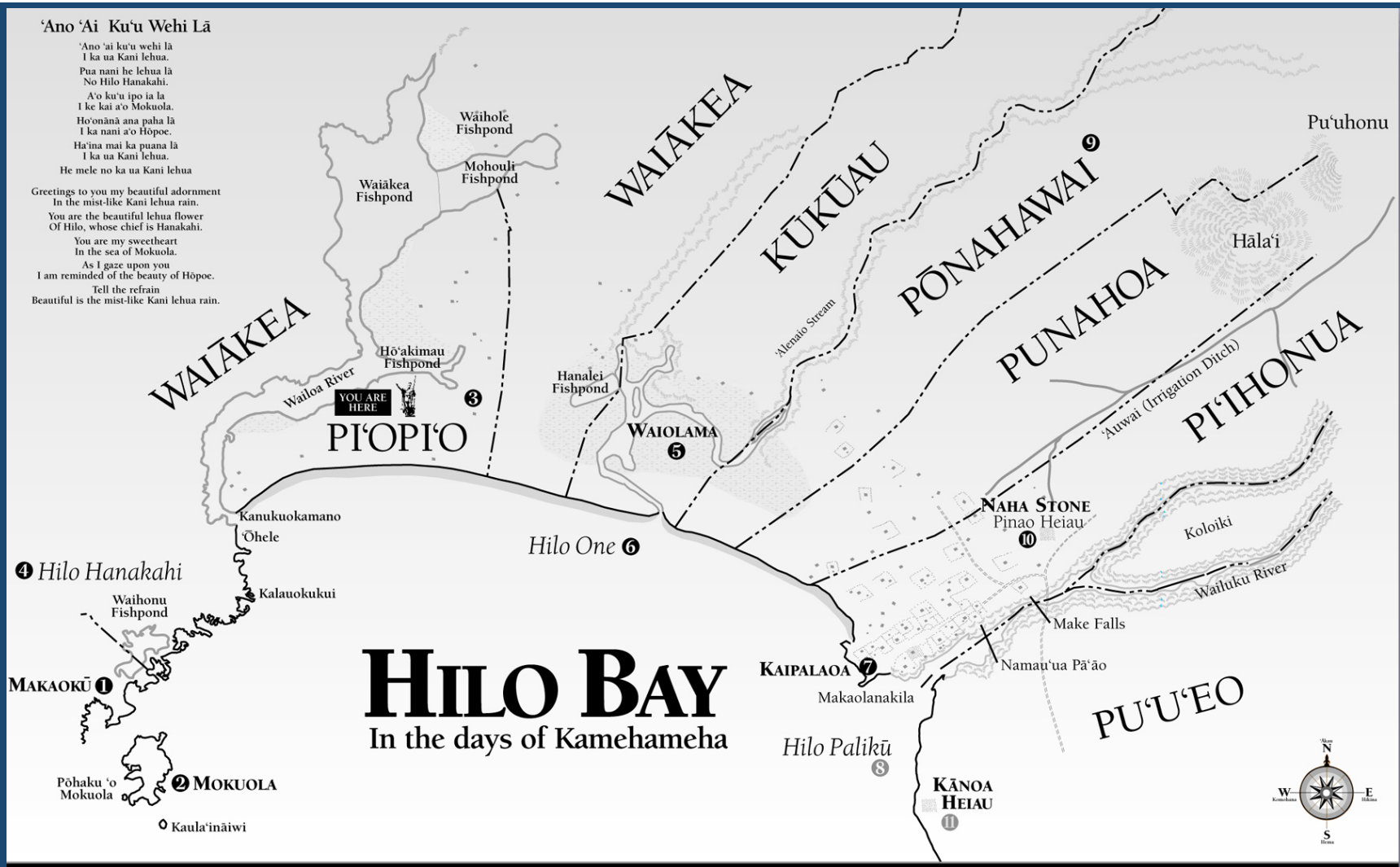
Ahupua`a



1 MAKAOKŪ This *'ili* contained the Waihonu fishponds known for their turtles. A *heiau* at Makaokū was dedicated to the god Kū. A portion of this area is now Queen Lili'uokalani Park.

2 MOKUOLA was an important *wahi pana*, or special place, in Hilo. It was a *pu'uhonua*, or place of refuge, where Hawaiians sought sanctuary from punishment for their transgressions. The island was a place for healing rituals through the early 20th century. Today, Mokuola is referred to as "Coconut Island".

3 PI'OPI'O Pi'opi'o was an *'ili* of Waiākea *ahupua'a* and considered an *ipukai* or foodbowl because its people controlled the rich "royal ponds" of the Wailoa Estuary. The *'ili* was a favored place of chiefly residence from ancient times. Keōua, father of Kamehameha I, was with the court of the paramount chief Alapa'inui when he died at Pi'opi'o in the 1750s. Upon his death Kamehameha gave Pi'opi'o to his wife Ka'ahumanu. It was the site of a residence for Princess Ruth Ke'elikōlani, the governess of Hawai'i in the 1860s and became part of the Estate of Bernice Pauahi Bishop in 1883. Pi'opi'o was traded with the Territory of Hawai'i in 1948 as part of the post-tsunami redevelopment of Hilo Bay front.

4 HILO HANAKAHI Region south of Hilo Bay named after an early chief and known for its groves of *hala*.

5 WAIOLAMA A wetland area that was fed by springs and intermittent stream flow from Alenaio Stream. These wetlands were transformed into fishponds and agriculture areas known as *kipi*. Reeds and mud were mounded into floating islands which were planted with taro and other crops.

6 HILO ONE Region of Hilo fronting the sandy beach of Hilo Bay.

7 KAIPALAOA This was the location of a chiefly compound near the mouth of the Wailuku River where Kamehameha and other *ali'i* were known to reside. It was the site of an important *heiau*. Today Kaipalaoa is the name of the point and former boat landing near the lighthouse fronting Downtown Hilo.

8 HILO PALIKŪ A region north of Hilo with high sea cliffs.

9 AHUPUA'A There were seven *ahupua'a*, or land divisions, which began at Hilo Bay and extended into the upper forests. Much of the early settlement in Hilo took place near the coast with agricultural fields scattered along the slope. *'Auwai* or ditches were dug from upland springs to bring fresh water to settlement areas for drinking and farming.

10 NAHA STONE A large, elongated stone was located at Pinao Heiau near the current State Library. The stone was associated with the *naha* chief and served to test the prowess of warriors and foretell the future of royal born children. Kamehameha was said to have lifted the stone as a young warrior adding to his reputation as a great future leader.

11 KĀNOA HEIAU Kānoa Heiau was one of six major *luakini* or sacrificial *heiau* on the Island of Hawai'i dating back to ancient times.

LEGEND

- Settlement Areas
- Marsh
- Heiau Location

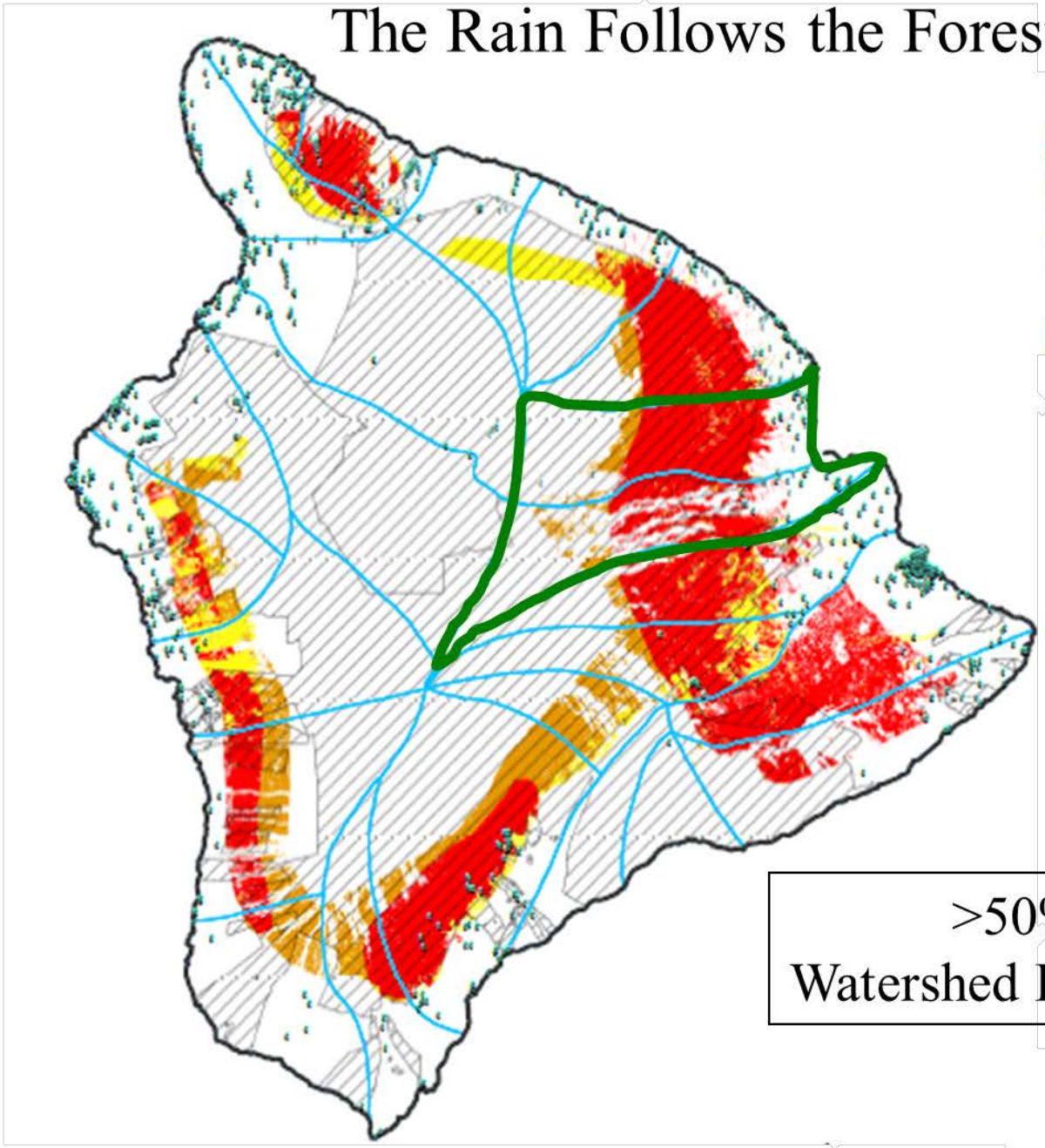
CREDITS

State of Hawai'i, Dept. of Land & Natural Resources, Division of State Parks

Kamehameha Schools Alumni Association, Māmalahoe Chapter

Hahai no ka ua i ka ululaau

The Rain Follows the Forest



>50% of area is
Watershed Protection Priority I

Why is water quality important?

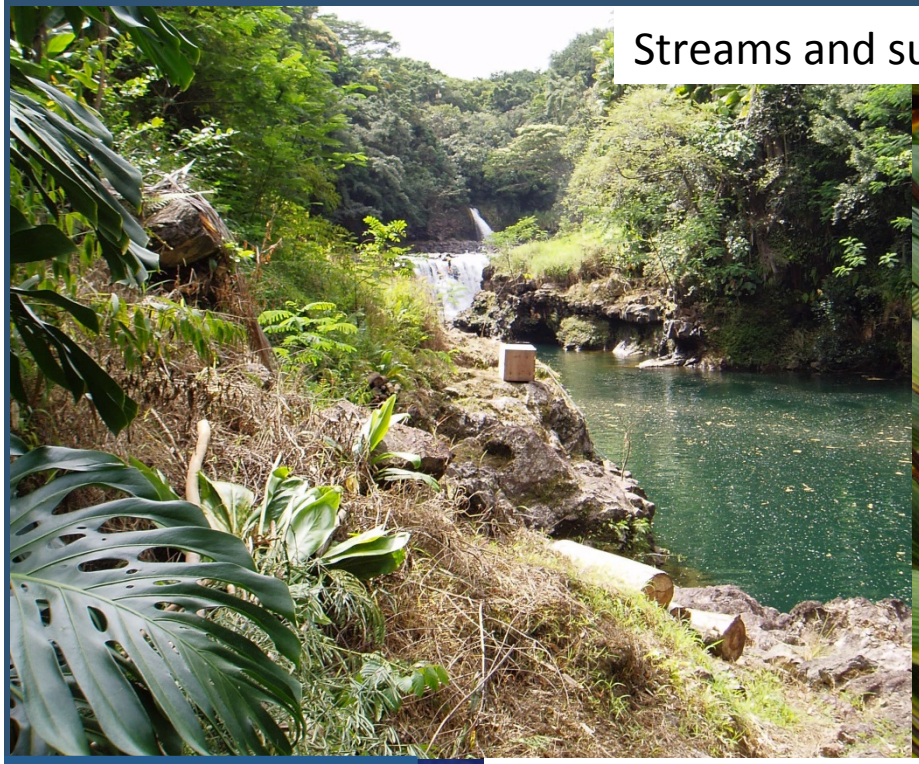
Human health

Ecosystem health

Economies

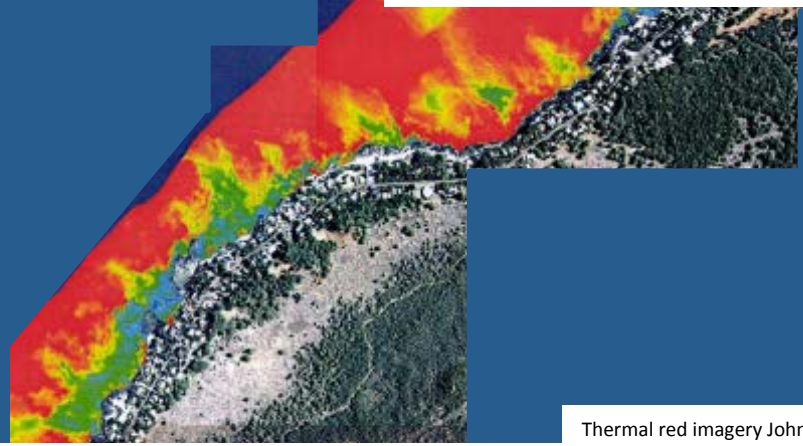
Culture

How does the pollution get into the streams and ocean?



Streams and surface runoff

Groundwater at shore and through the benthic substrate

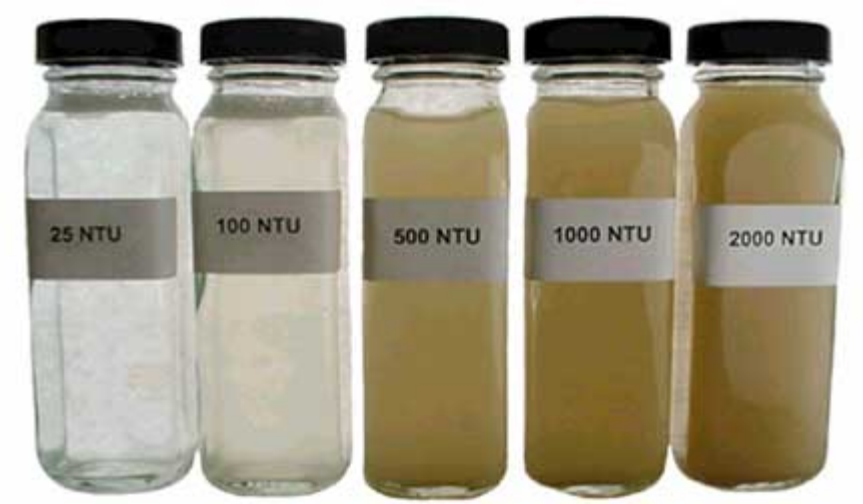


Thermal red imagery Johnson 2008

What do we measure to assess water quality in fresh and marine waters?

Turbidity: measure of water clarity

Measures reflectance of light off of particles suspended in water



Turbidimeter

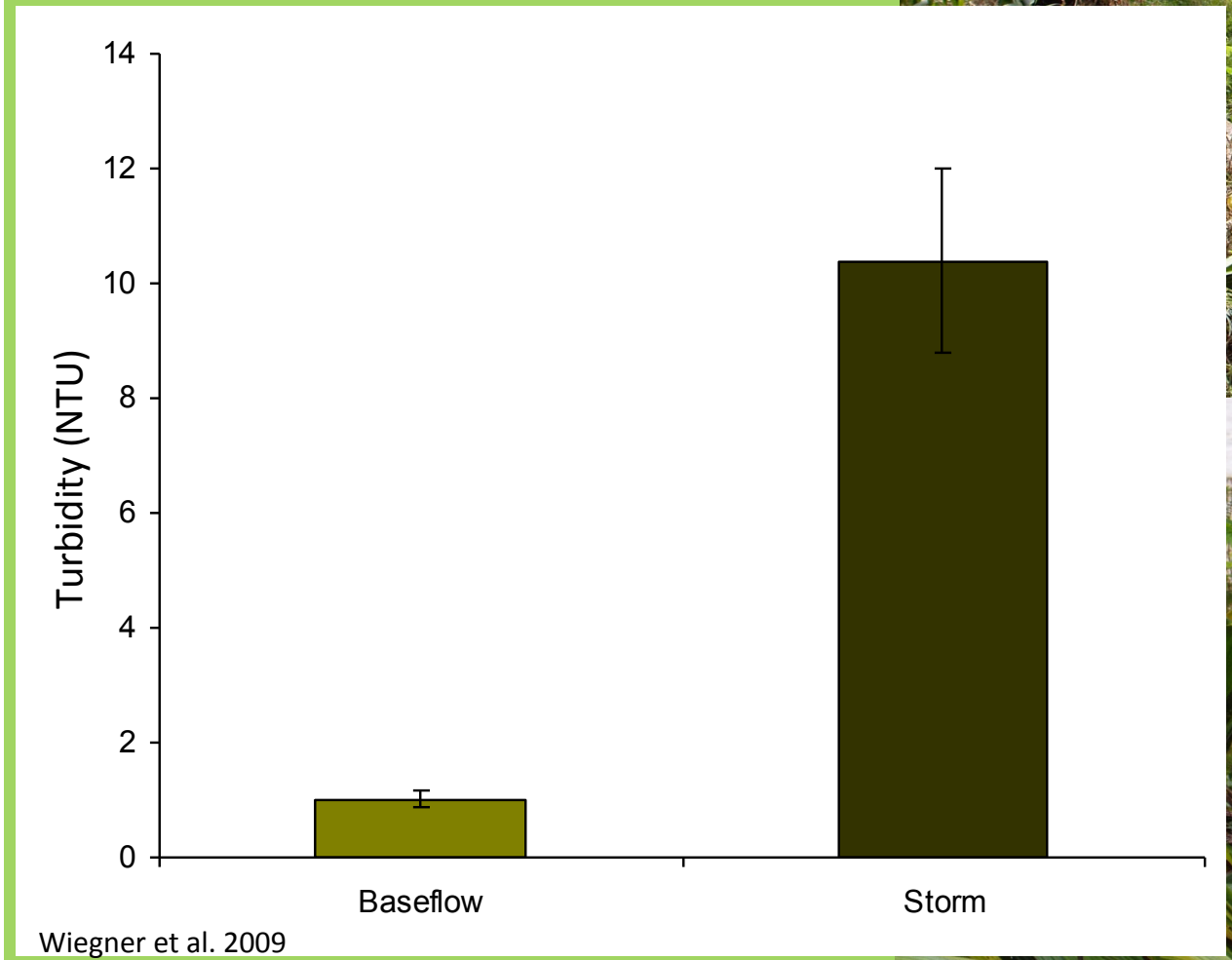
Sources of Turbidity

Erosion from land clearing

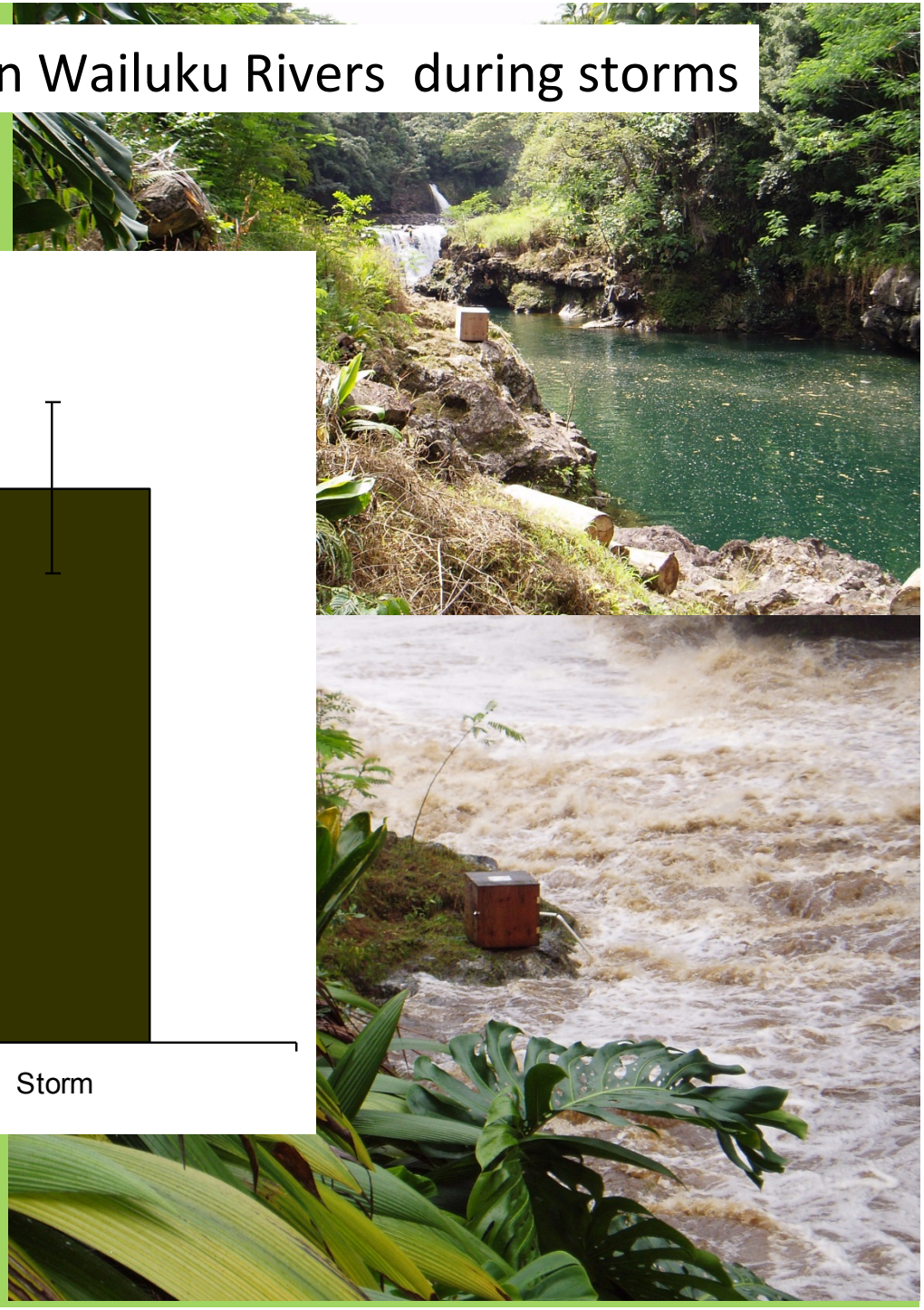
Re-suspension of sediments during storms

Erosion from feral animals

Turbidity increases in Wailuku Rivers during storms

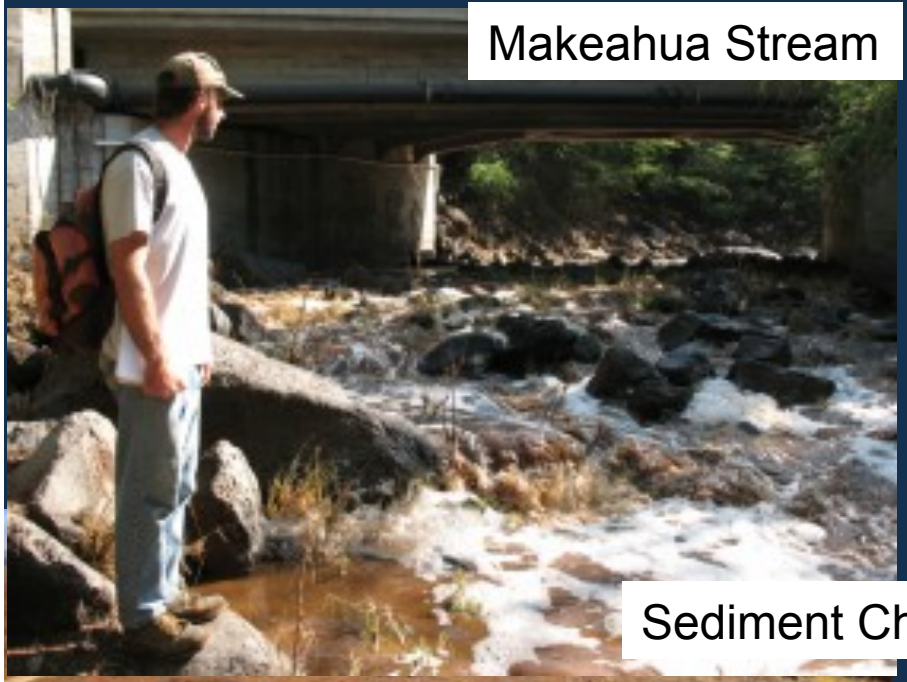


Wiegner et al. 2009



Sediment runoff makes Pelekane Bay brown

Makeahua Stream



Pelekane Bay

Sediment Check Dams

Kohala Watershed Partnership

Nutrients: elements that make plants grow

Nitrogen: NO_3^- (nitrate) & NH_4^+ (ammonium)

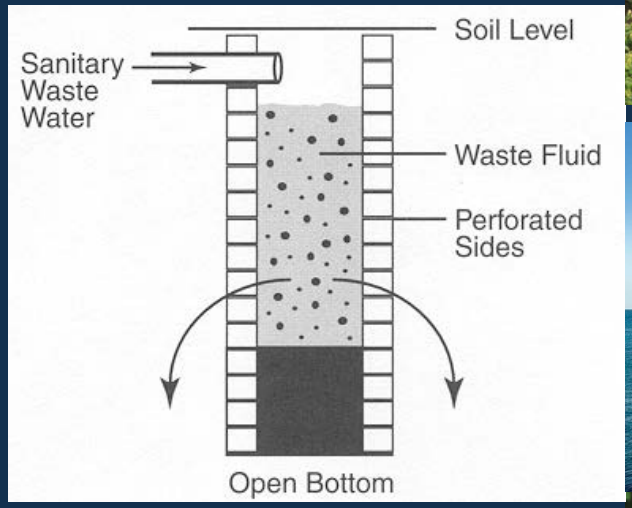
Phosphorus: PO_4^{3-} (phosphate)

Sources of Nutrients

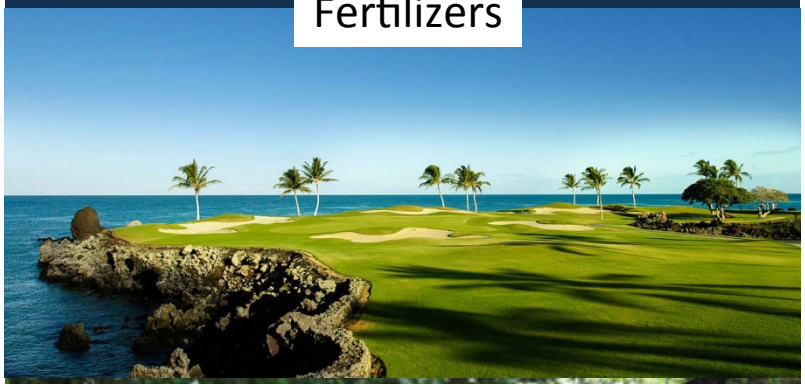
Fertilizers

Sewage

Animal waste



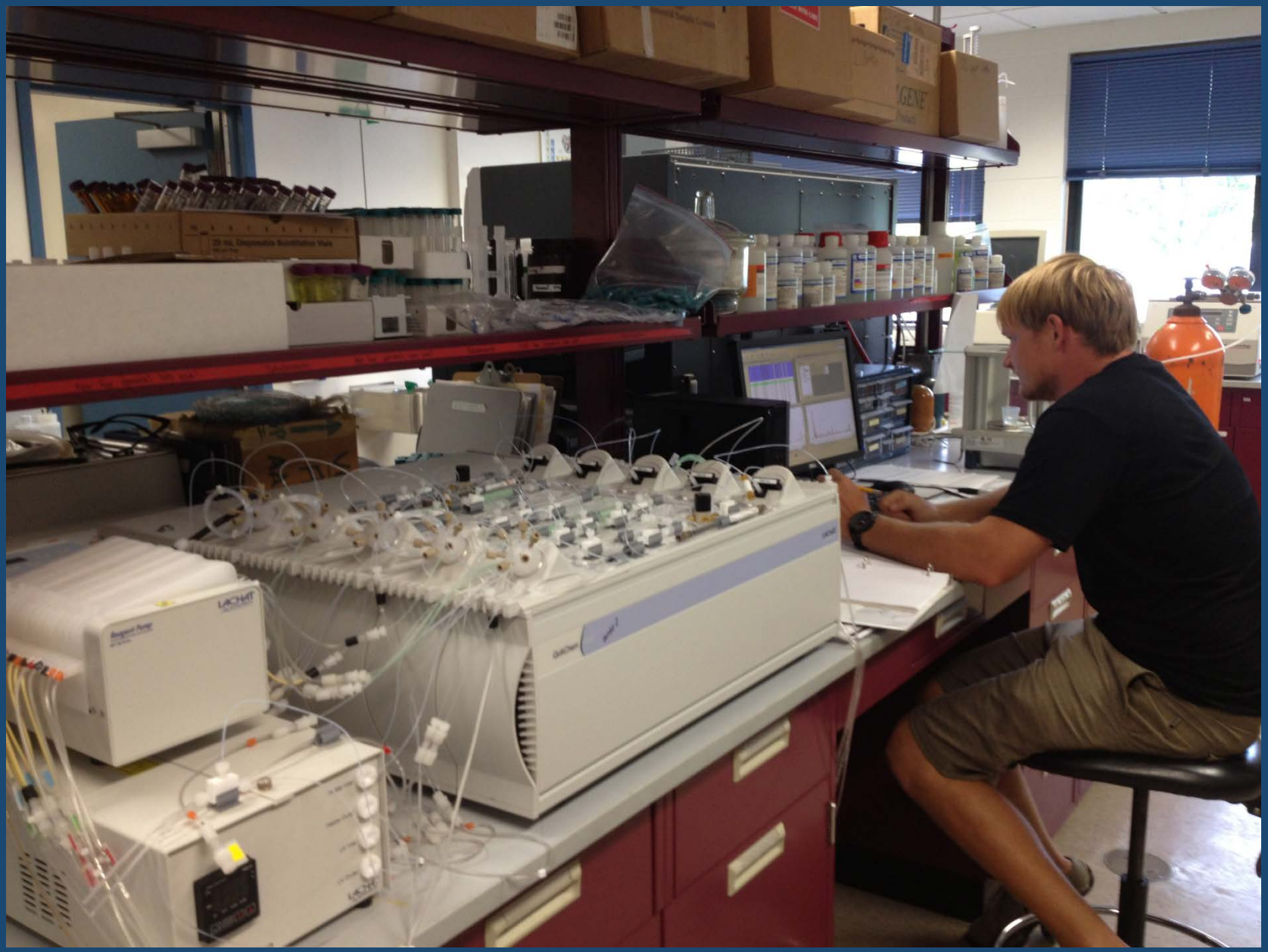
Fertilizers



Sewage

Livestock

Measuring nutrients: Autoanalyzer

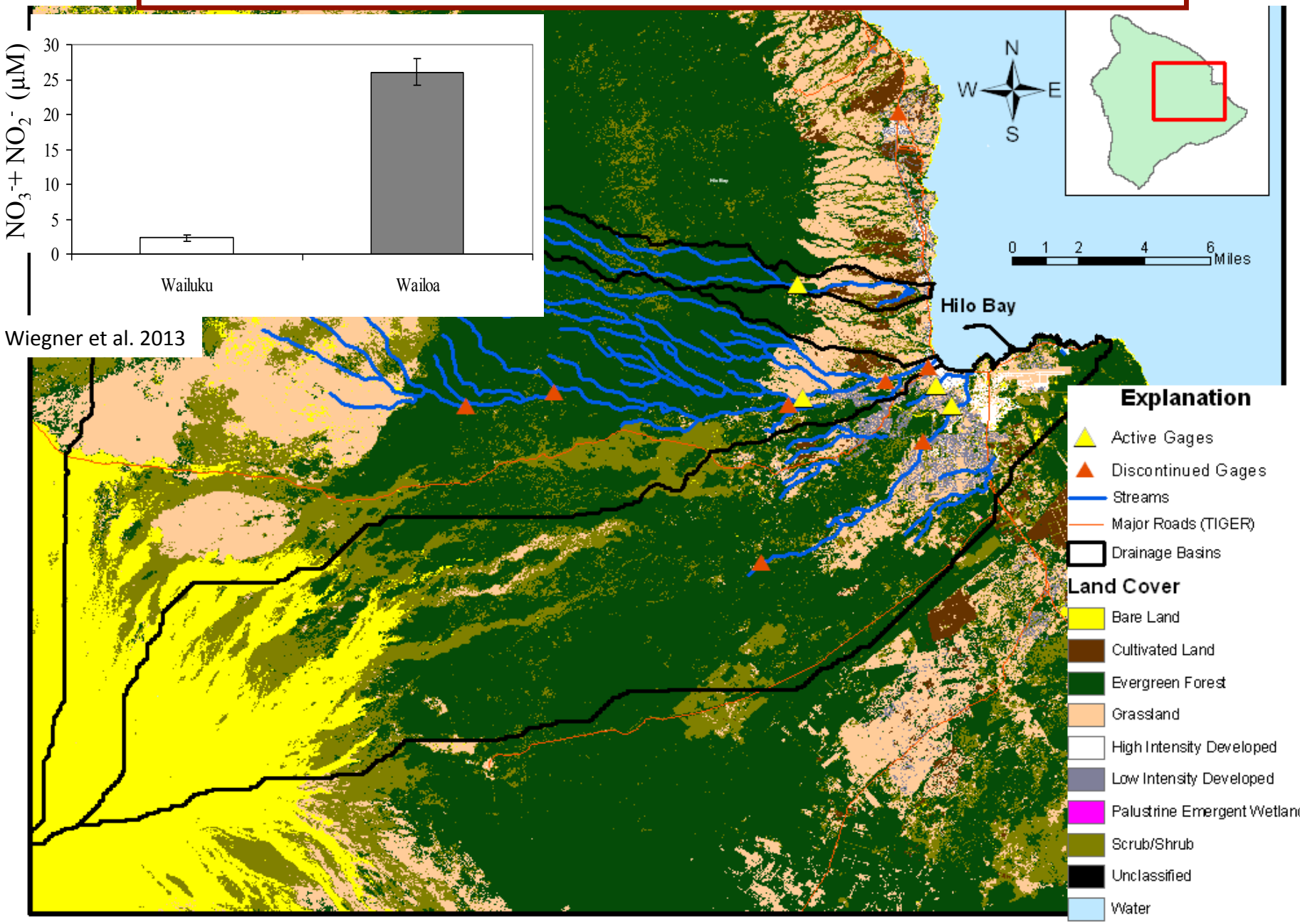


Ecologically and economically devastating seaweed blooms in Maui –in part- from a sewage injection well

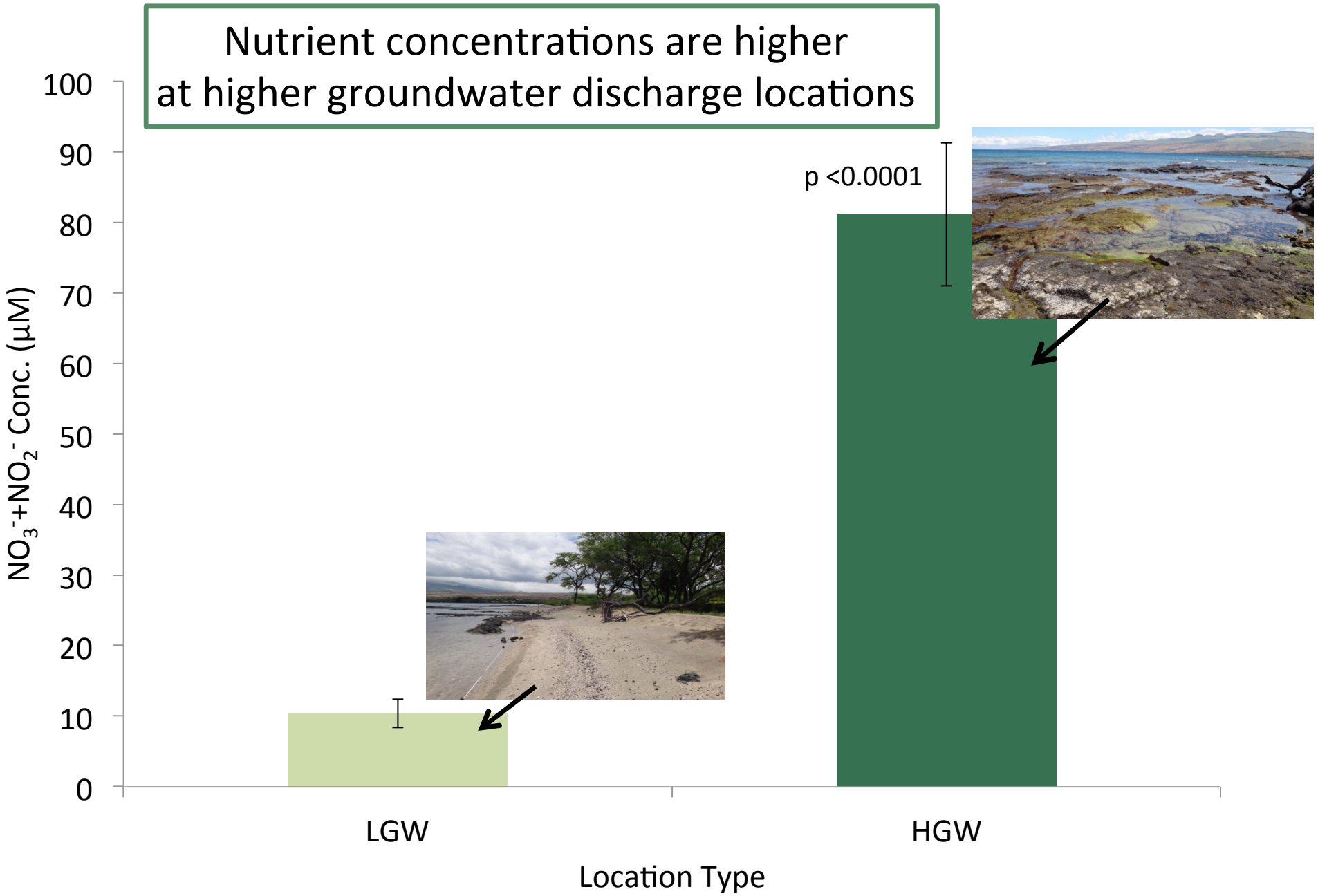
Hypnea musciformis bloom - Maui

Cladophora bloom – Maui

Why does the nitrate concentrations differ between the two rivers?



Wiegner et al. 2013

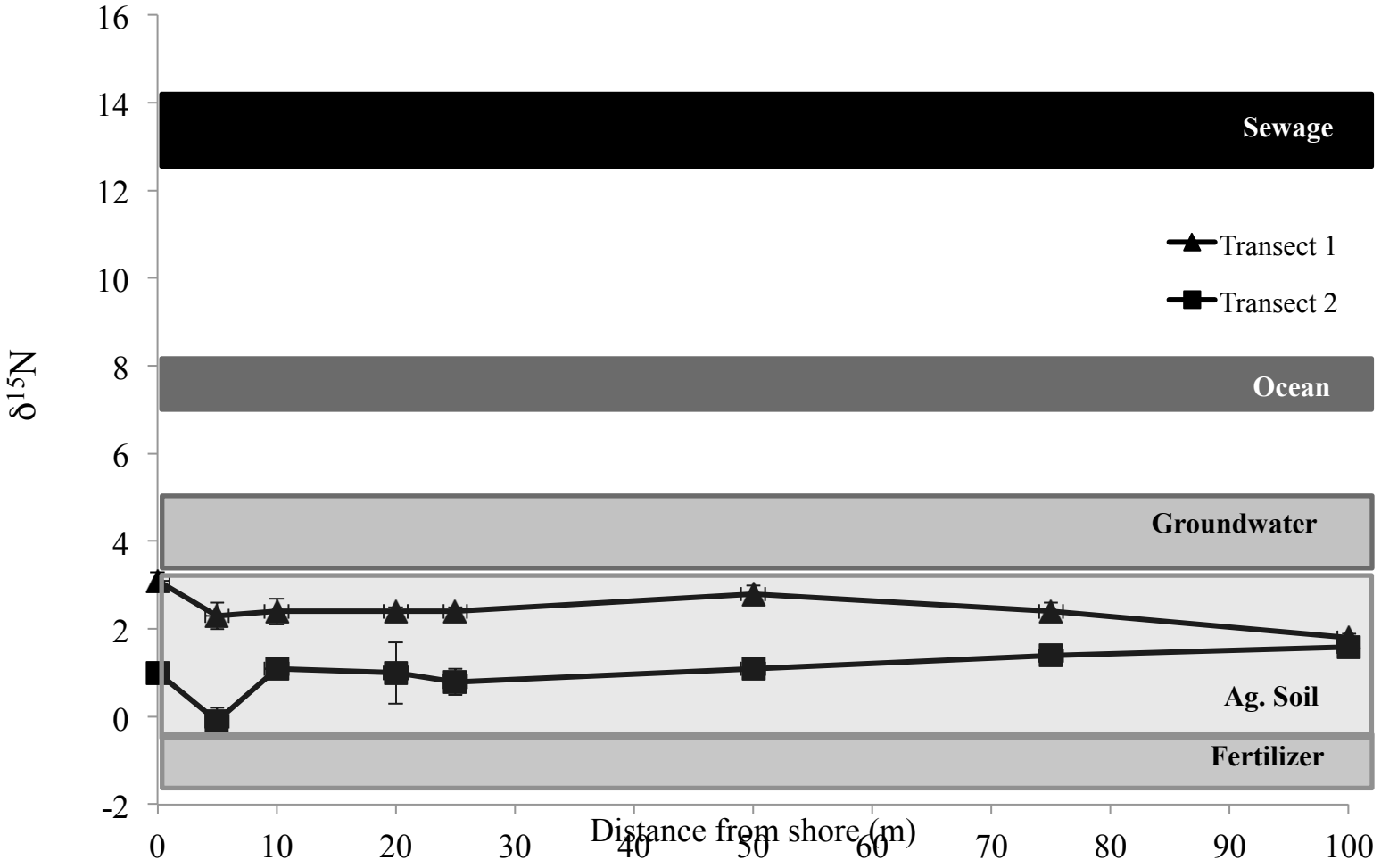


Wiegner et al. unpubl. data

Determining nutrient sources using ^{15}N seaweed measurements: Puakō

Sewage $\delta^{15}N$ = +7 to +20 ‰
Soil N $\delta^{15}N$ = +2 to +5 ‰
Fertilizer/Kiawe $\delta^{15}N$ = 0 to+3‰

$\delta^{15}N$ seaweed measurements indicative of fertilizer pollution at Wai Opae



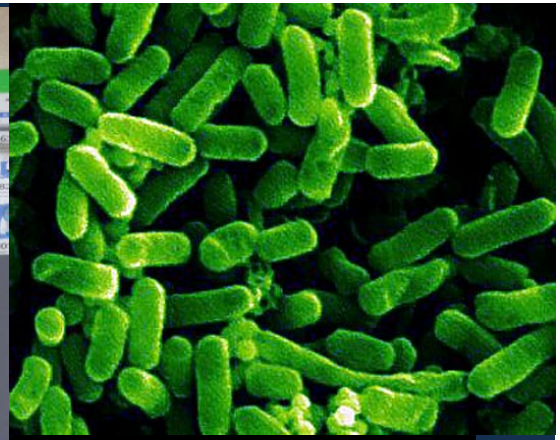
Wiegner et al. accepted 2015

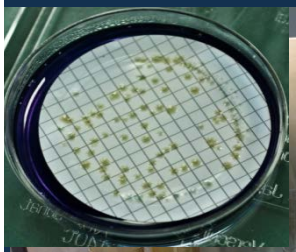
Bacteria

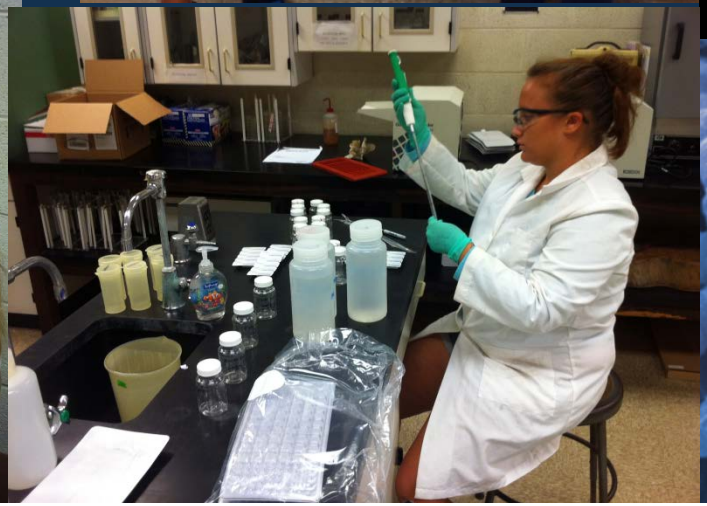
Freshwater:
Escherichia coli

Marine: *Enterococcus*

Tropically relevant:
Clostridium perfringens





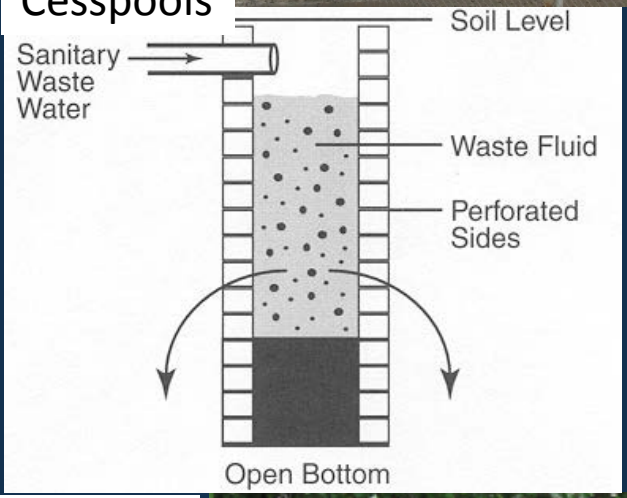


Sources of Bacteria

- Sewage
- Animal waste
- Soils
- Sands
- Frack

Sewage treatment plant

Cesspools

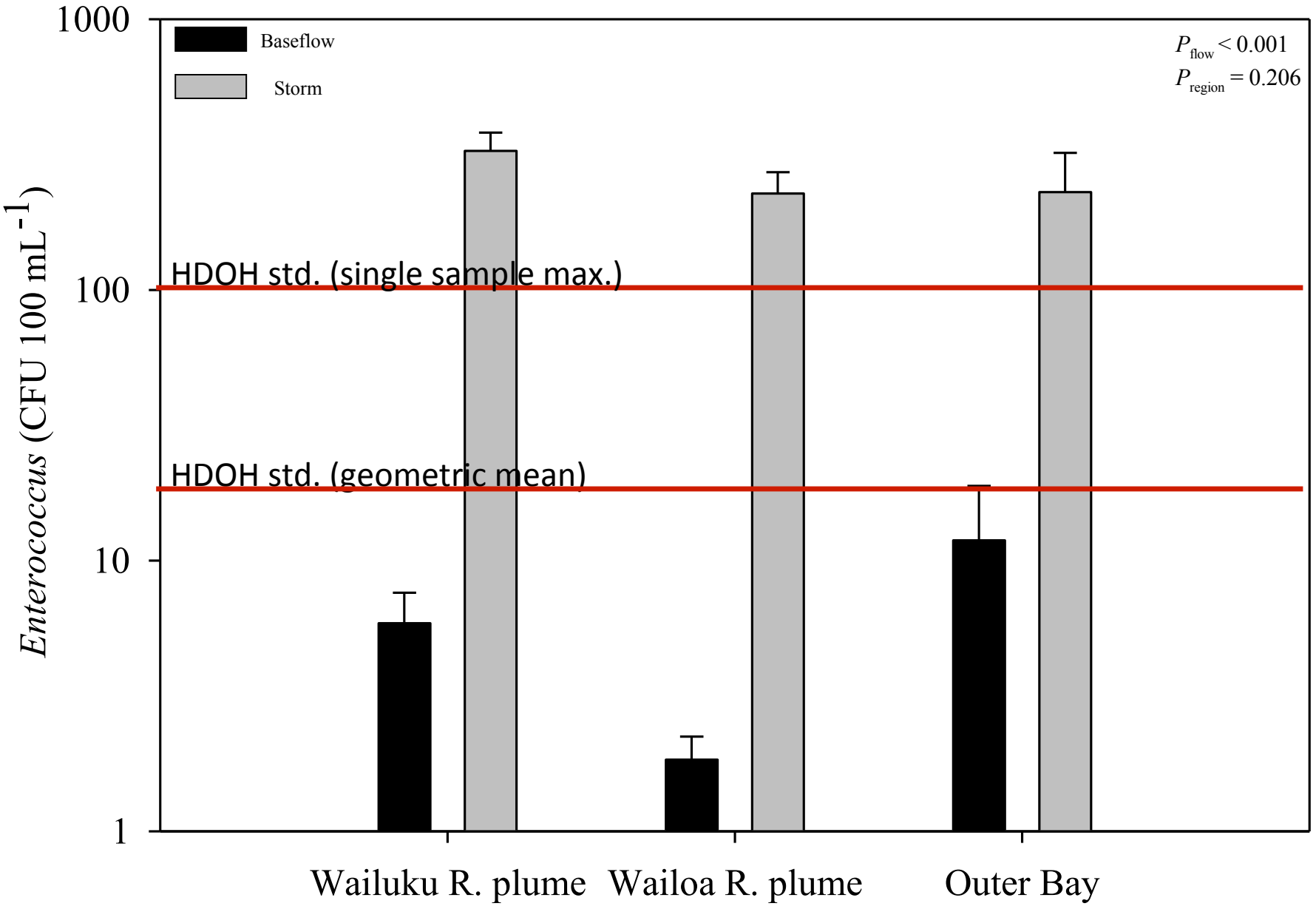


Soil runoff

Sands/frack

Animal waste

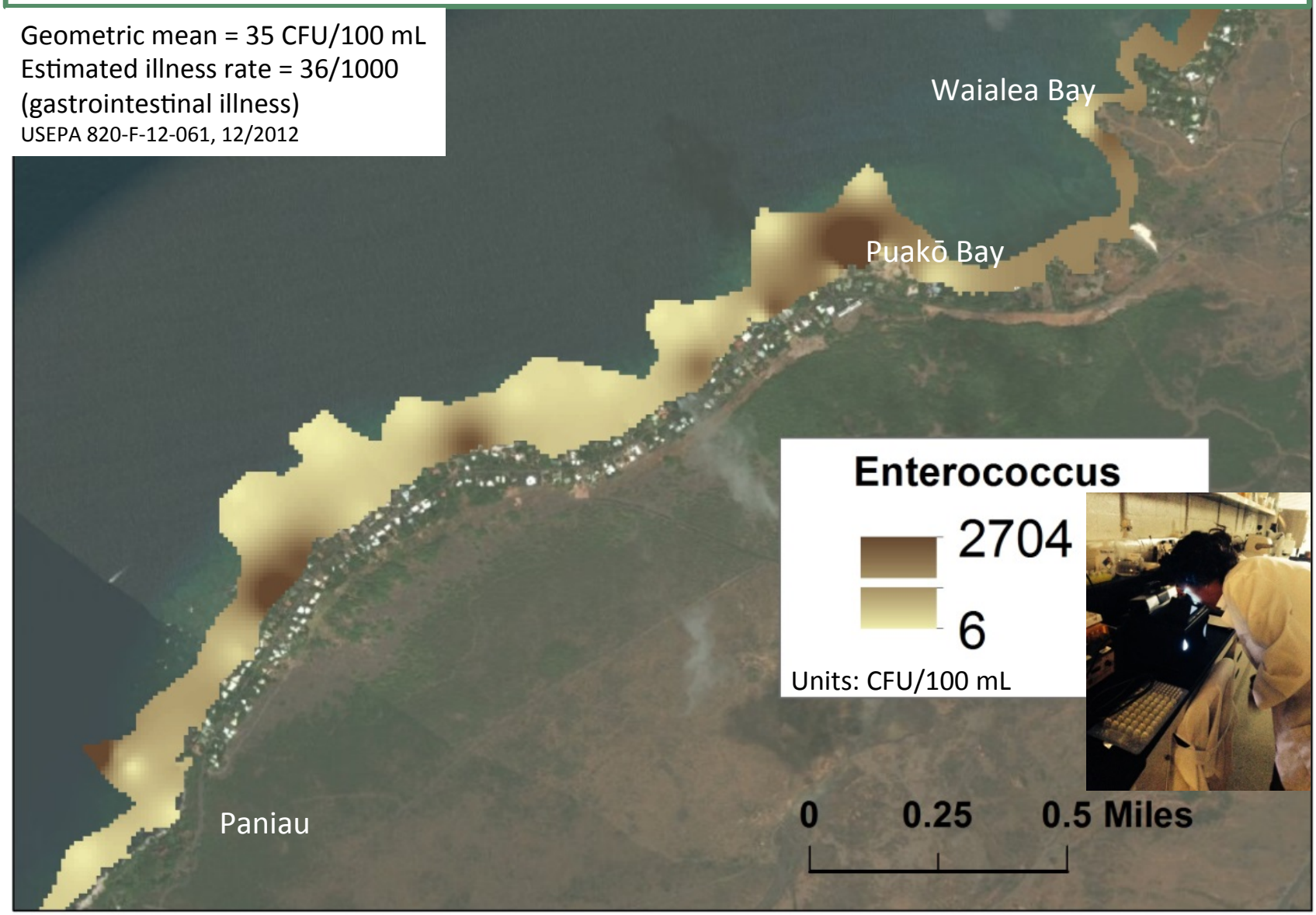
Bacteria increase after storms and exceed state standards



Wiegner et al. 2013

Enterococcus levels suggest hot spots of sewage pollution at Puako

Geometric mean = 35 CFU/100 mL
Estimated illness rate = 36/1000
(gastrointestinal illness)
USEPA 820-F-12-061, 12/2012



UHH & TNC

Bacteriodes

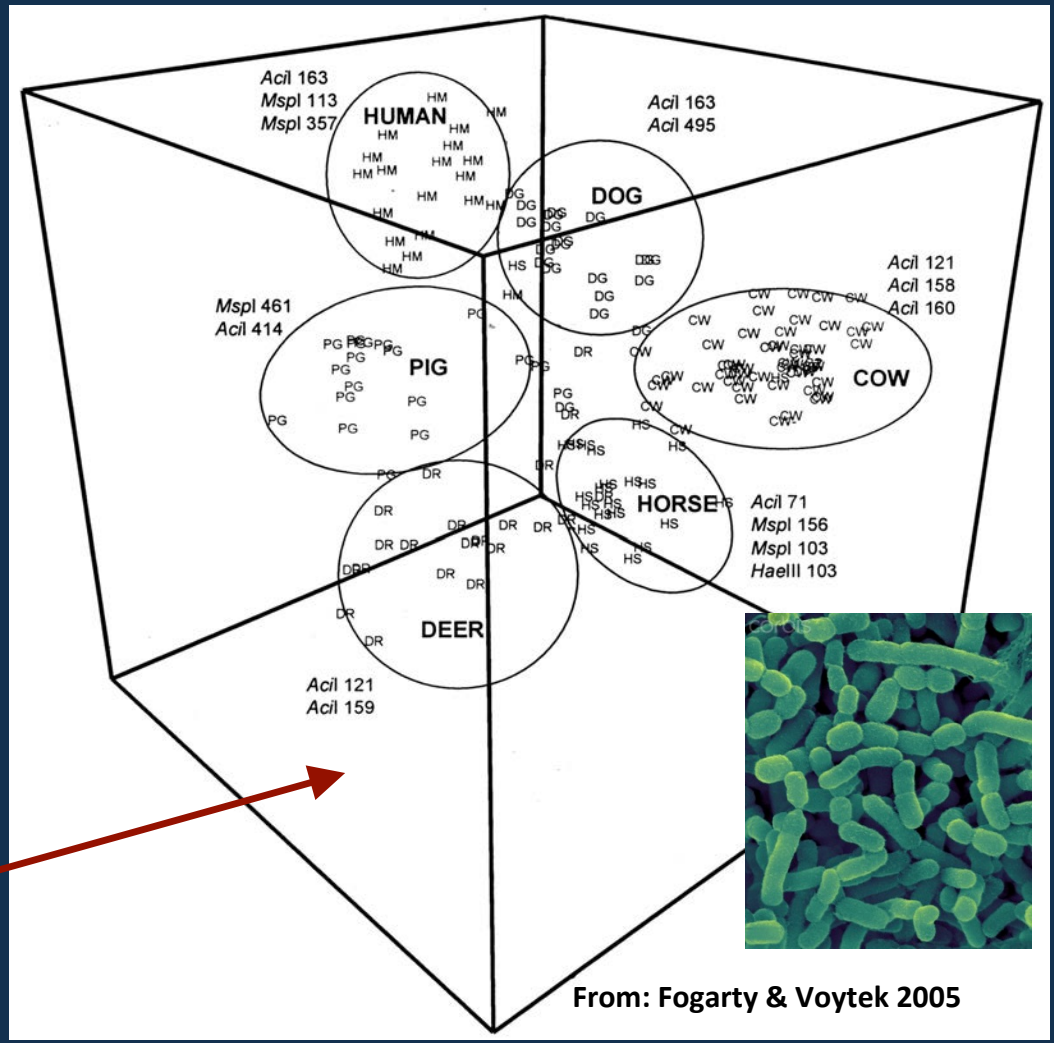
Strict anaerobic bacteria

Gut of warm-blooded animals

Larger % of fecal bacteria than fecal coliforms or enterococci

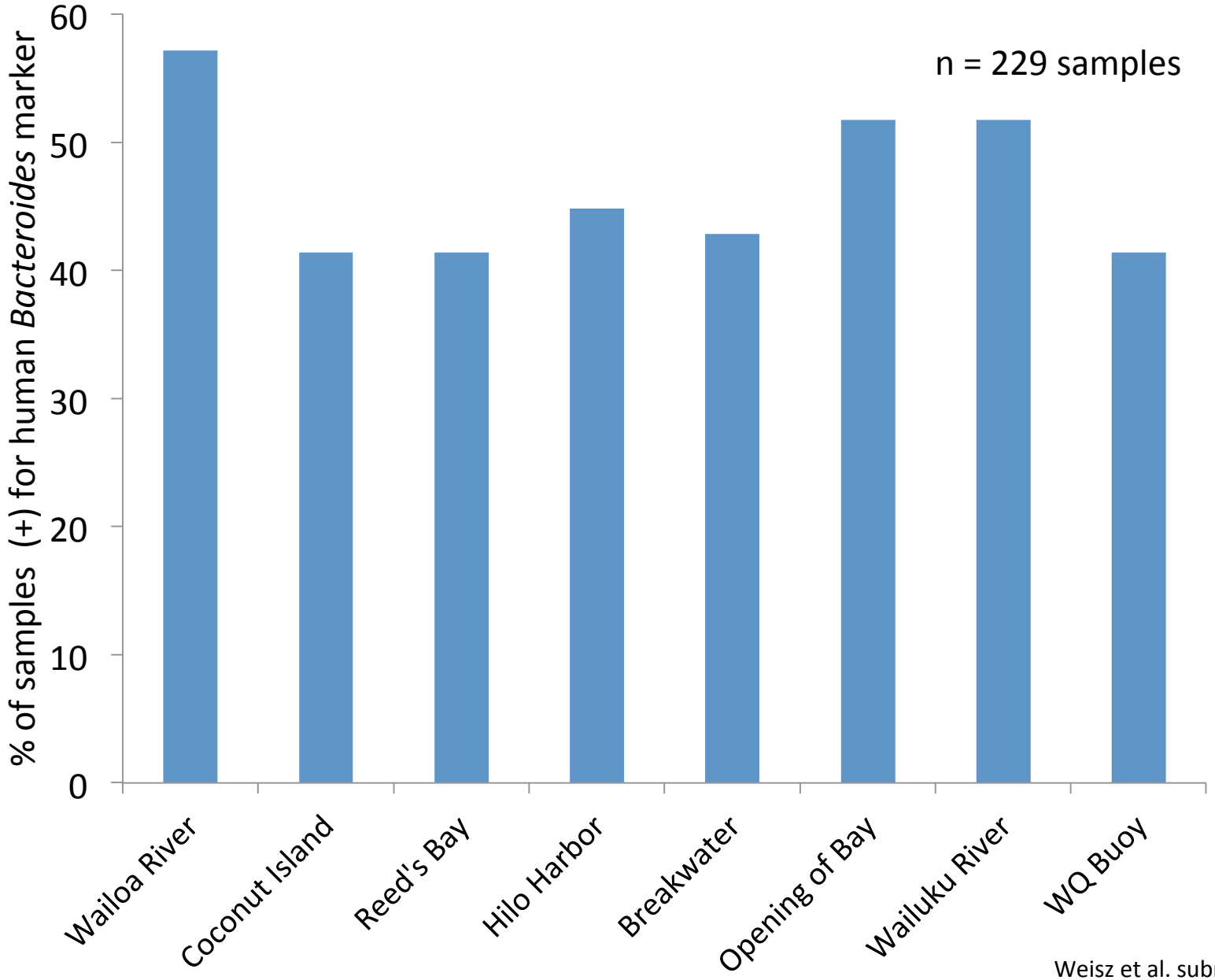
Does not multiply in environment

PCR primers distinguish among: human, ruminant, swine, equine, canine, & avian fecal sources



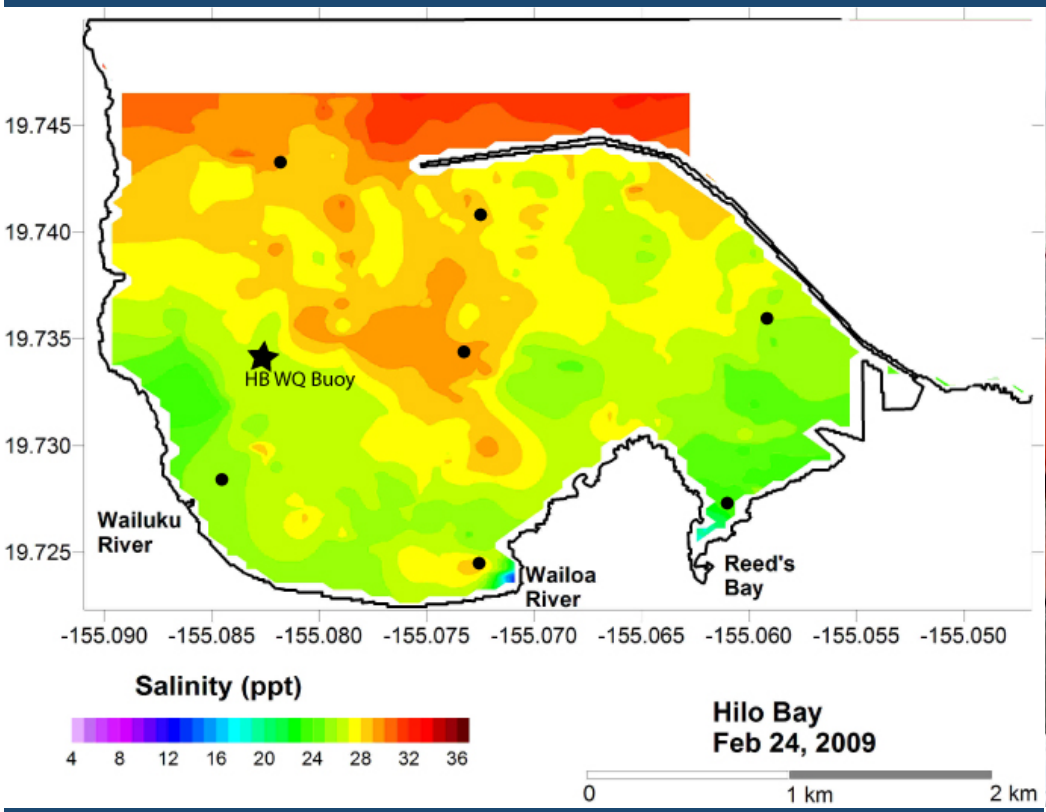
From: Fogarty & Voytek 2005

Bacteroides in Hilo Bay:
~40-60% of samples were positive for human marker



Weisz et al. submitted 2015

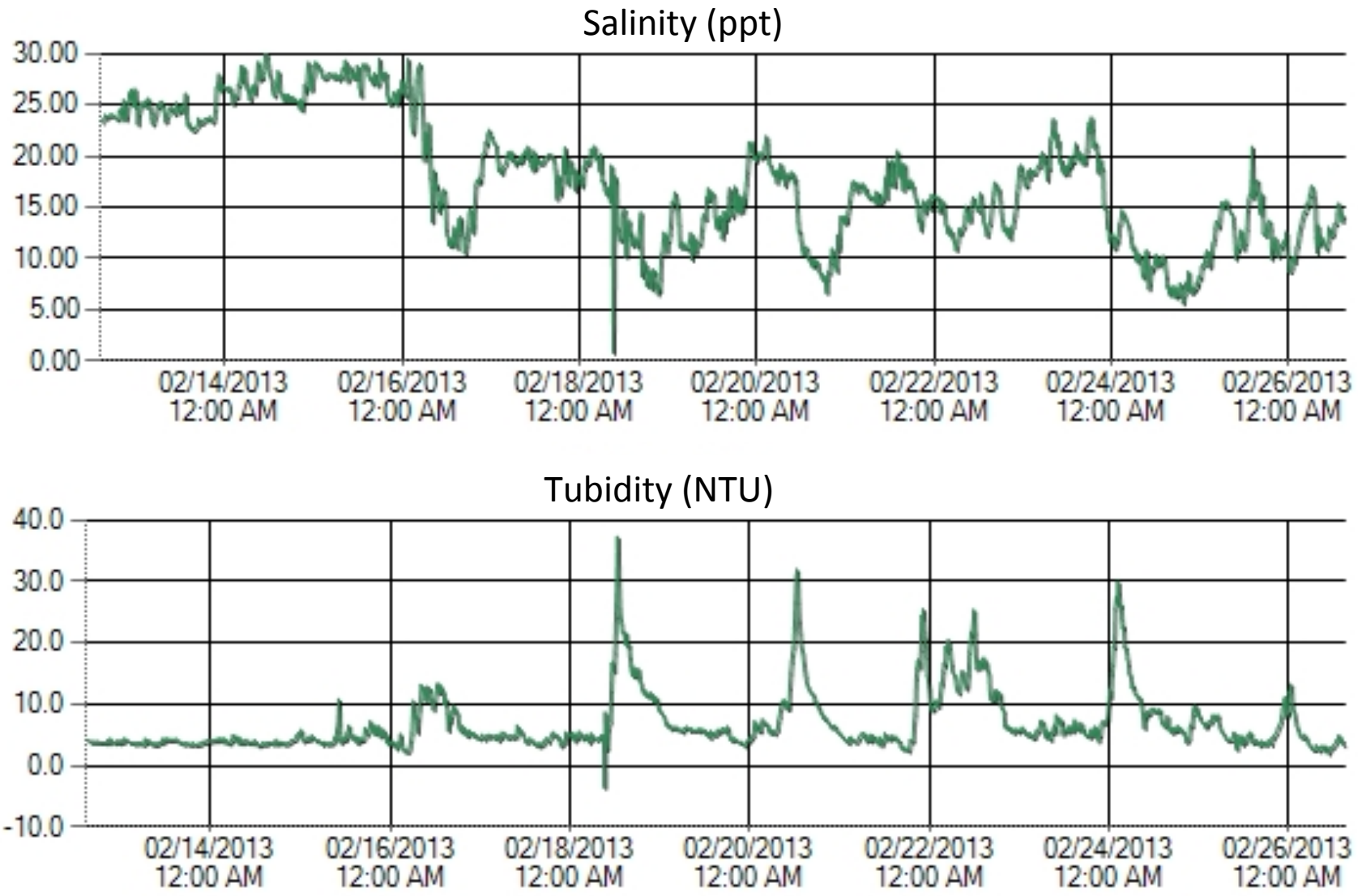
Real-time measurements using deployed sensors
Hilo Bay Water Quality Buoy



measures: salinity, temperature, pH, turbidity, O_2, chlorophyll *a*

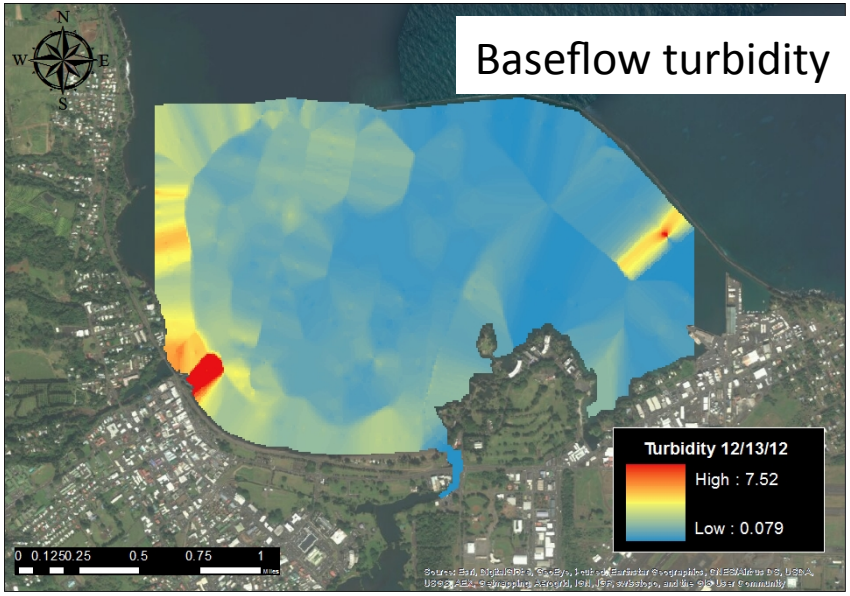
http://oos.soest.hawaii.edu/pacioos/focus/waterquality/wq_hawaii.php

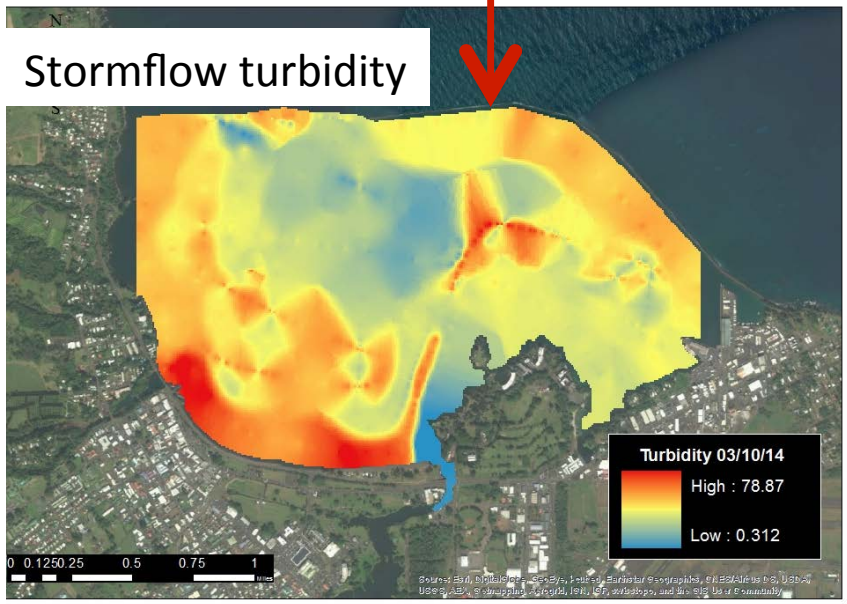
During storms, salinity decreases, and turbidity increases



Adolf et al. unpubl. data; http://oos.soest.hawaii.edu/pacioos/focus/waterquality/wq_hawaii.php

Visualizing spatial patterns through surface water quality mapping





Weisz 2014


Mahalo!
Students
Collaborators
Funders
Mālama
MAKALI'I
Sea Grant
University of Hawai'i
PacIOOS
Pacific Islands Ocean Observing System
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NOAA
U.S. DEPARTMENT OF COMMERCE
NSF
COUNTY OF HAWAII
STATE OF HAWAII
Puako
COMMUNITY ASSOCIATION
c·more
center for microbial oceanography: research and education
PIPES