



NPS Petition for Water Management Area Action: Scientific Overview

Commission on Water Resource Management
September 17, 2014 Special Meeting

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Criteria for Designation

- 1) → Authorized planned use > 90% SY
- 2) → Withdrawals causing saltwater intrusion
- 3) → Chlorides increasing
- 4) → Excessive preventable waste is occurring
- 5) DOH finds actual or threatened water quality degradation
- 6) → Serious disputes over water use are occurring
- 7) Declining groundwater levels
- 8) → Public development projects may result in one the above

(HAR §13-171-7; HRS §174C-44)

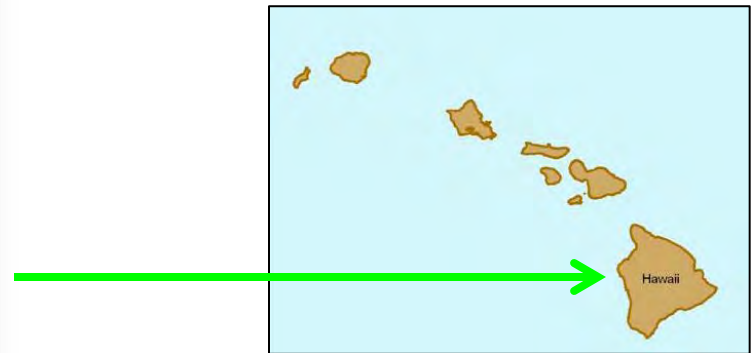
Outline

- Potential threats
- Hydrogeology
- Aquatic habitat
- Scientific uncertainty

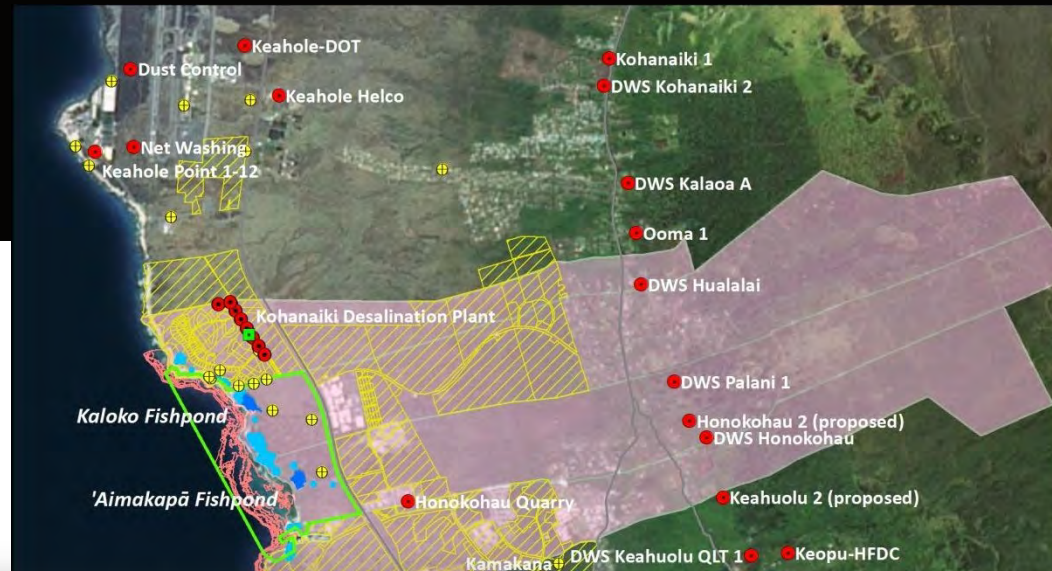
Water Resources



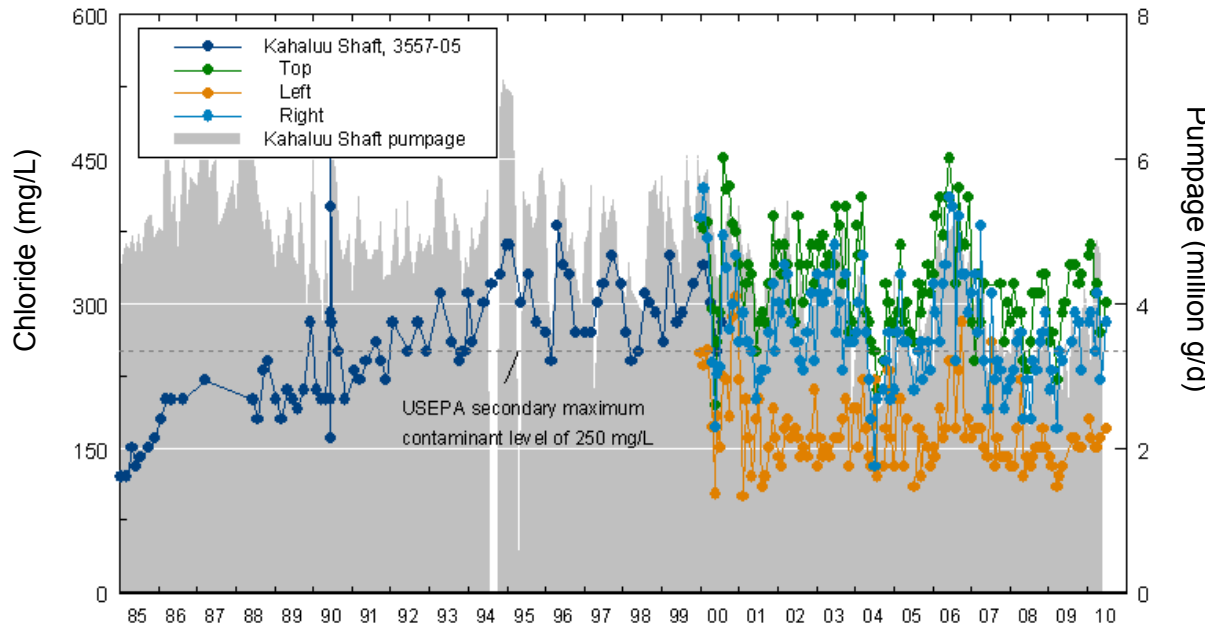
Kaloko-Honokōhau National Historical Park



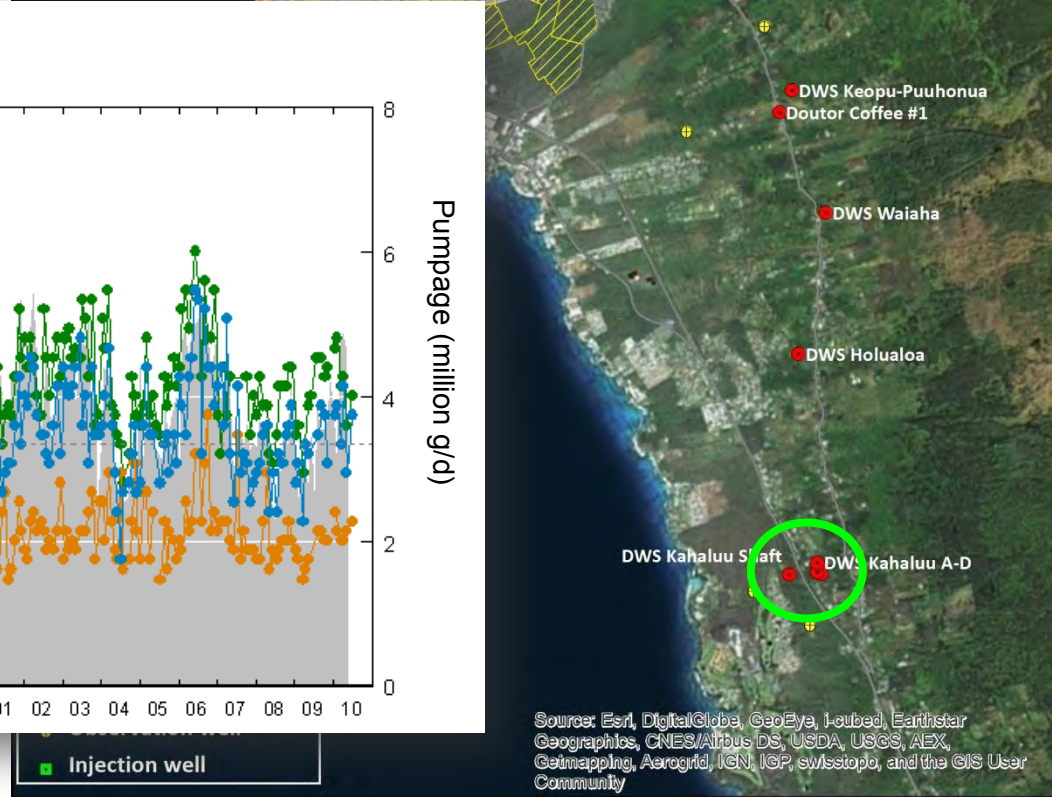
Pumping Wells



Kahaluu

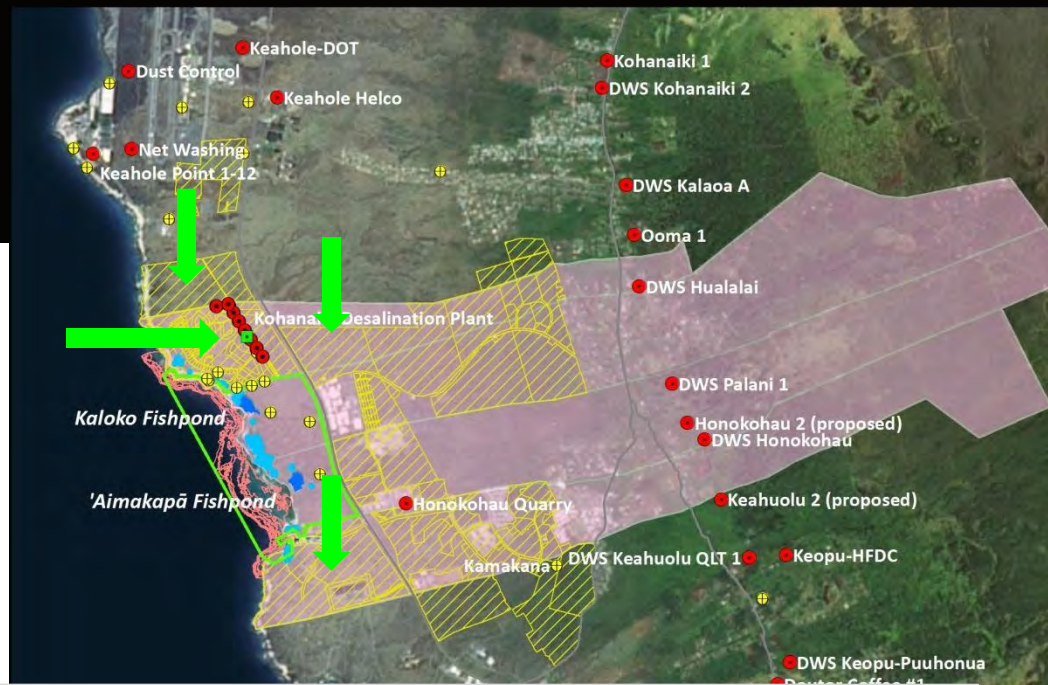


<http://hi.water.usgs.gov/recent/westhawaii/chloride.html>



Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Desalination



“Desalination is a costly, but viable resource enhancement measure... the area between Queen Kaahumanu Highway and Mamalahoa Highway might be a suitable location for brackish water wells.”

2010 Hawaii County Water Use and Development Plan Update



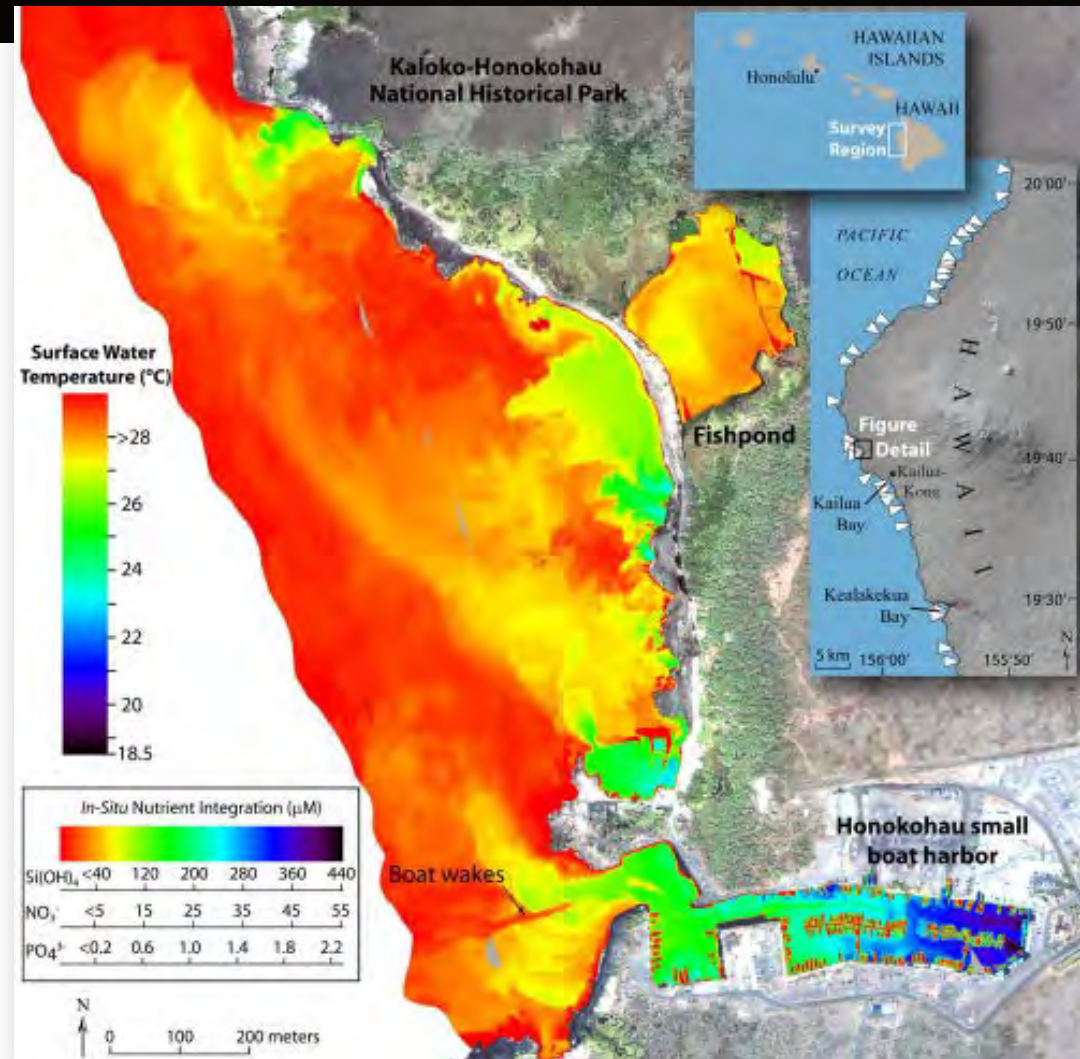
Hydrogeology

- Recharge & discharge areas
- Conceptual models
- Mathematical models
- Monitoring data

Temperature

- 31 major groundwater discharge plumes along Kona coast

University of Hawaii
(Johnson et al. 2008)

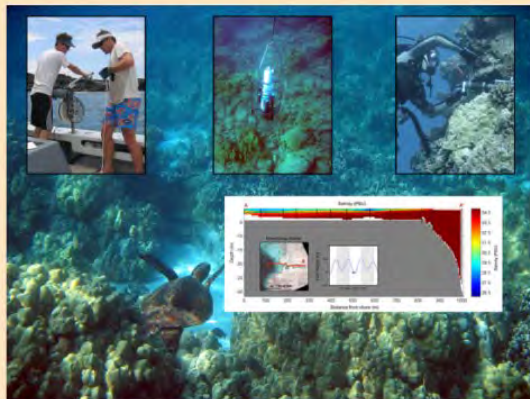


Salinity



Submarine Groundwater Discharge and Fate
Along the Coast of Kaloko-Honōkohau National
Historical Park, Island of Hawai'i

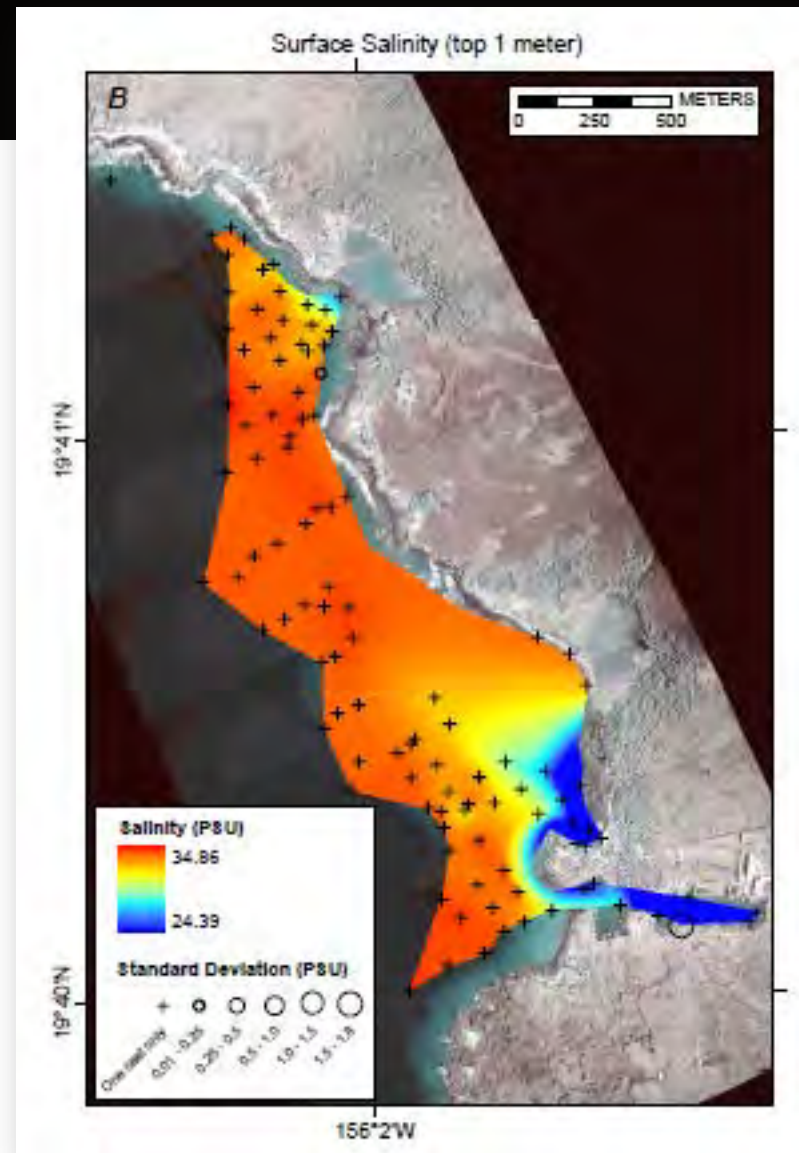
Part 3, Spatial and Temporal Patterns in Nearshore
Waters and Coastal Groundwater Plumes,
December 2003–April 2006



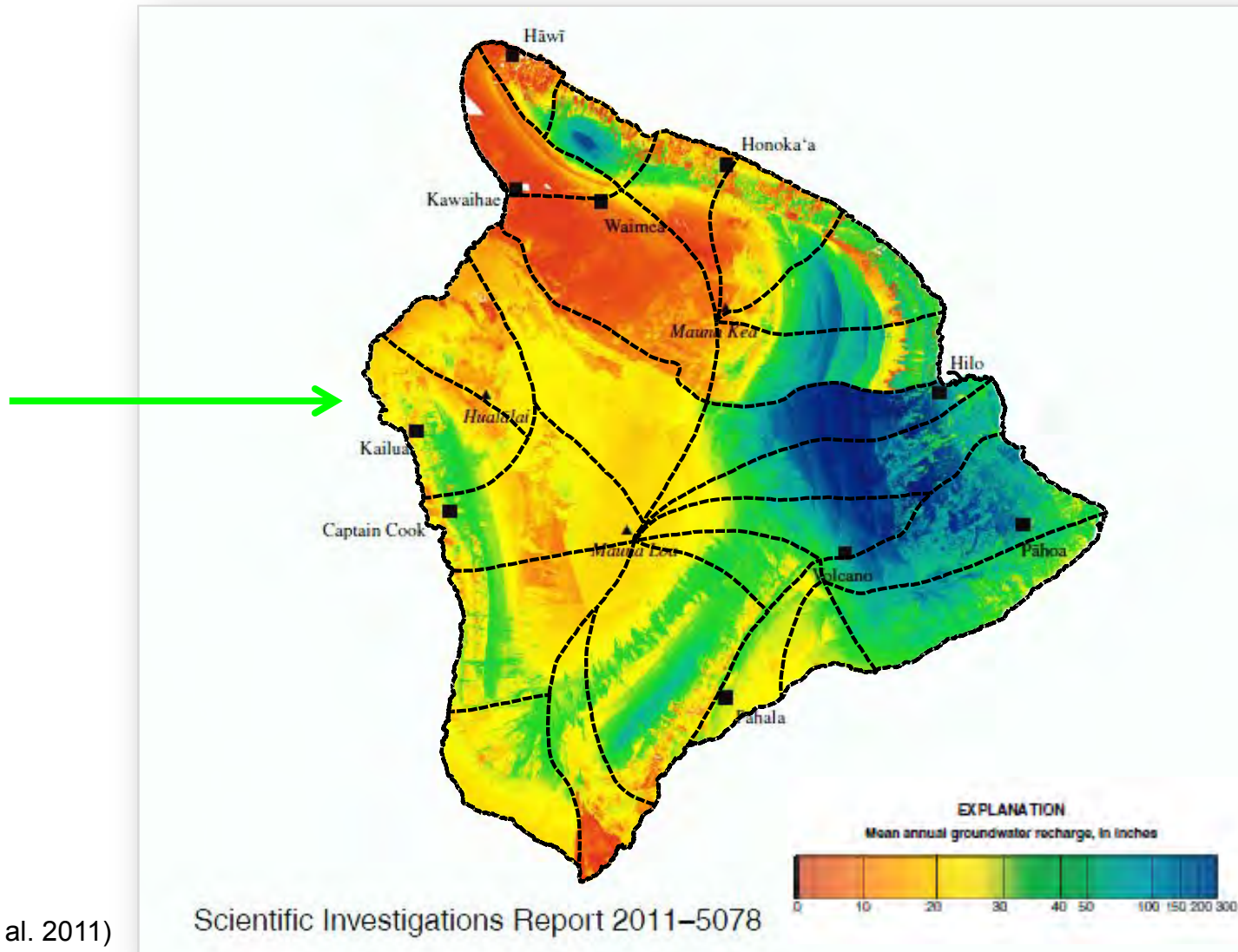
Scientific Investigations Report 2010-5081

U.S. Department of the Interior
U.S. Geological Survey

(Grossman et al. 2010)



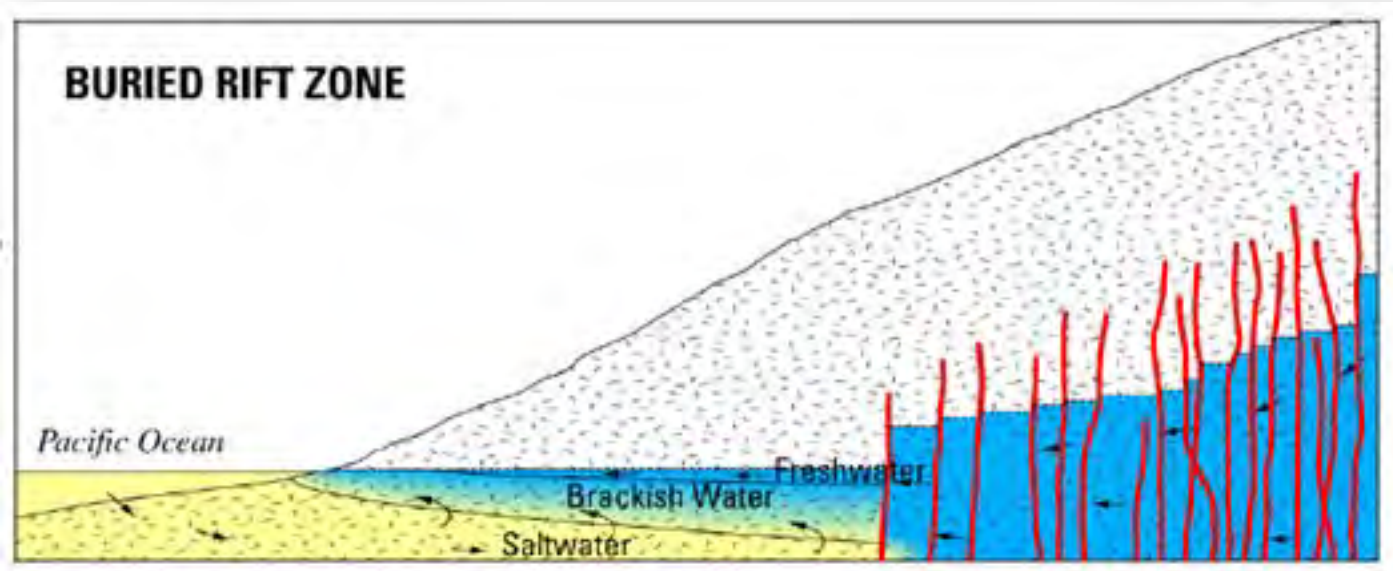
Groundwater Recharge



(Engott et al. 2011)

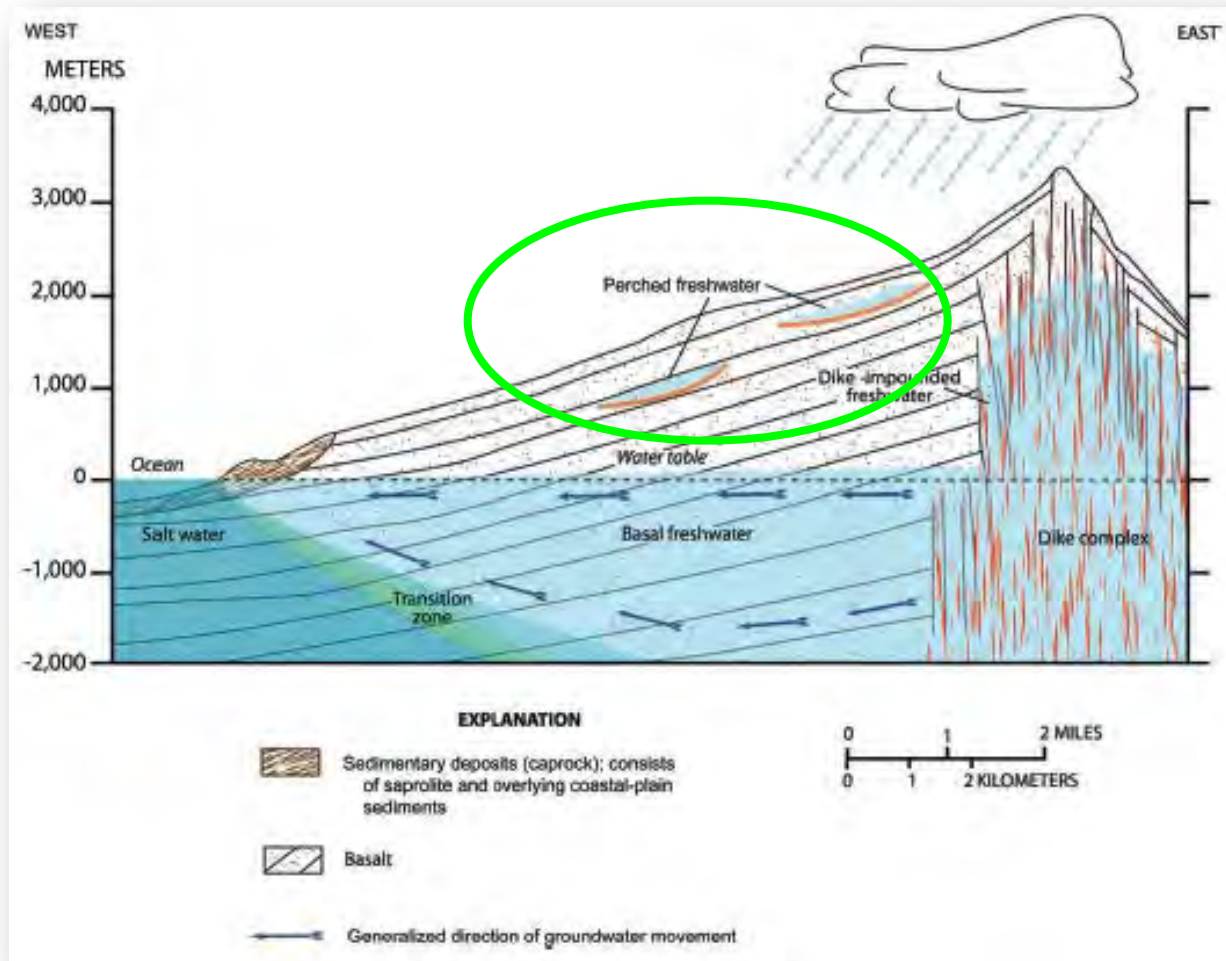
Scientific Investigations Report 2011-5078

Conceptual Models



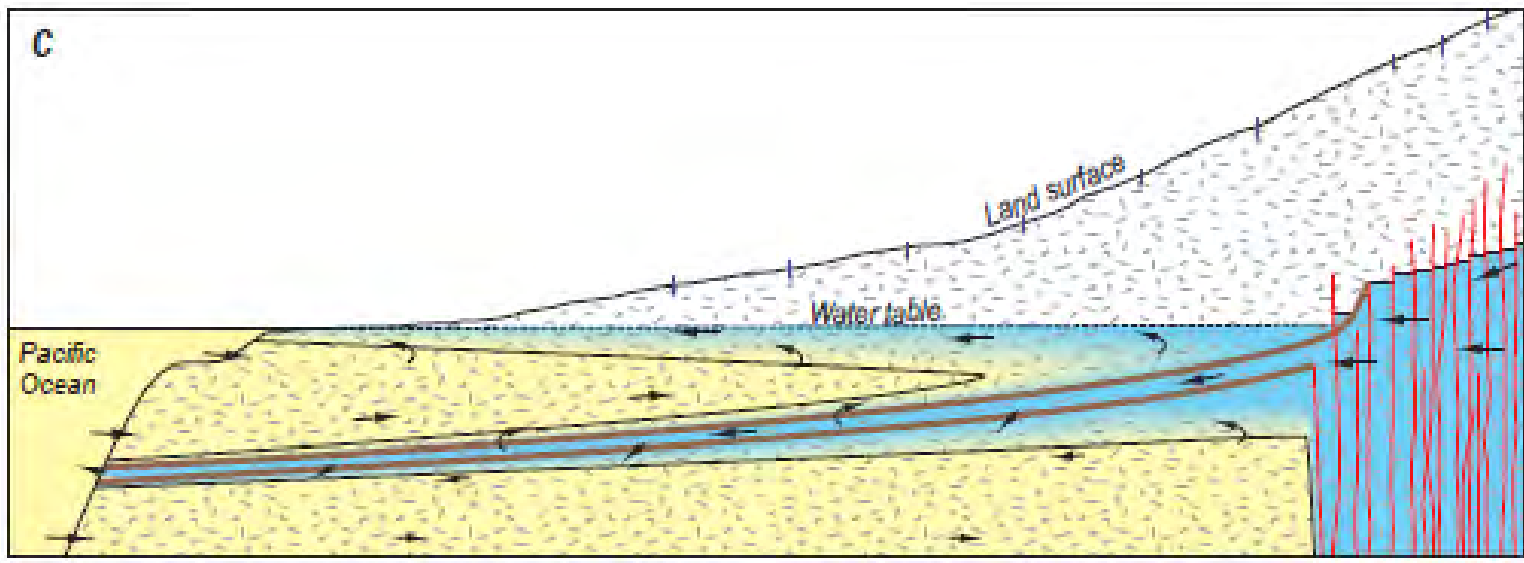
(Courtesy of S. Anthony, USGS, 2012)

Conceptual Models



(USGS Open File Report 2009-1135)

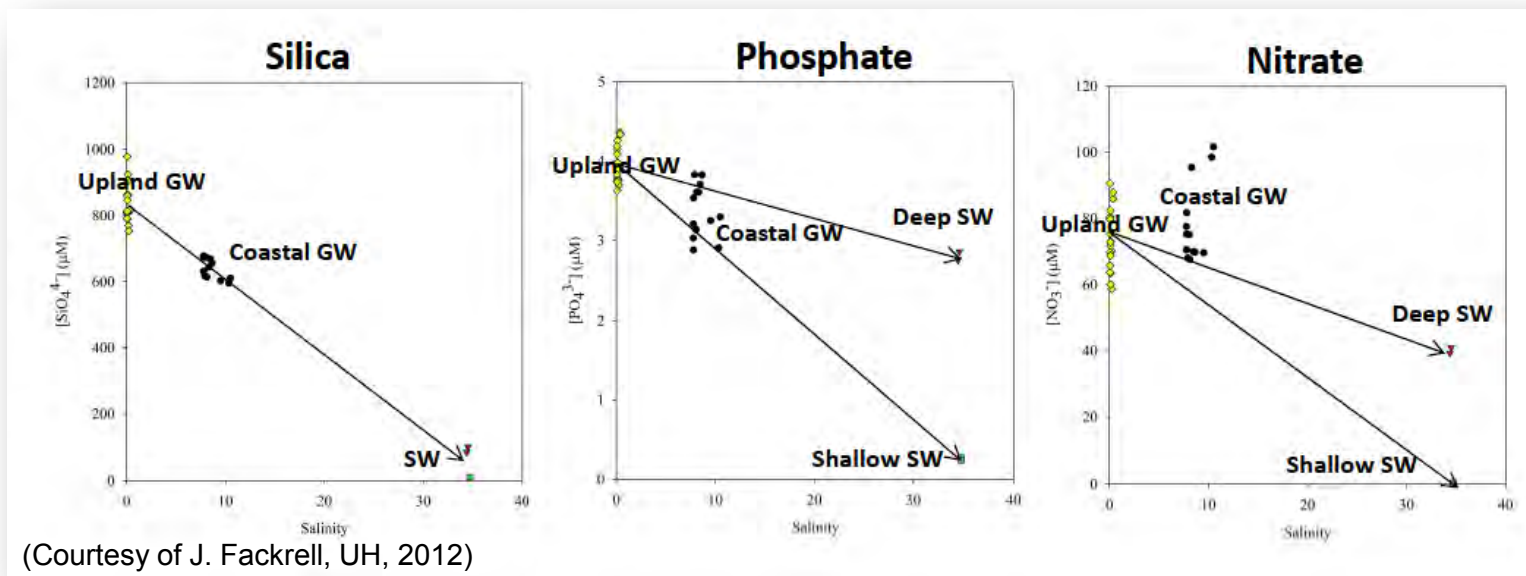
Conceptual Models



(USGS Open File Report 2014-1173)

***NPS Petition pages 44 - 46**

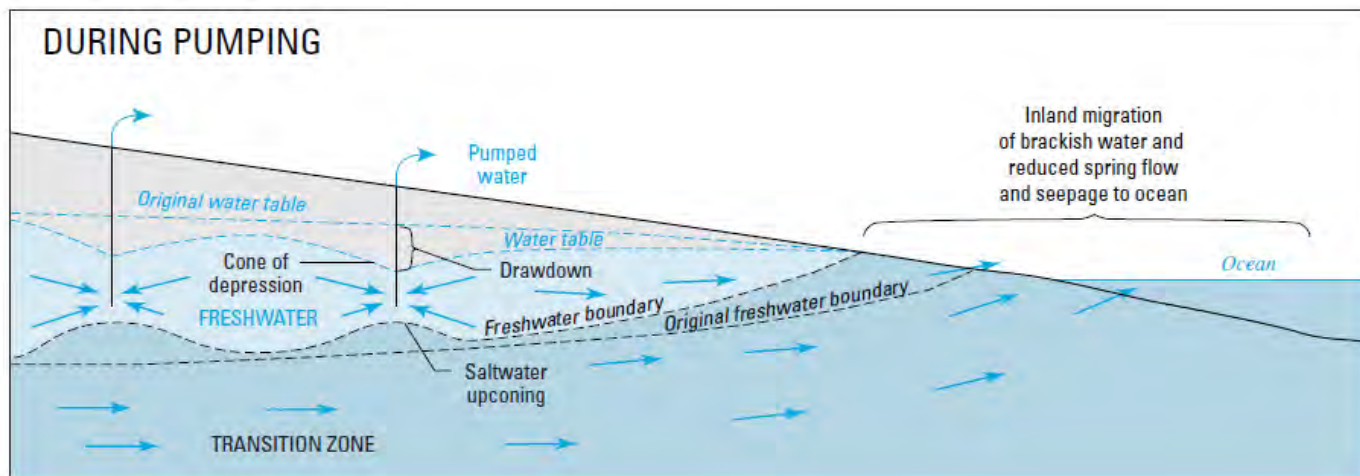
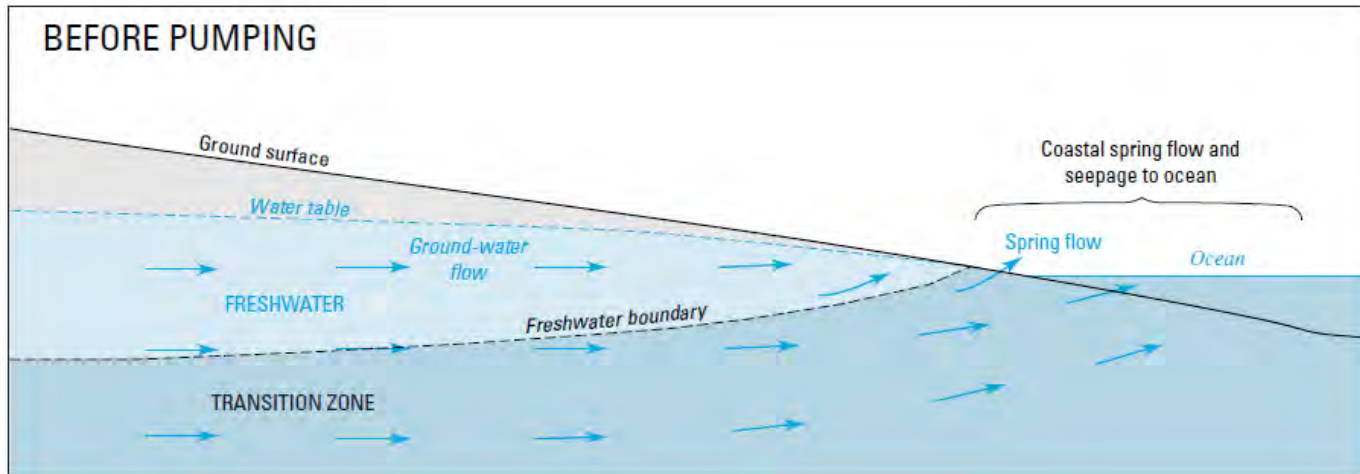
Geochemistry



Our results indicate that a hydrologic connection exists between the high-level and basal systems and that withdrawals from the high-level system have the potential to impact the quantity and quality of basal groundwater and the SGD it feeds.

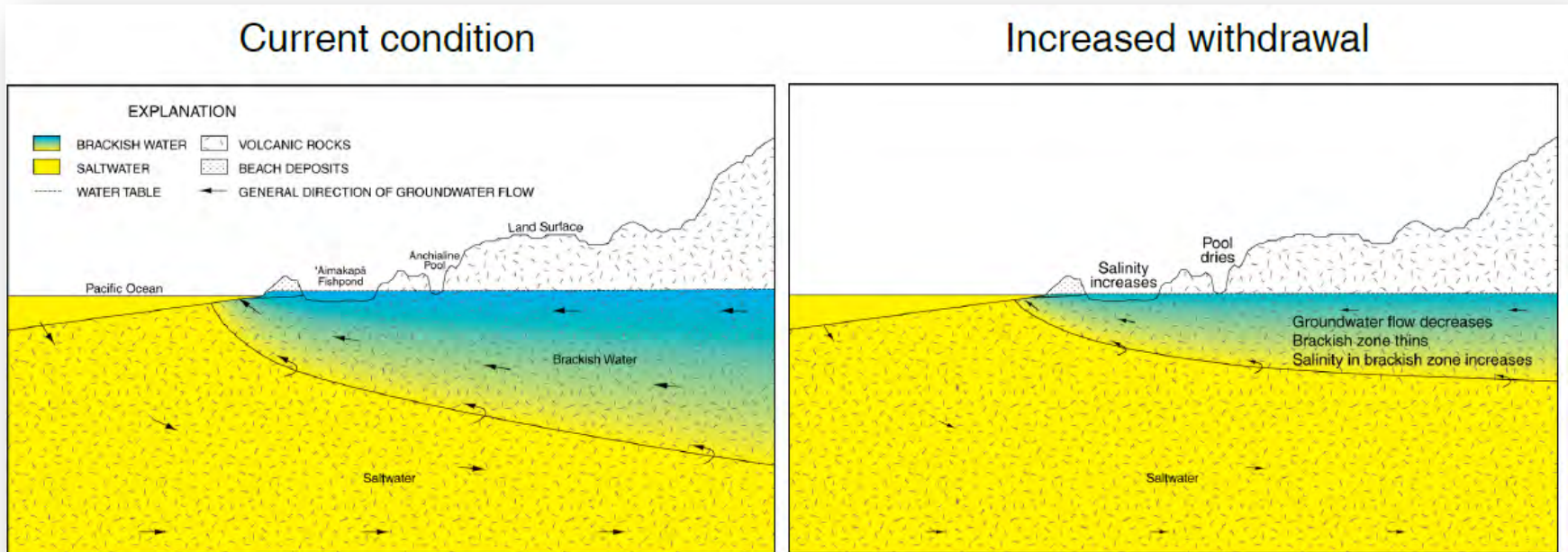
University of Hawaii (Fackrell & Glenn 2014)

Effects of Groundwater Withdrawal



(USGS Water-Resources Investigation Report 03-4178)

Effects of Groundwater Withdrawal



- Groundwater levels decline
 - Anchialine pools may dry up
 - Fishponds may get shallower
- Salinity increases
- Groundwater flow rate decreases

Mathematical Models

Robust Analytical Model

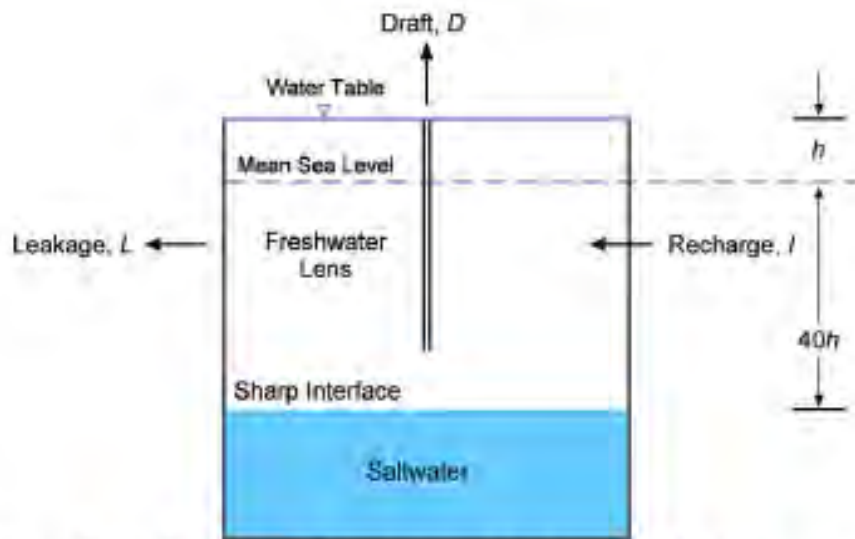


Figure 3-10. Conceptual formulation of the basal aquifer in the robust analytical model (RAM).

(2008 Water Resources Protection Plan)

$$SY = Recharge \times \left[1 - \left(\frac{Postdevelopment\ water\ level}{Predevelopment\ water\ level} \right)^2 \right]$$

- Basal aquifer
- Recharge and wells evenly distributed
- Sharp interface

Mathematical Models

Sustainable Yield for Keauhou Aquifer System:

- Water levels reduced by 25%
- Coastal discharge reduced by 44%
- Does not explicitly consider water needed non-consumptive public trust uses

***NPS Petition pages 23-25**

Mathematical Models

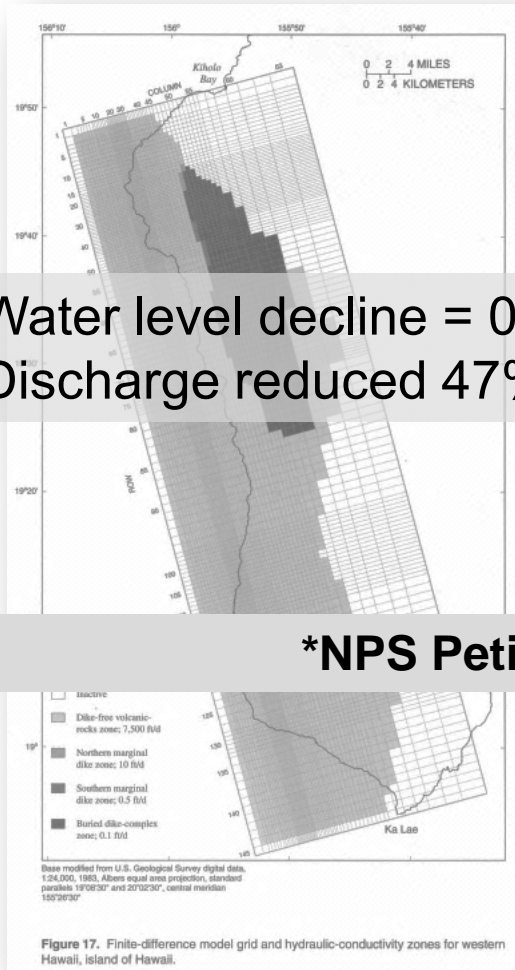
1999 USGS numerical model

- Water level decline = 0.5 ft
- Discharge reduced 47%

2015 USGS numerical models

- Deep well data
- New recharge estimates
- Geochemistry

***NPS Petition pages 11, 23-25, 41 and 44-46**

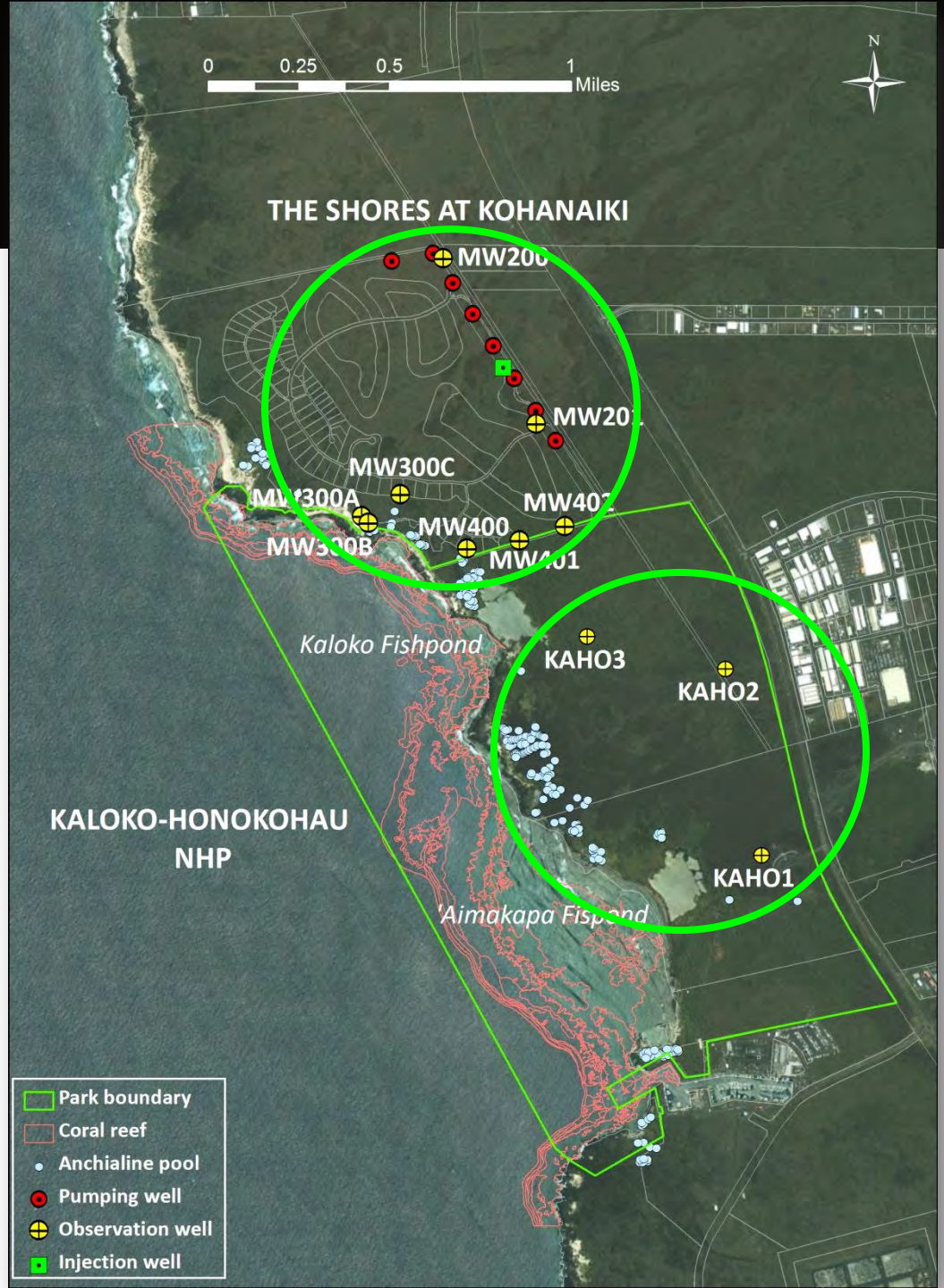


(Oki et al. 1999)

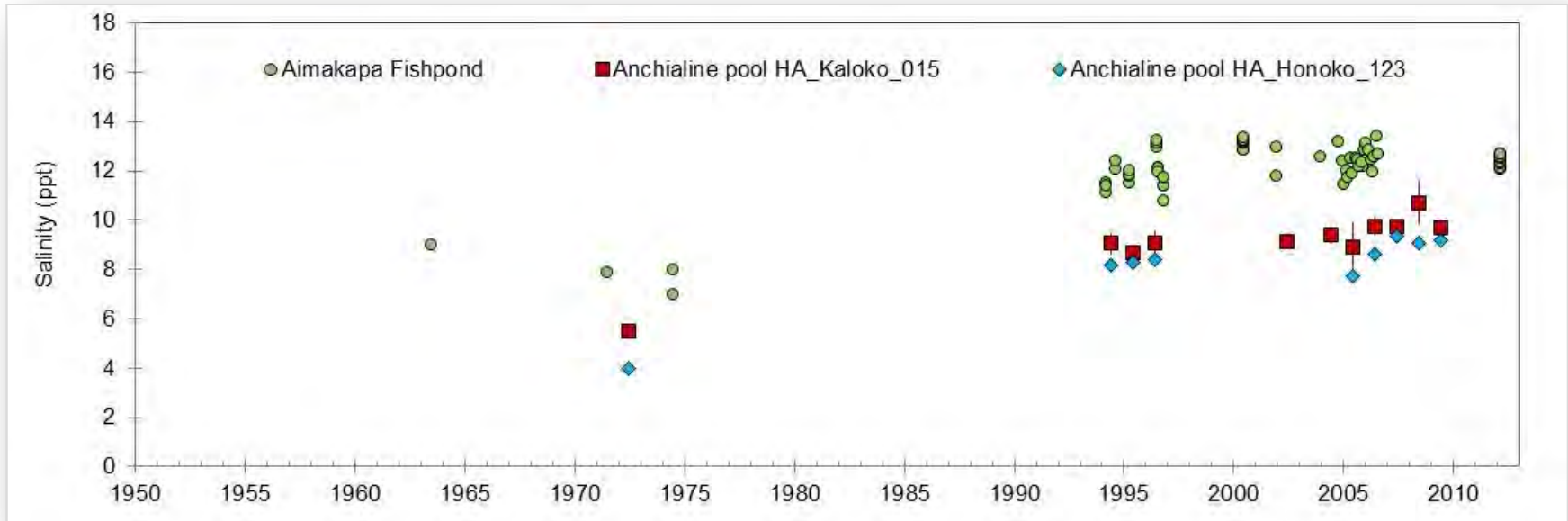
Monitoring

Monthly (periodic)

15-min (continuous)



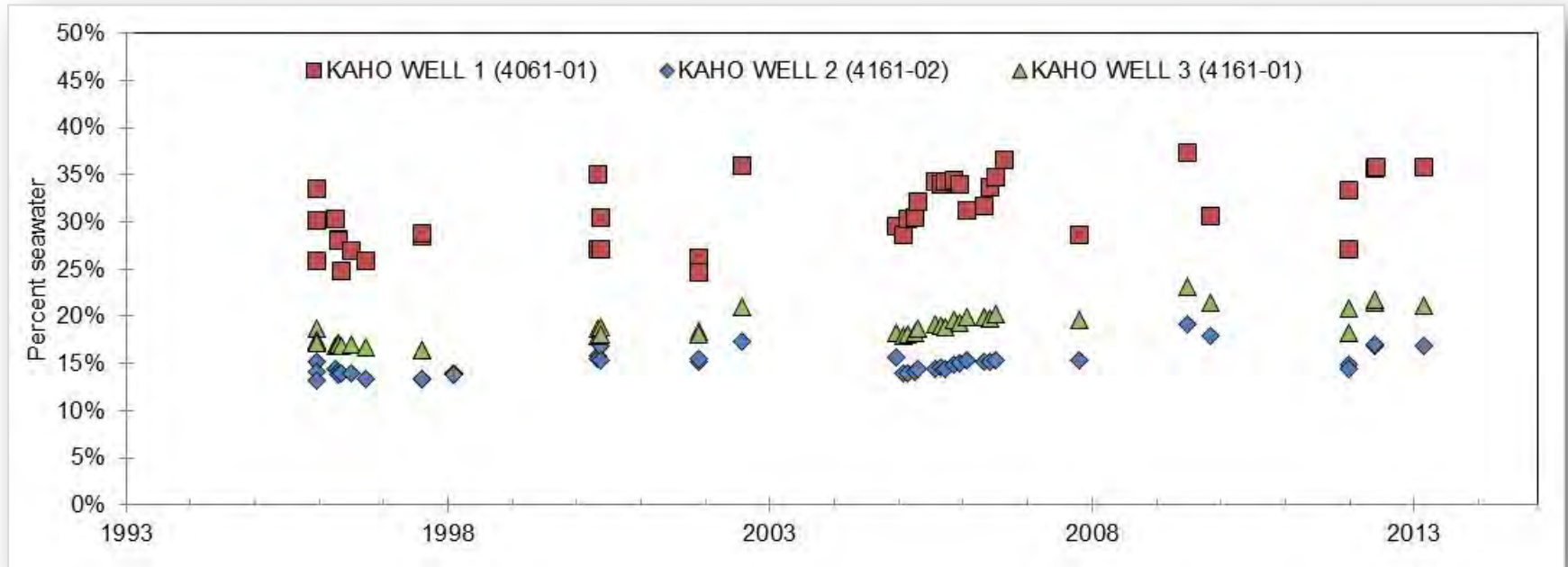
Periodic Data (provisional)



(Sparks 1963 ; Kikuchi & Belshe 1971; Maciolek & Brock 1974; Brock & Kam 1997; Marine Research Consultants 2000; TNWRE 2002; Bienfang 2007; Knee et al. 2008 ; Dollar & Nance 2012; NPS 2013)

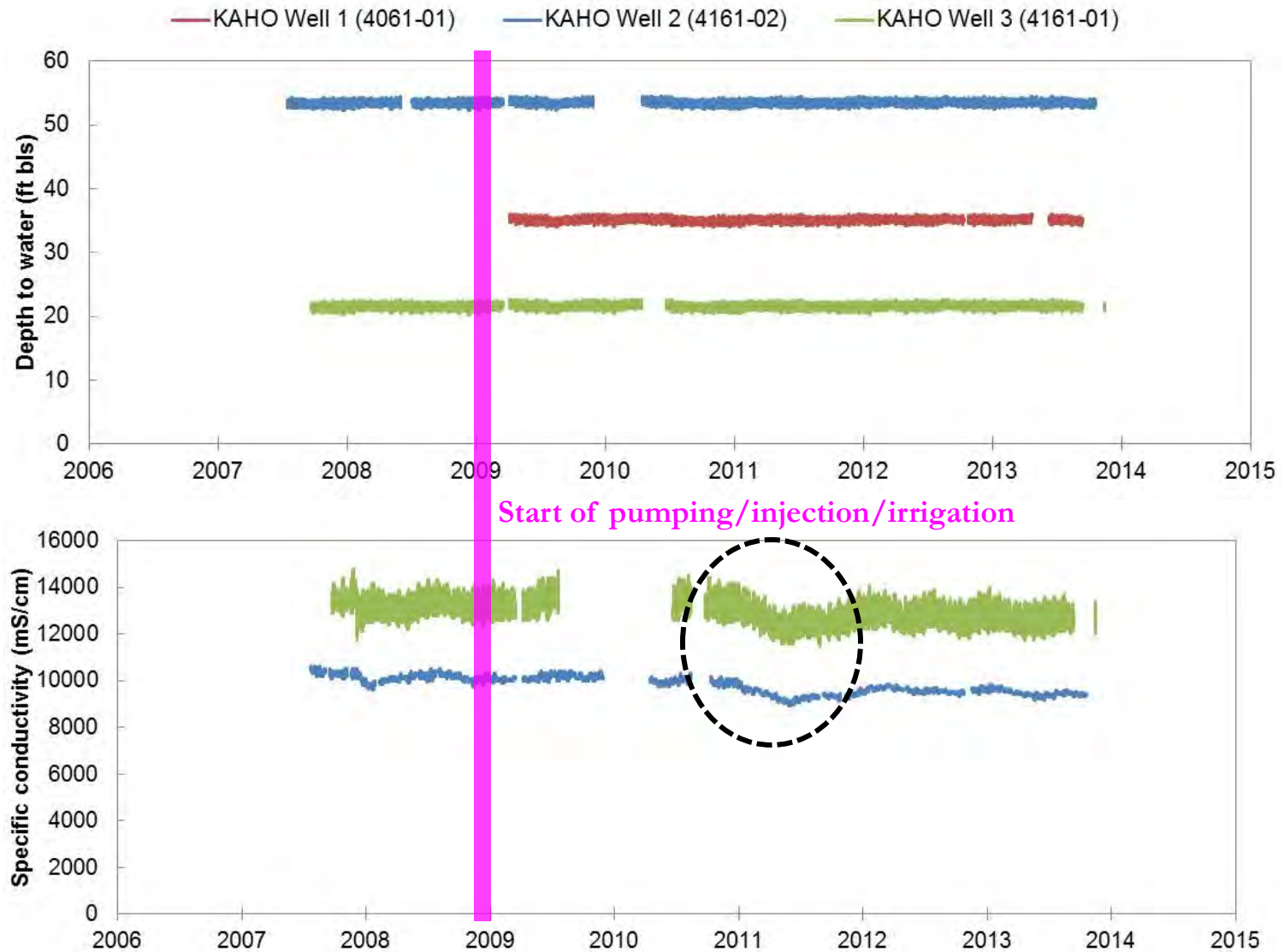
***NPS Petition page 29**

Periodic Data (provisional)

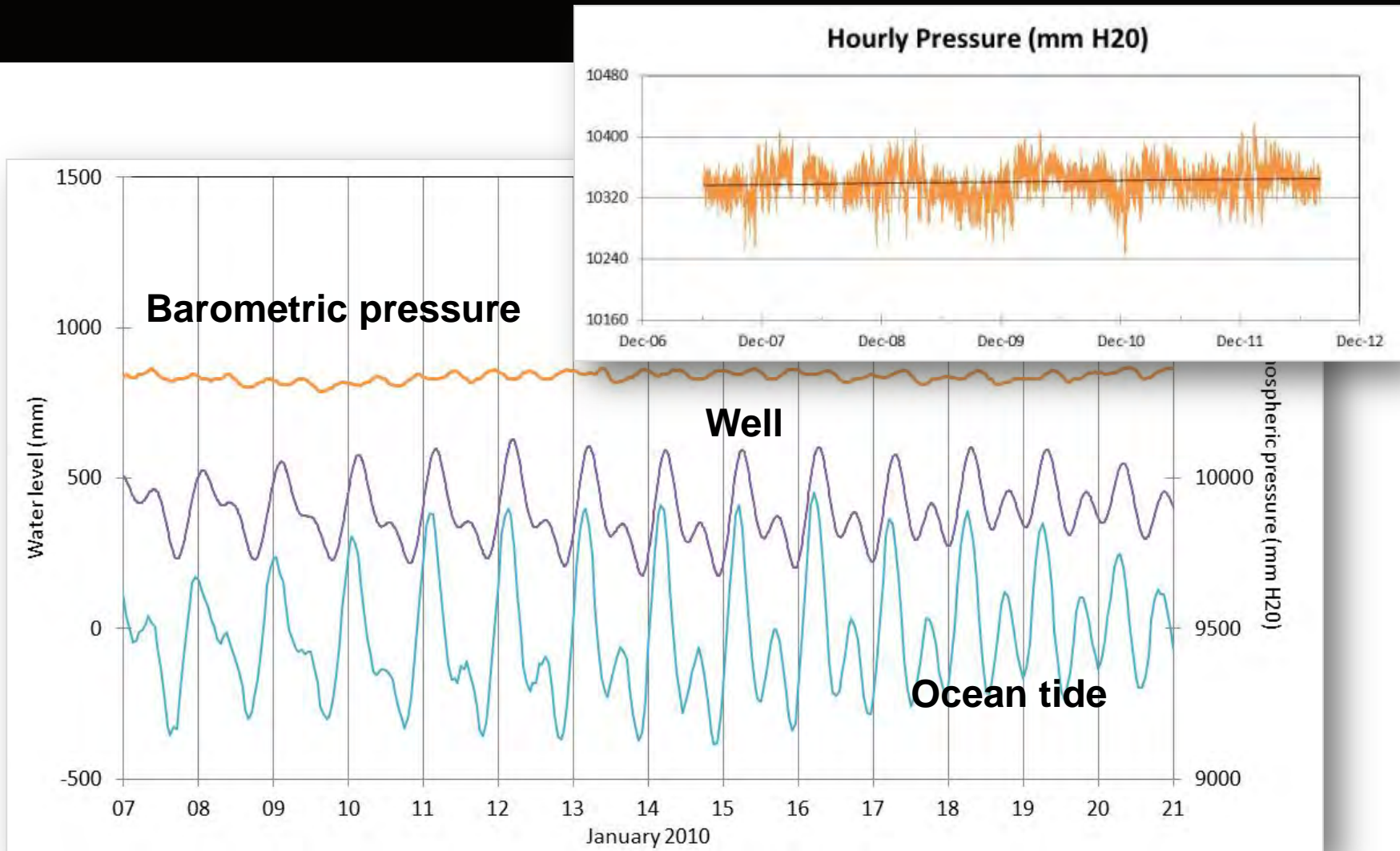


(Oki et al. 1999; Brock & Kam 1997; TNWRE 2008; USGS 2013; Waimea Water Services 2006; Bienfang 2007; Dollar & Nance 2012)

Continuous Data

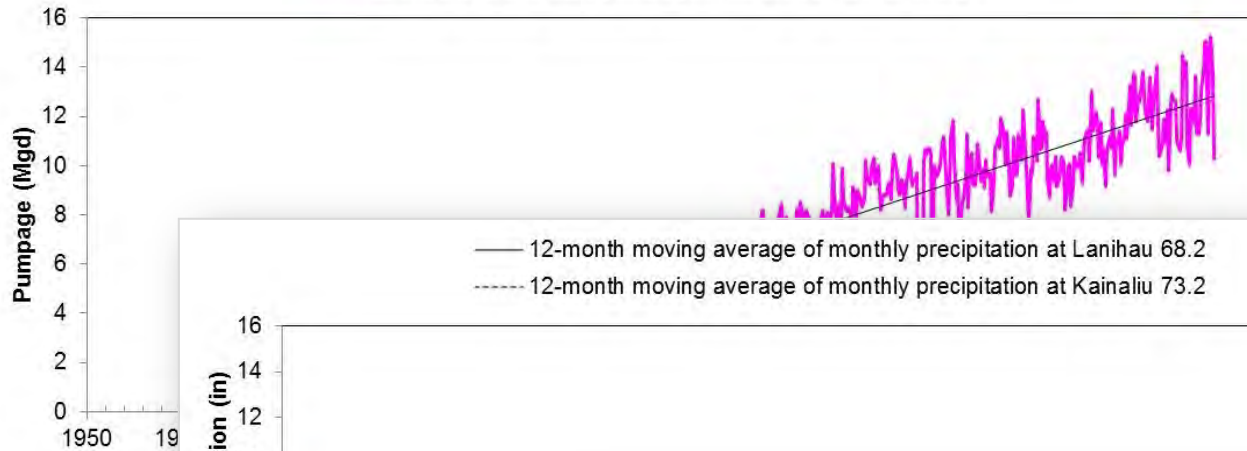


Natural Fluctuations



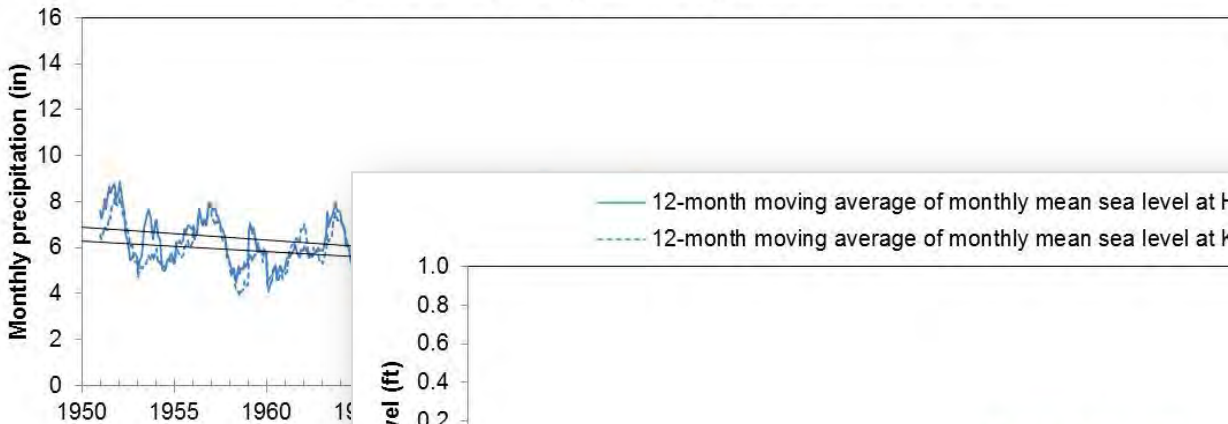
Regional Trends

— Reported average daily pumpage in Keauhou Aquifer System



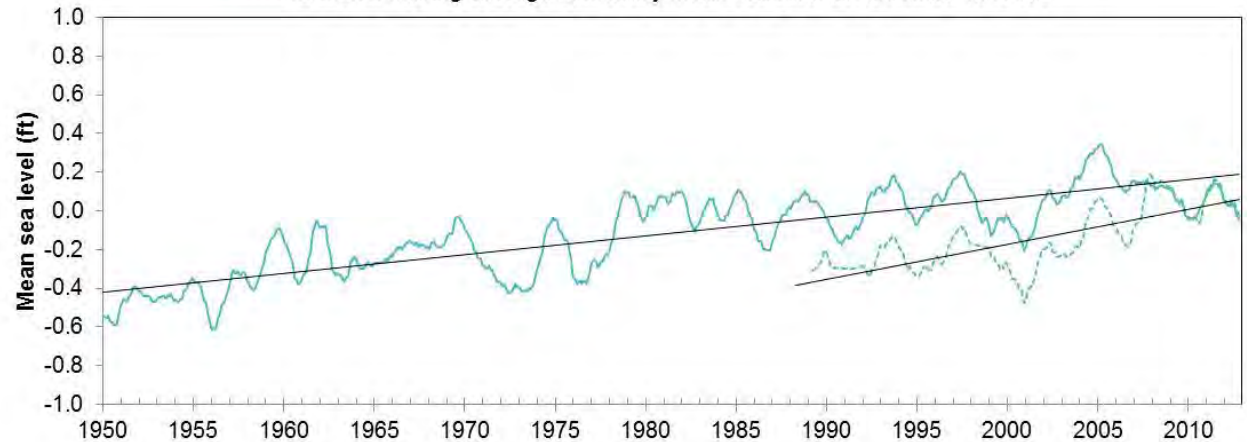
<http://hi.water.u>

— 12-month moving average of monthly precipitation at Lanihau 68.2
- - - 12-month moving average of monthly precipitation at Kainaliu 73.2



<http://www.wrcc.dri.edu>

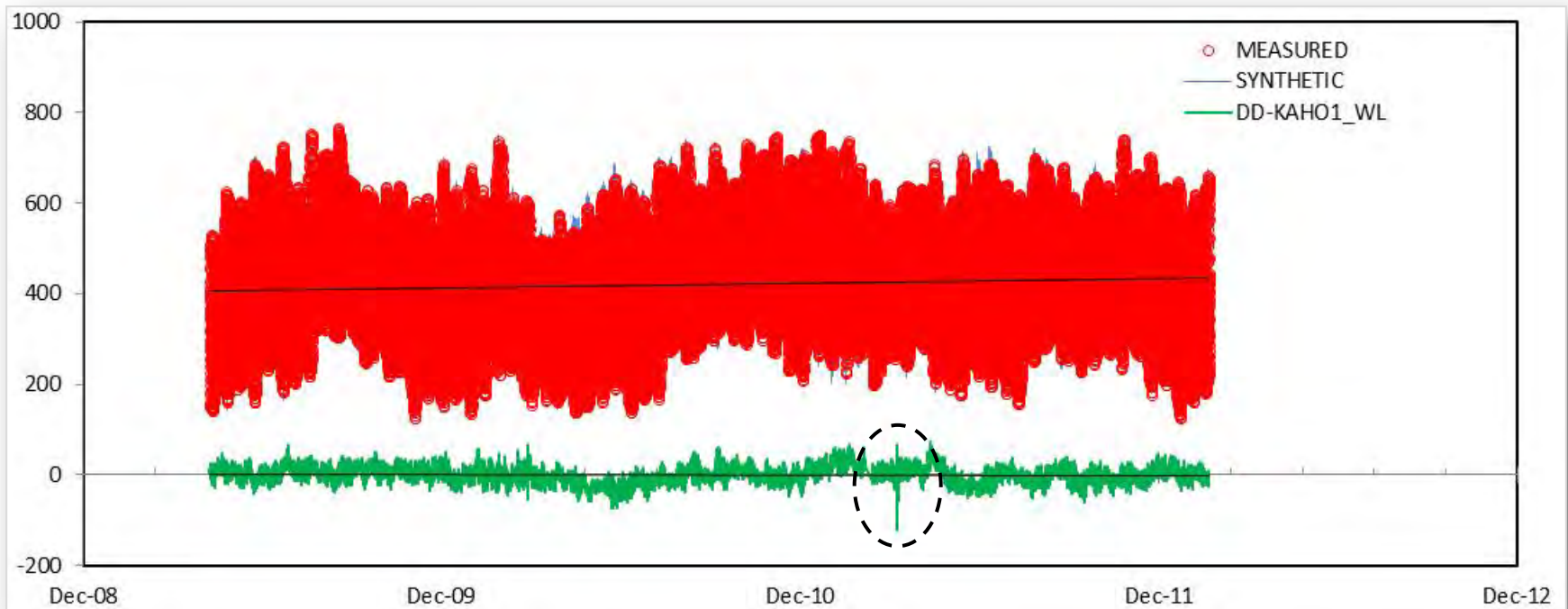
— 12-month moving average of monthly mean sea level at Hilo 1617760
- - - 12-month moving average of monthly mean sea level at Kawaihae 1617433



<http://tidesandcurrents.noaa.gov/index.shtml>

Removing Natural Fluctuations

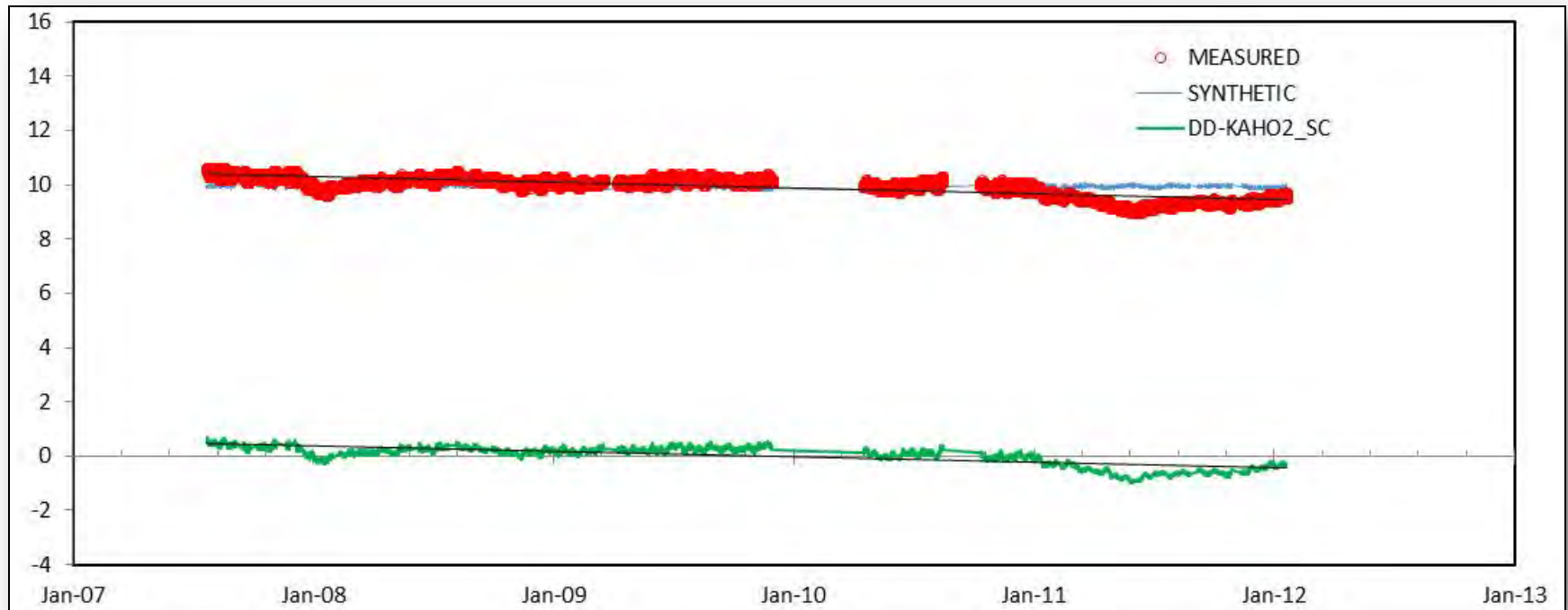
Filtered Water Level: Visitor Center Well (KAHO1)
Variance reduced by 97%



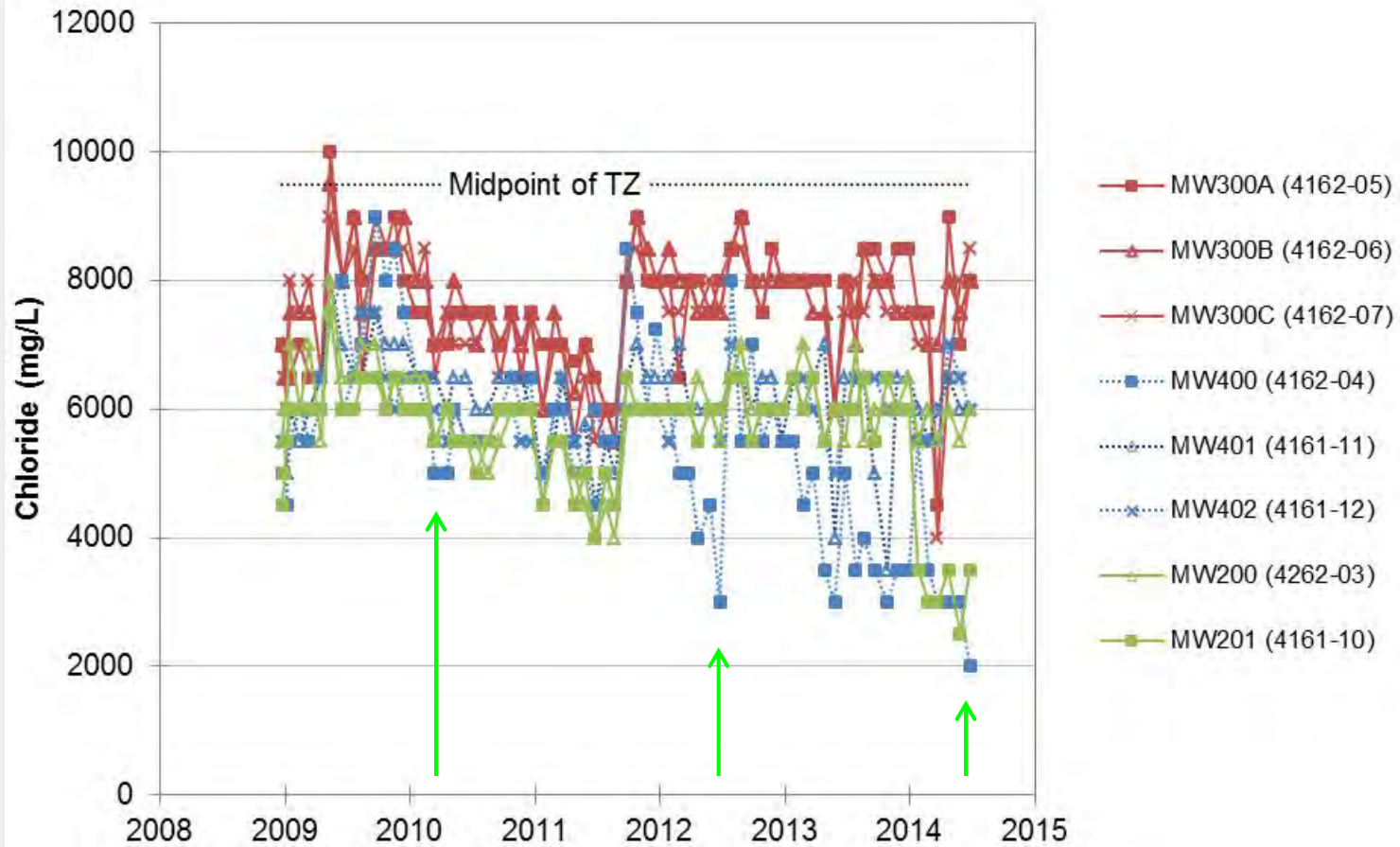
March 2011 earthquake

Removing Natural Fluctuations

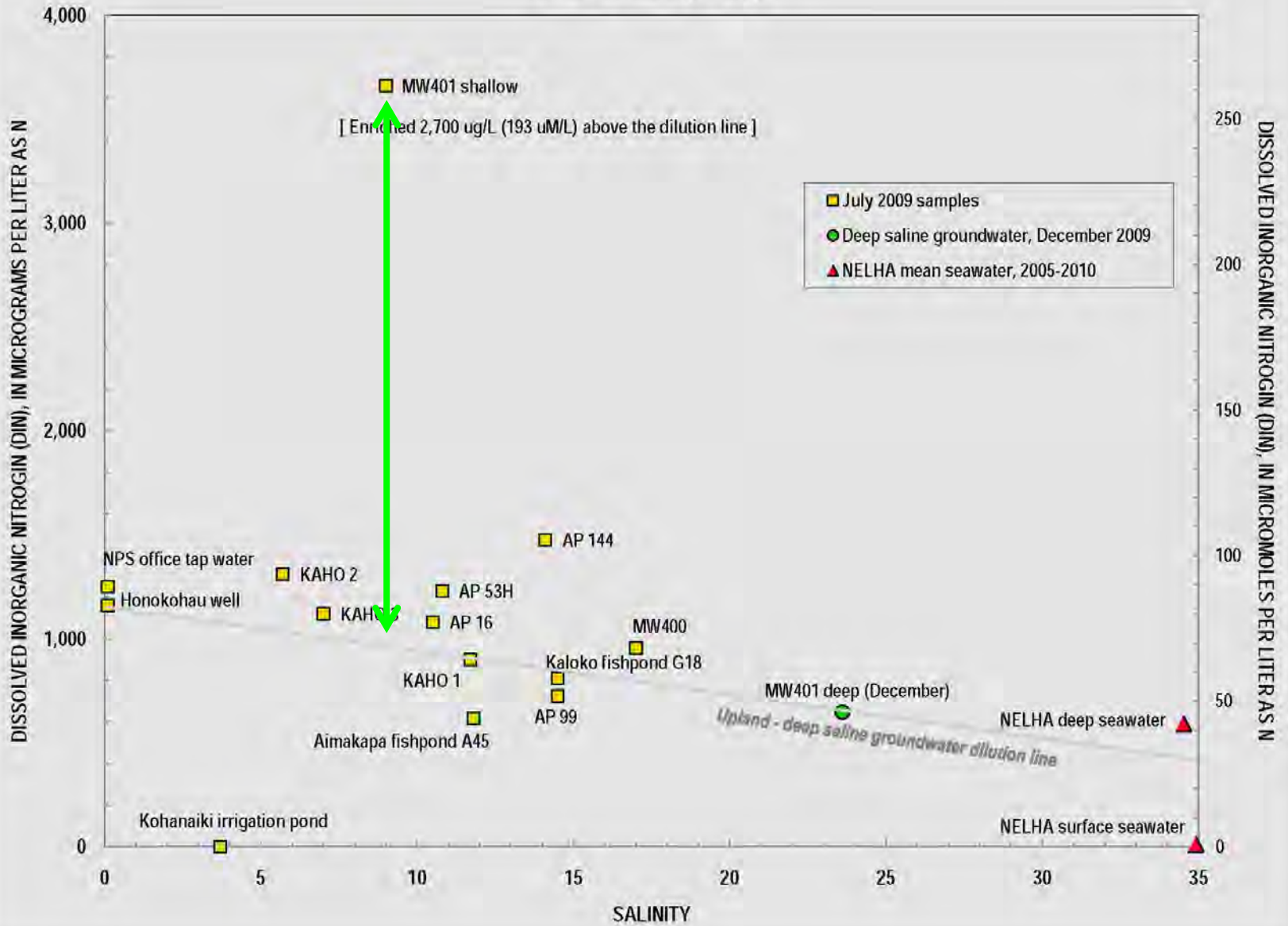
Filtered Salinity: Upper Kaloko Road (KAHO2)
No reduction in variance



Periodic Data



DIN vs Salinity, July

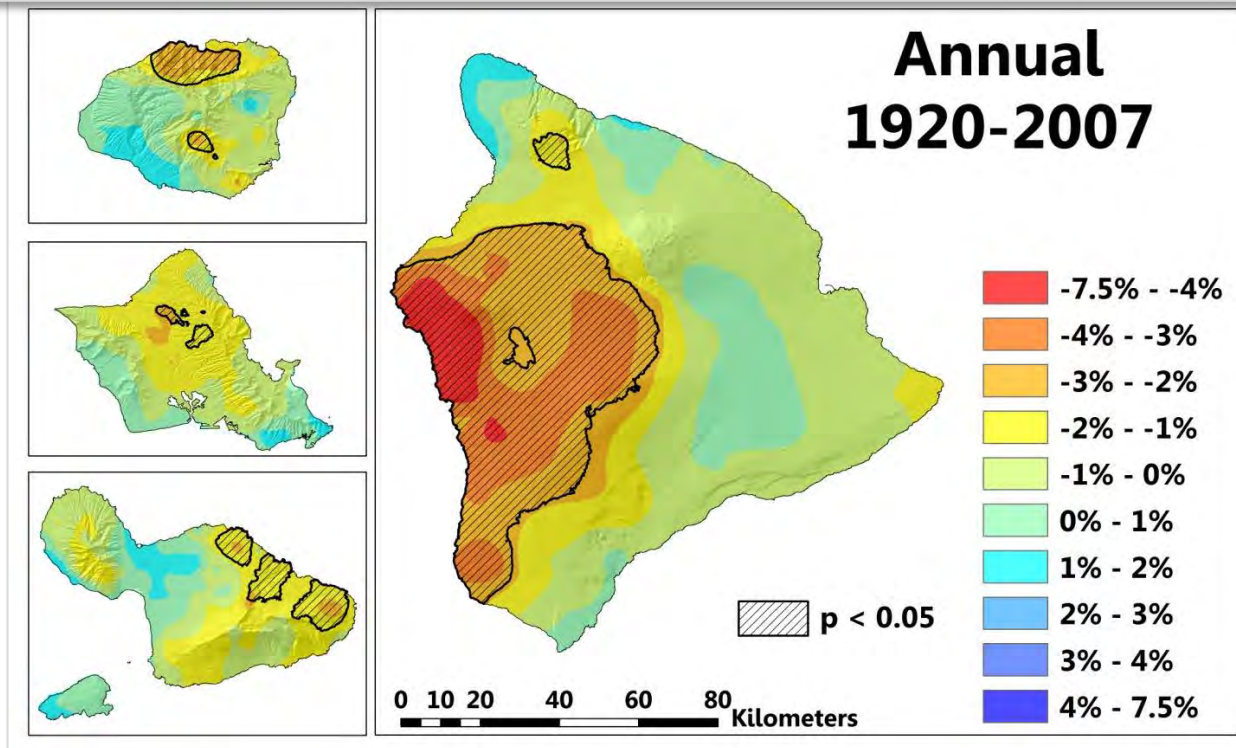


(Courtesy of C. Hunt, USGS, 2010)

Declining Rainfall

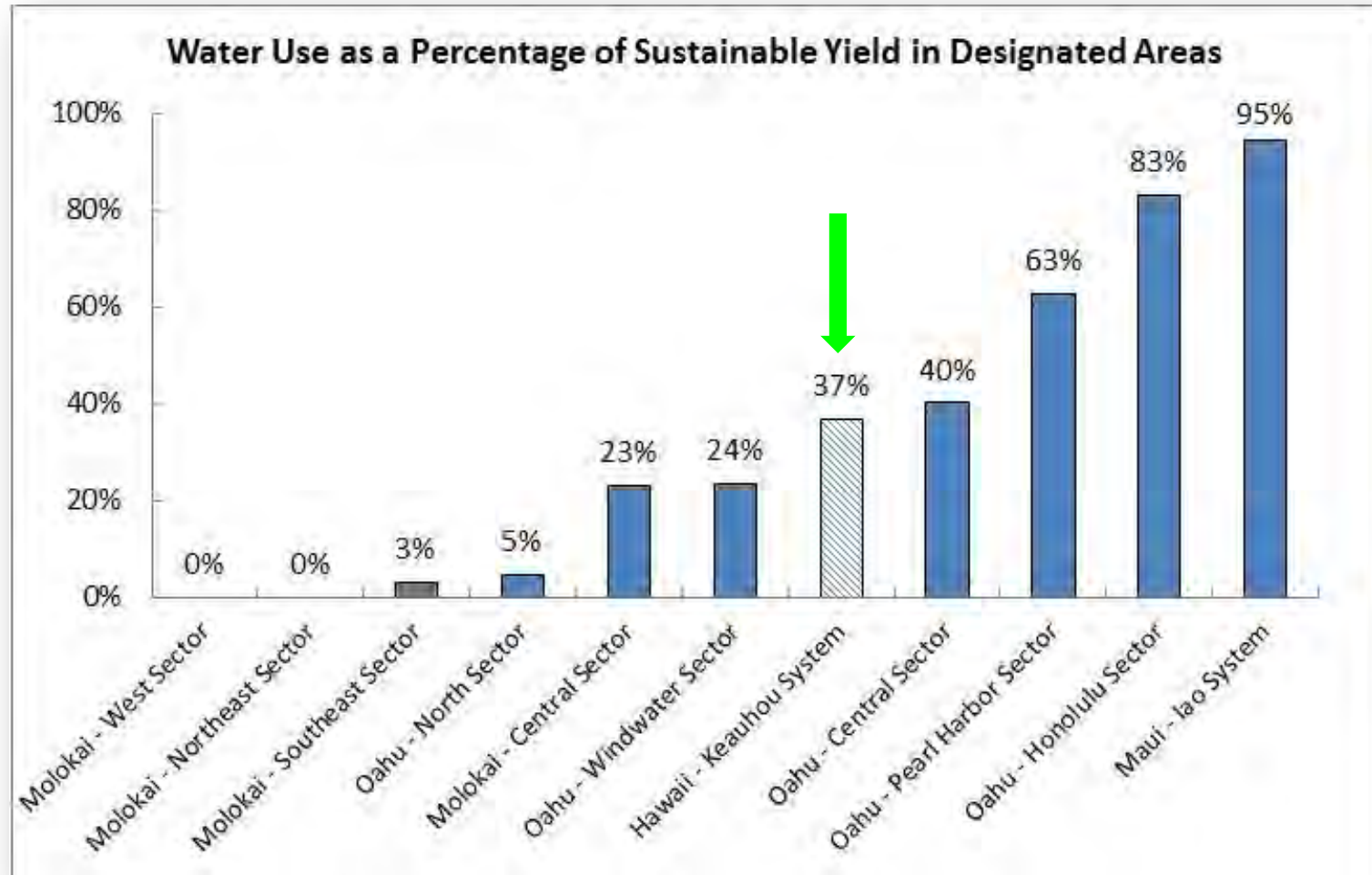
University of Hawaii climate researchers encouraged the Commission to determine which non-designated areas are most threatened by climate-related trends, and commence the process of designating such areas.

University of Hawaii (Wallsgrove & Penn 2012)



(Courtesy of A. Frazier, University of Hawaii, 2014)

2005 Water Use in Designated Areas



(2008 Water Resources Protection Plan; <http://dlnr.hawaii.gov/cwrm/groundwater/activities/keauhou/>)

Summary

- RAM/1999 USGS models predict water levels and coastal discharge will decline due to planned water use
- Water demand is increasing
- Rainfall is declining
- Withdrawals in the area of the park are increasing

Aquatic Habitat

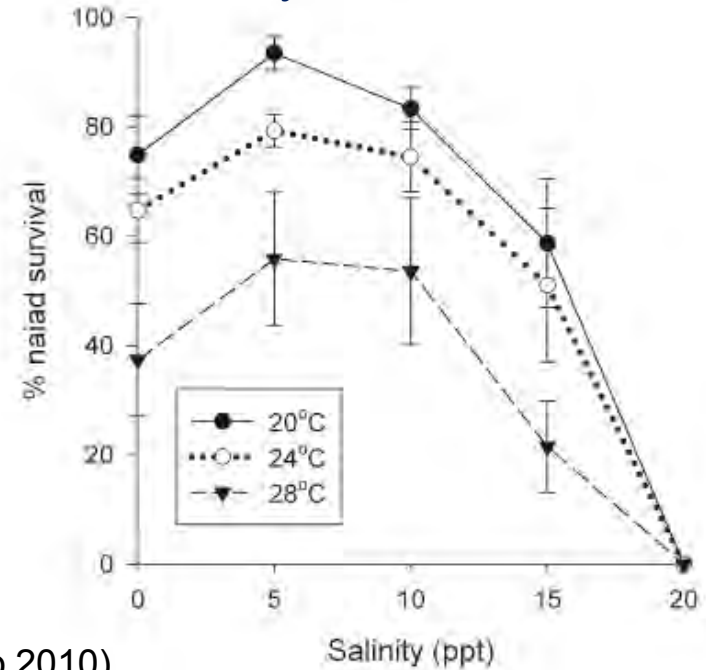
- Rare native species in anchialine pools and wetlands
- Culturally important fish and limu
- Potential effects of reducing groundwater discharge

***NPS Petition pages 11 - 16**

Anchialine Pools



Damselfly Larval Survival



(Tango 2010)

Larva displayed a threshold response to salinity above 15 ppt with no naiads surviving at 20 ppt. The results of this study raise awareness of the importance of water quality and quantity for organisms in these rare environments.

‘Aimakapā Fishpond

Saltwater intrusion and reduced freshwater discharge may adversely affect the long-term recovery of Hawaiian waterbirds.

(U.S. Fish & Wildlife Service 2011)





Kaloko Fishpond

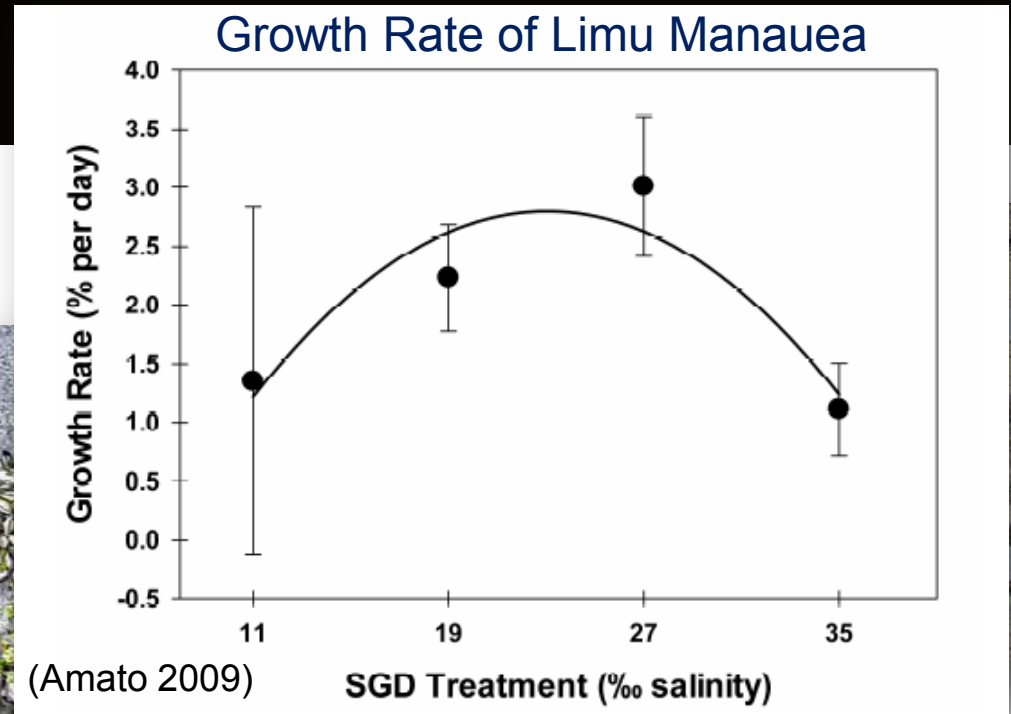
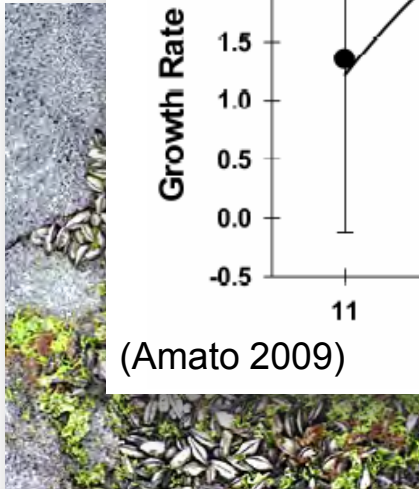
Sustained freshwater discharge into estuaries and natural estuarine conditions are primary mechanisms influencing suitable fish habitat and enhanced juvenile fish recruitment.

Hawaii Dept. of Aquatic Resources (Shimoda et al. 2014)

Bays with Hawaiian fishponds may need further protection to restore the native striped mullet.

Hawaii Dept. of Aquatic Resources (Nishimoto et al. 2007)

Tide Pools



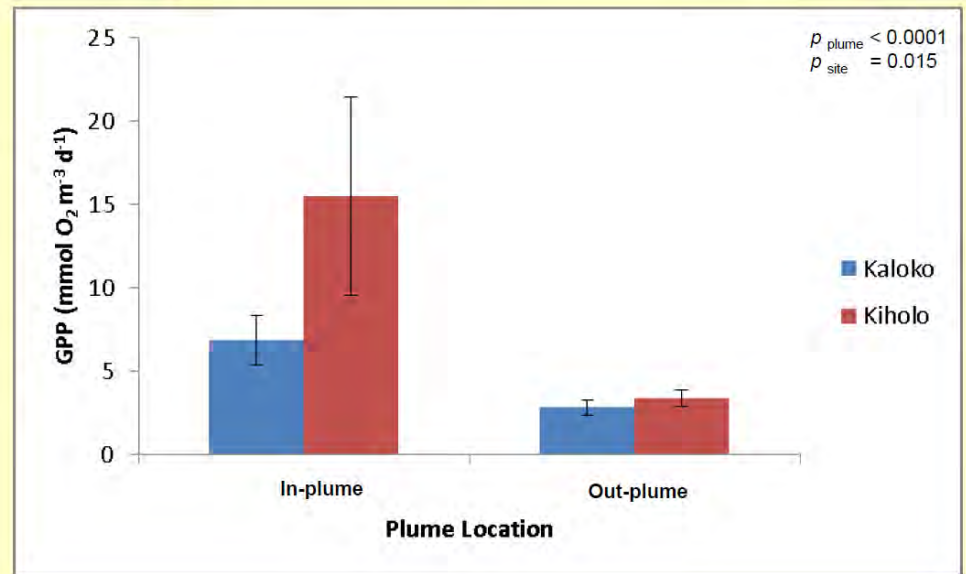
Excessive groundwater withdrawals may limit the productivity and distribution of culturally important species such as the native limu manauea.

University of Hawaii (Duarte et al. 2010)

Coastal Waters



SGD Stimulates Primary Production in Coastal Waters



Johnson and Wiegner 2013, Estuaries and Coasts

(Courtesy of T. Wiegner, Univ. of Hawaii, 2014)

At current nutrient-loading rates, Honokohau Bay will exhibit evidence of further degradation in future years.

University of Hawaii (Parsons et al. 2010)

“Decreases in groundwater discharge may significantly alter the chemical properties of coastal waters endangering unique plants and animal species with ecological, cultural and economic value.”

University of Hawaii (Duarte et al. 2010)

Summary

- Groundwater withdrawals from the higher-elevation and basal aquifers will effect water quality and quantity at the coast.
- Numerous peer-reviewed and published studies warn that reduced freshwater discharge can adversely effect the habitat for rare and culturally important native species.
- The uncertainty regarding the timing and magnitude of these impacts to public trust resources is not a reason for inaction.

Kaloko-Honokōhau National Historical Park

www.nps.gov/kaho



National Park Service
U.S. Department of the Interior