Submarine Groundwater Discharge (SGD) and its Importance to Coral Reef Ecosystems, West Hawaii

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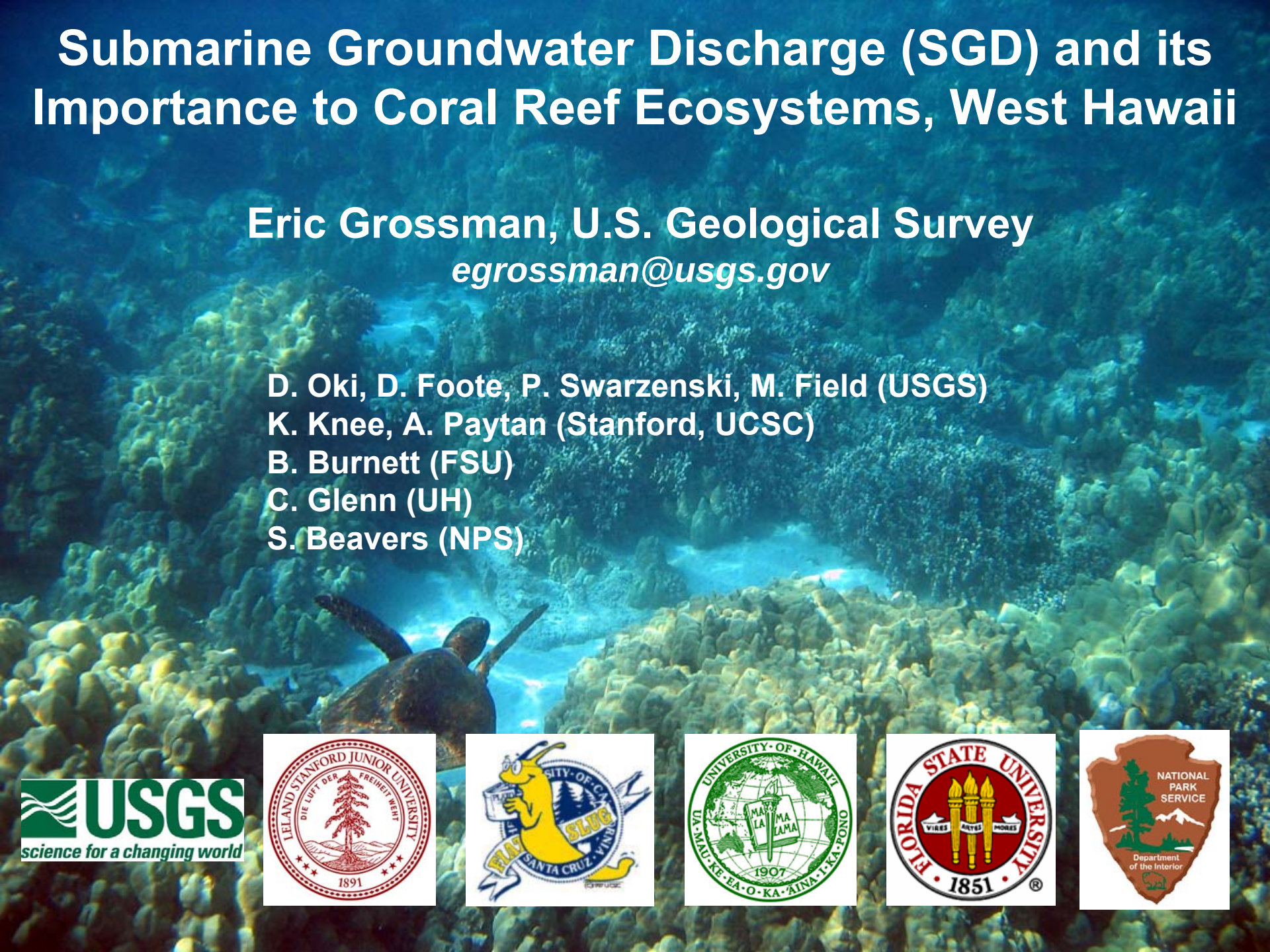


Submarine Groundwater Discharge (SGD)
Why is it a concern?

10-16% global freshwater input to ocean; Locally, ≤100%

100% nutrient Input
10-100x ocean concentrations

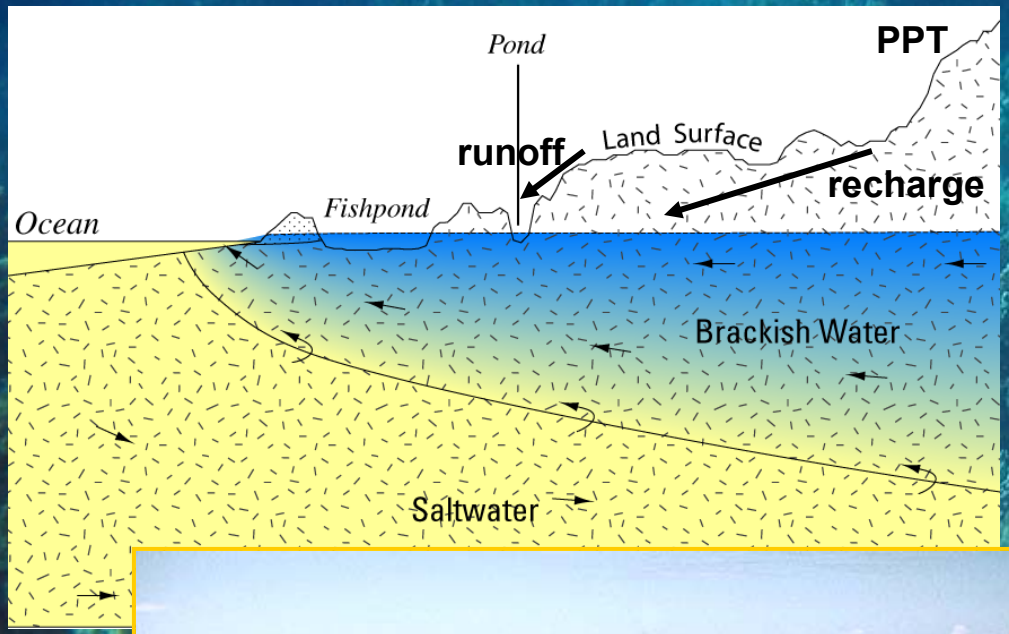
"Out of sight, out of mind"

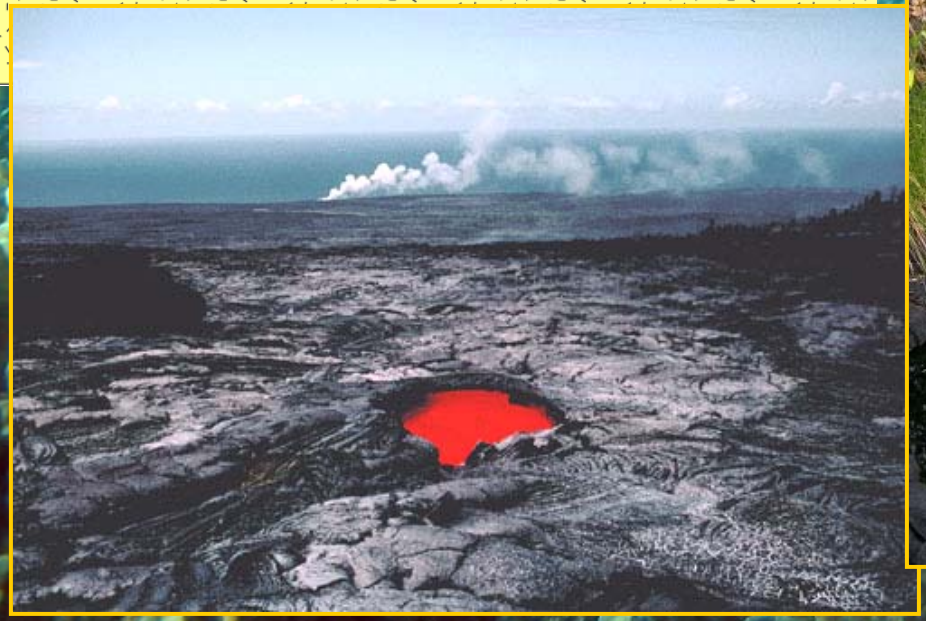
Groundwater use, runoff, waste disposal altering quantity and quality

MILLENNIUM ECOSYSTEM ASSESSMENT

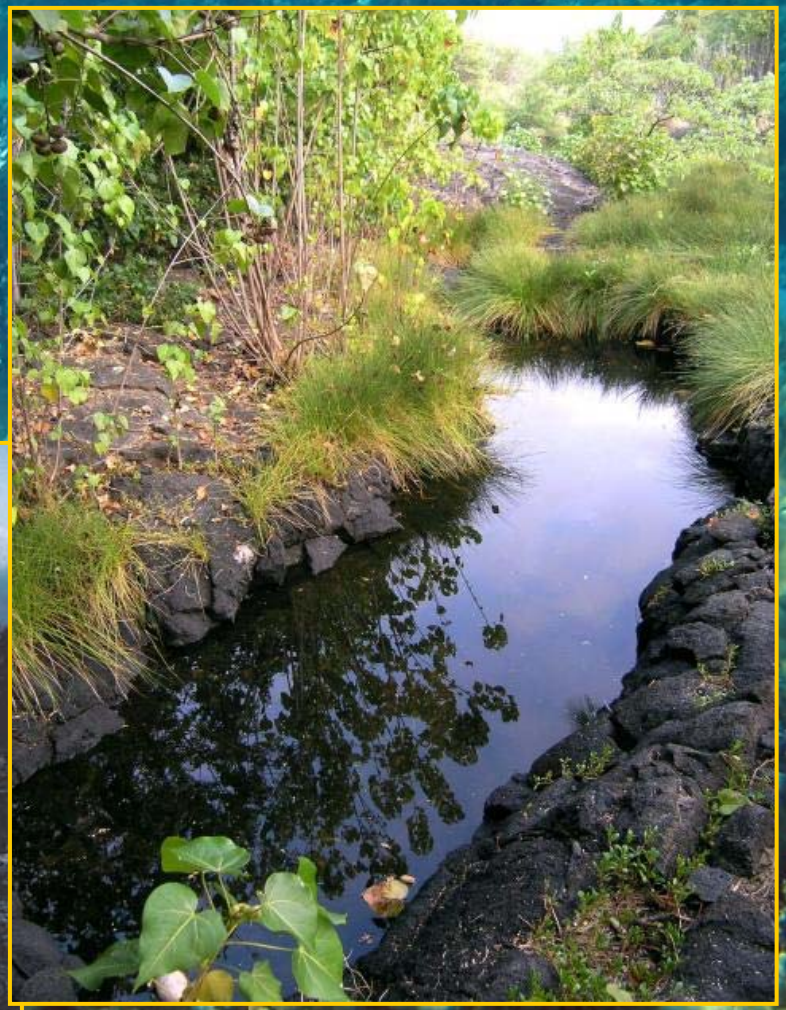
Excessive nutrient loading is expected to become a growing threat to rivers, lakes, marshes, coastal zones, and coral reefs. Since 1950, nutrient loading—anthropogenic increases in nitrogen, phosphorus, sulfur, and other nutrient-associated pollutants—has emerged as one of the most important drivers of ecosystem change in freshwater and coastal ecosystems, and this driver is projected to substantially increase in the future (*high certainty*). Wetlands provide an important service by treating and

Submarine Groundwater Discharge (SGD)
What is it?





Window into aquifer



Approach:

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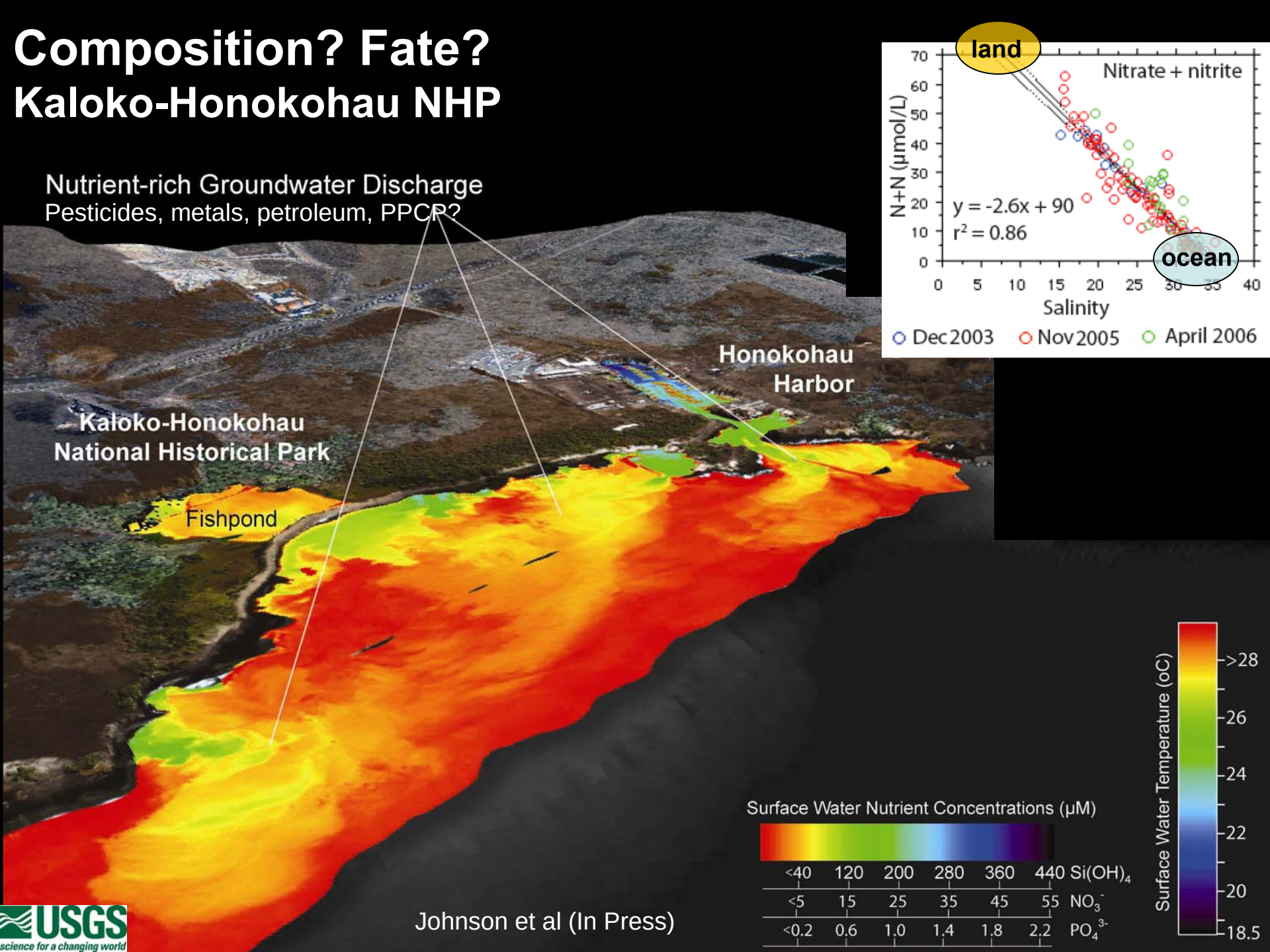
Composition? Fate?
Kaloko-Honokohau NHP



Johnson et al (In Press)

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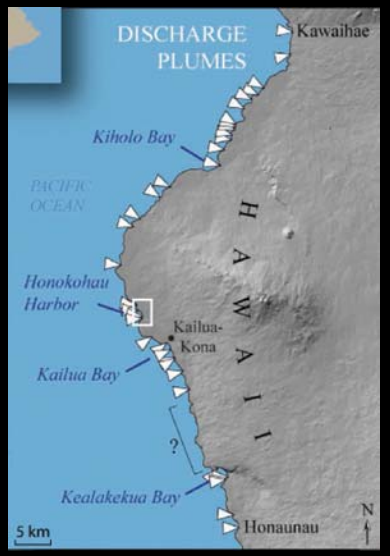
How much fresh groundwater enters coast? Nutrient?

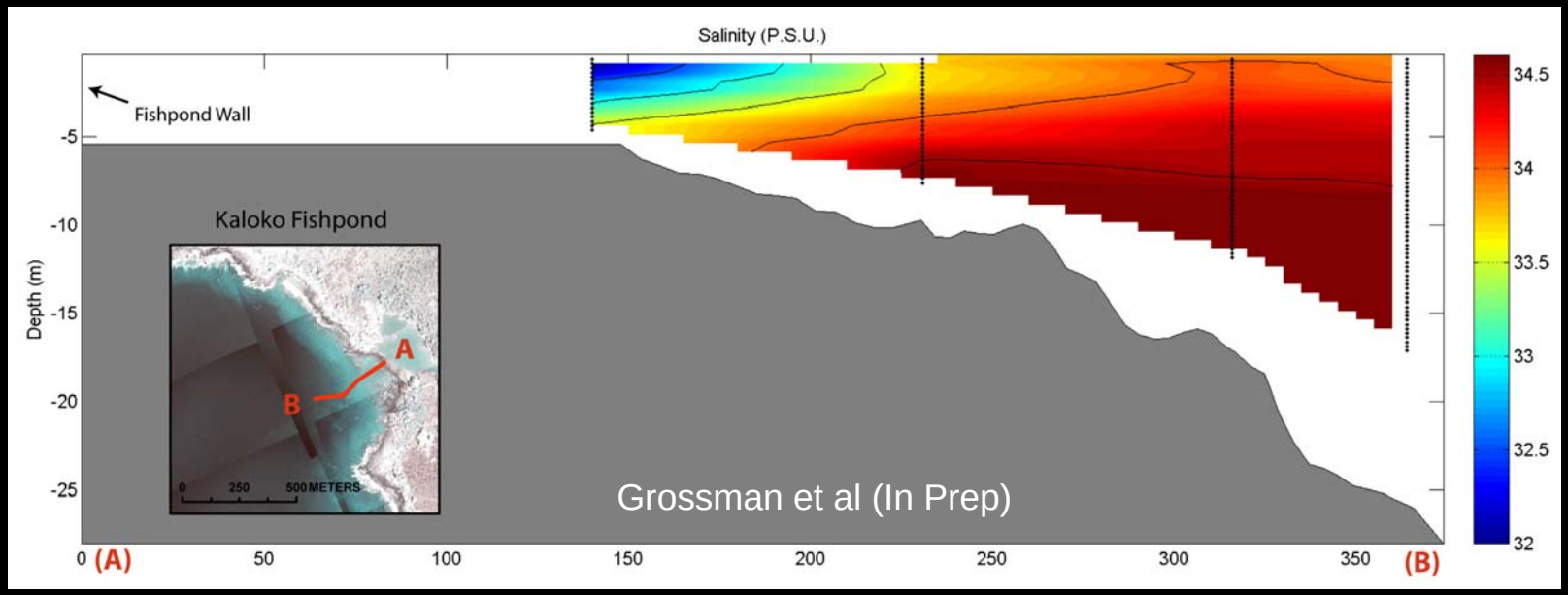
	SGD (MGal/day)	Nitrogen (Kg/d)
Kaloko:	2-3	45-70
W. Hawaii:	<1,400	2000-3500

Knee et al (2008); Grossman et al (In Prep)

Since 1990s
NO_3 (2x)
PO_4 (5x)

Parsons et al 2008





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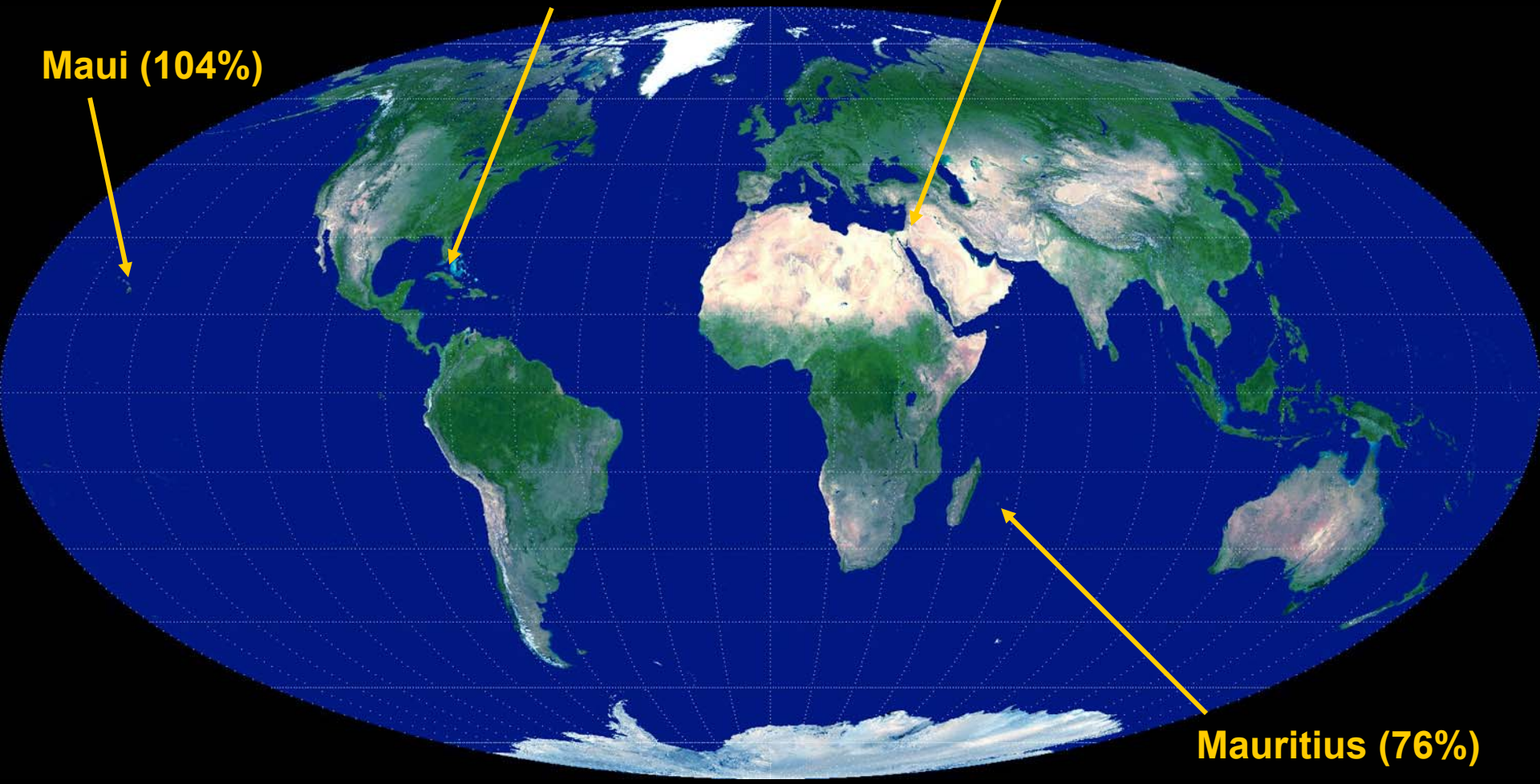
SGD Fluxes to Coral Reefs Worldwide

Relative to Kona (in percent)



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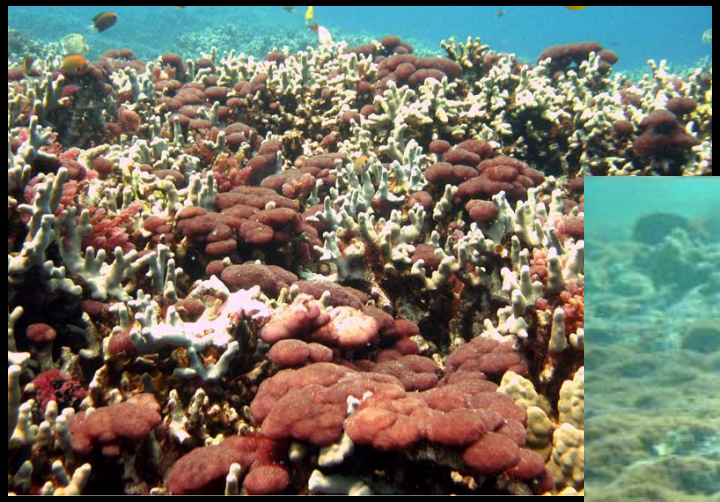
After Paytan et al (2006)

SGD – Importance to Coral Reefs

Chronic and episodic disturbance

Phase shifts
algal, cyanobacteria?



Community structure
Octocorals ~ SGD/nutrients

Buffer to
thermal bleaching?

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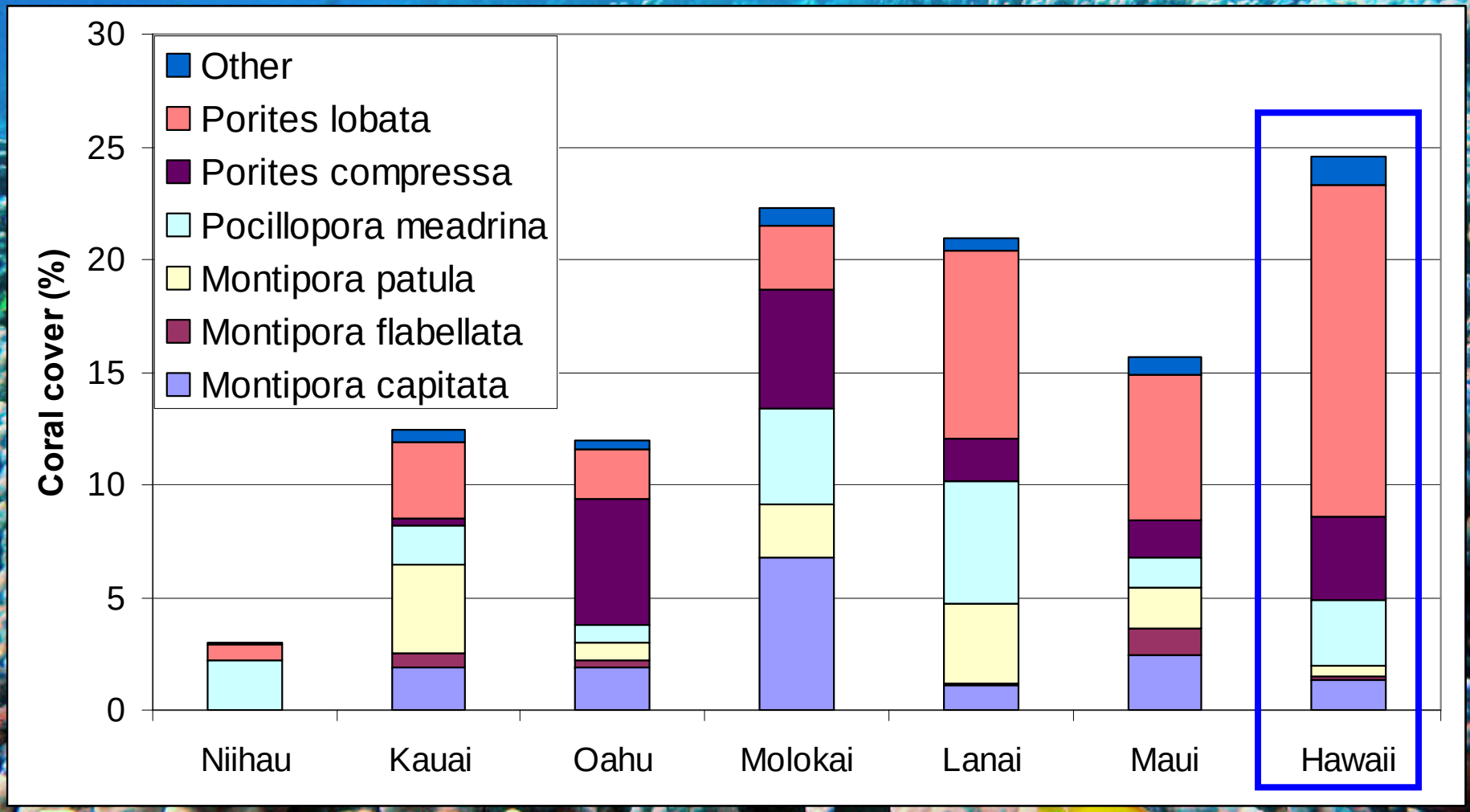
Importance of West Hawaii Coral Reefs coral reef cover & diversity



Friedlander et al. 2008

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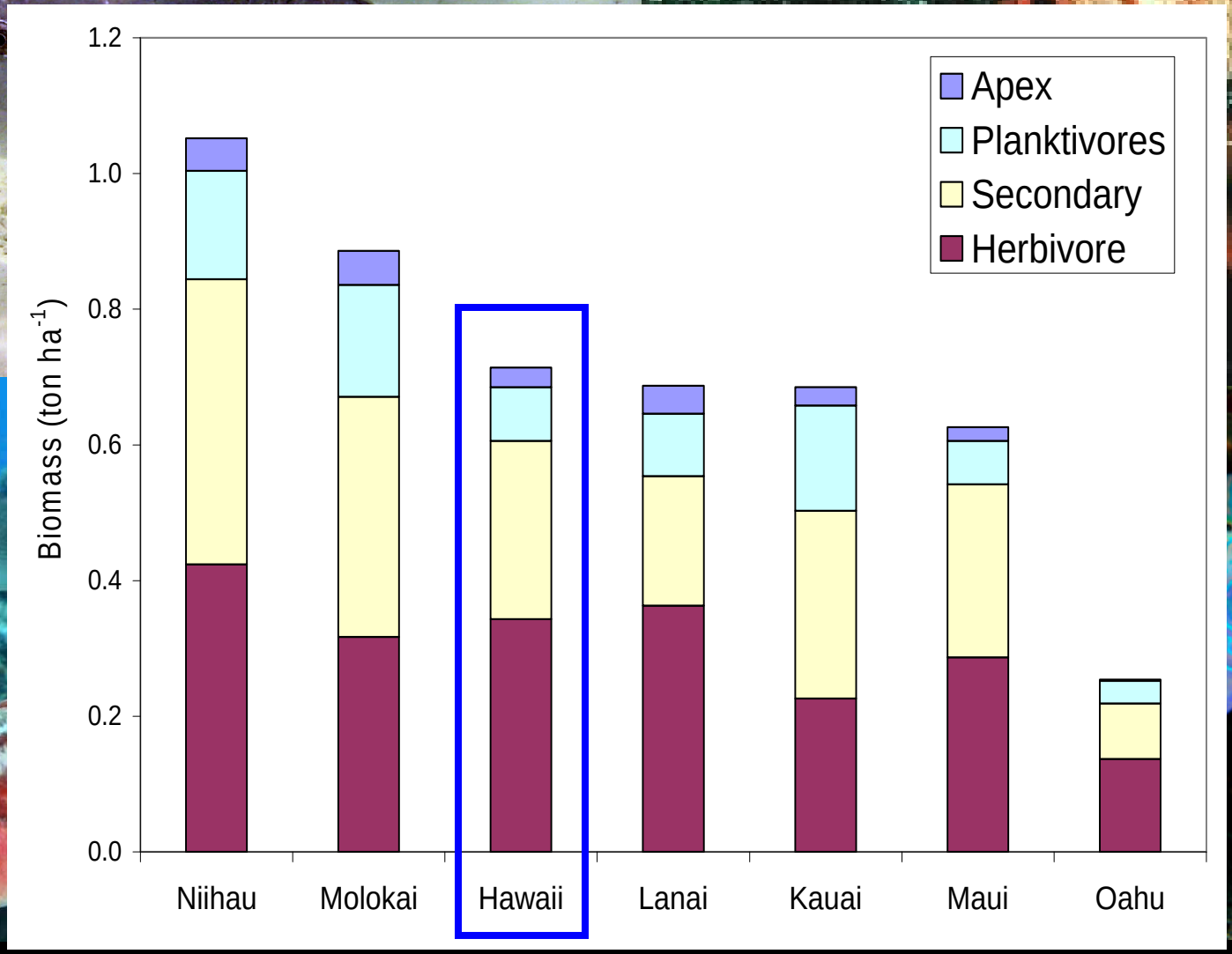
Importance of West Hawaii Coral Reefs
Ecosystem structure & services



Human Population

Friedlander et al. 2008

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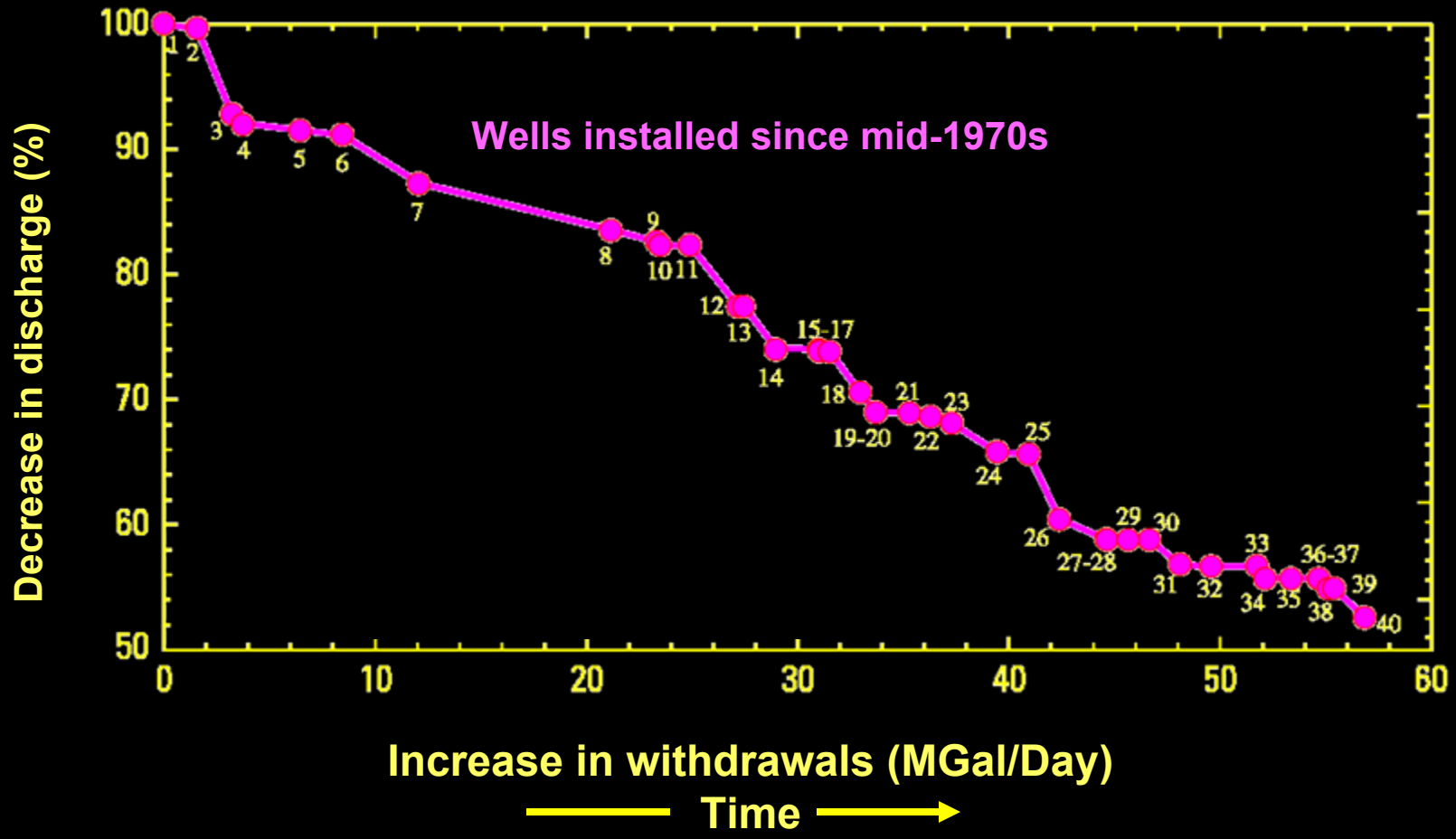
Modeled ~50% ↓ in freshwater discharge (KAHO)

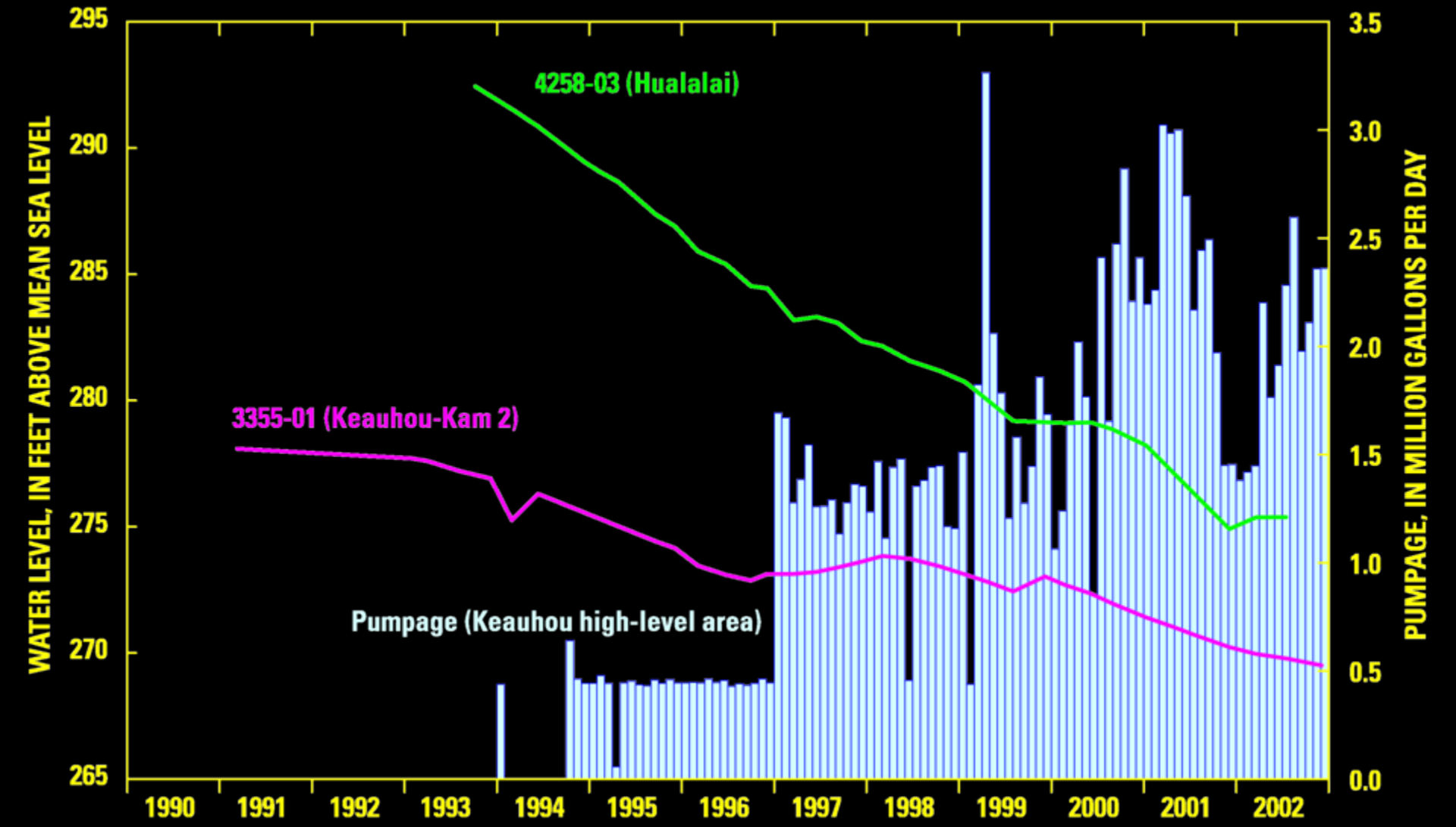
since mid-1970s



Oki et al 1999

Measured Water Level Declines

15-20 ft (high elevation) 5-10 ft (coastal)



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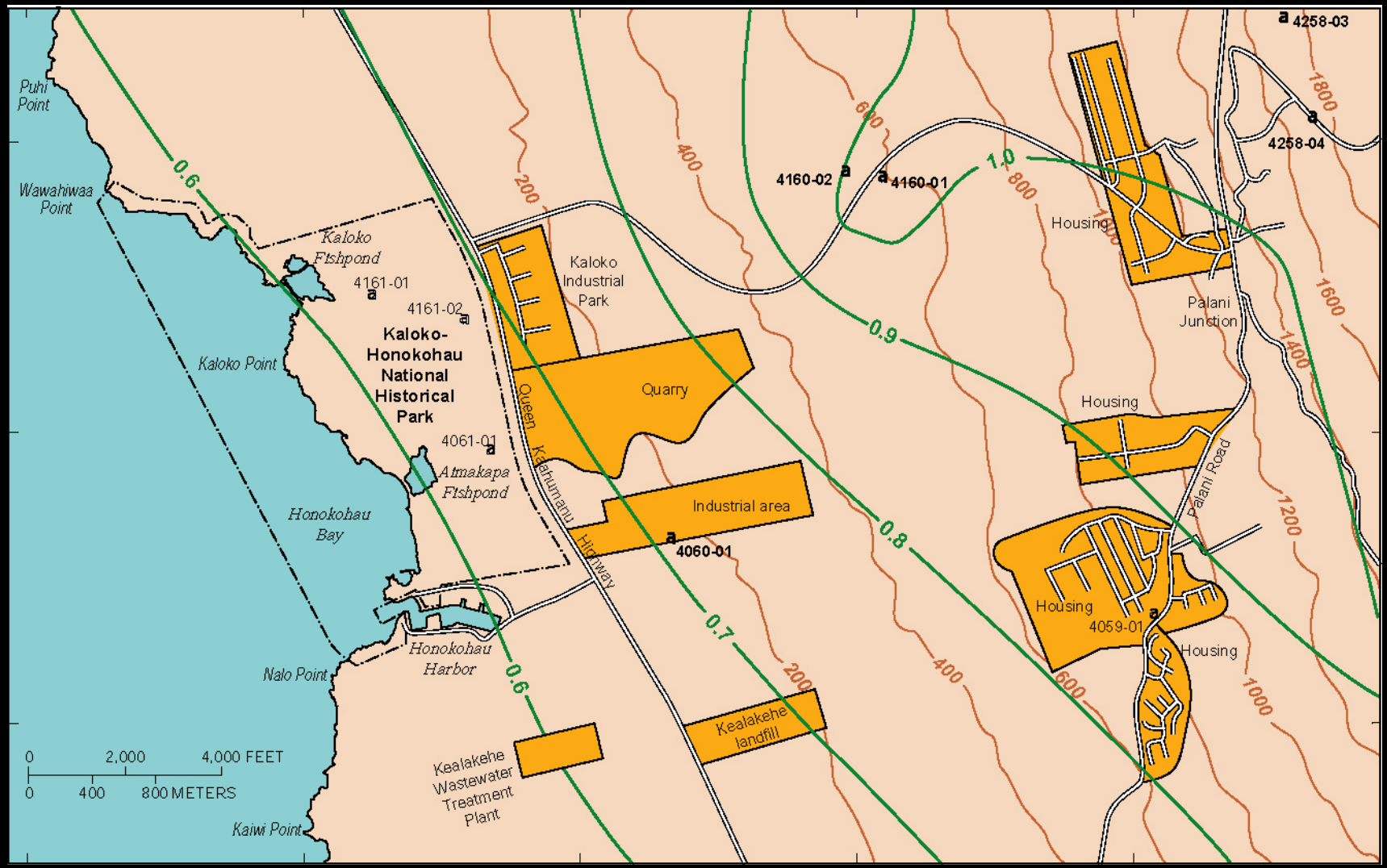
Data from Hawaii Commission on Water Resource Management

Modeled 1-ft water table drawdown at coast

Decrease in SGD? Saltwater intrusion?

Projected 46% increase in development by 2020



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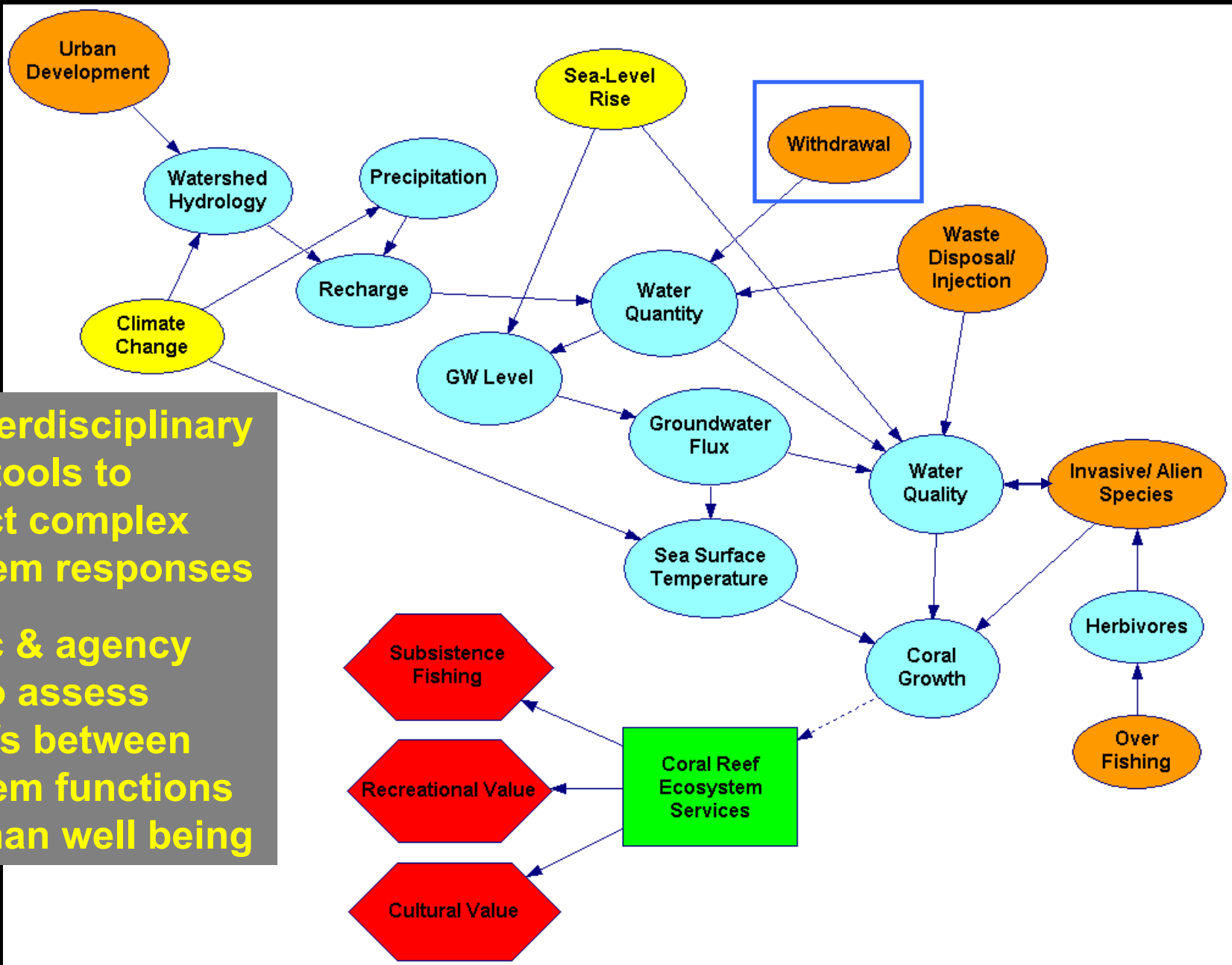
Oki et al 1999

Ground Water System - Linkages



Need interdisciplinary models/tools to
1) predict complex ecosystem responses

2) Public & agency buy-in to assess trade-offs between ecosystem functions and human well being

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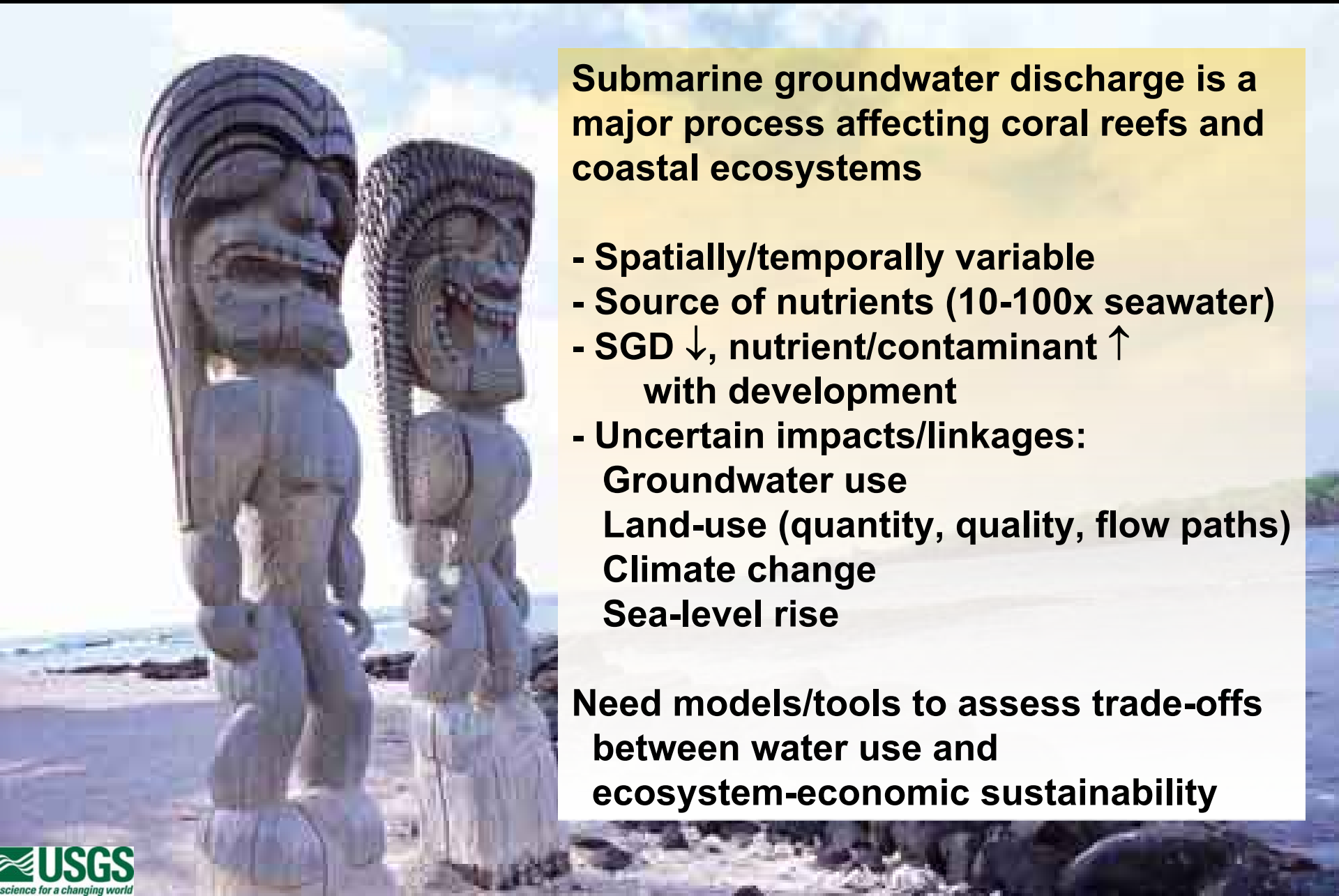
Conclusions:

http://coralreefs.wr.usgs.gov



Submarine groundwater discharge is a major process affecting coral reefs and coastal ecosystems

- **Spatially/temporally variable**
- **Source of nutrients (10-100x seawater)**
- **SGD ↓, nutrient/contaminant ↑ with development**
- **Uncertain impacts/linkages:**
  - **Groundwater use**
  - **Land-use (quantity, quality, flow paths)**
  - **Climate change**
  - **Sea-level rise**

Need models/tools to assess trade-offs between water use and ecosystem-economic sustainability

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