National Park Service
U.S. Department of the Interior

Natural Resource Science and Stewardship

Specific information requested under Item C.3.a) of Preliminary Order HA-WMA-2013-1

Meeting of the Commission on Water Resource Management
Kailua-Kona, Hawai‘i
May 19, 2016

Paula A. Cutillo, Water Resources Division

Background

- September 2013 – NPS Petition for WMA
- December 2014 – CWRM Preliminary Order:

a) *The quantity of groundwater needed to support 1) natural resources, and 2) cultural resources of the Kaloko-Honokōhau National Historical Park*

b) *Specific traditional and customary practices that are exercised in the Kaloko-Honokōhau National Historical Park*

Background

- May 2015 – Existing quantity of fresh groundwater discharging in the Park is the minimum needed to support natural and cultural resources
- August 2015 – Report with supporting information

Background

- The Problem:
  - Salinity at limits of survivability for public trust resources in the park
  - Saltwater intrusion, declining rainfall, and nutrient pollution are occurring

- What we can do:
  - Understand the impacts of groundwater withdrawals
  - Identify areas where new withdrawals will have minimal impacts on public trust resources

Background

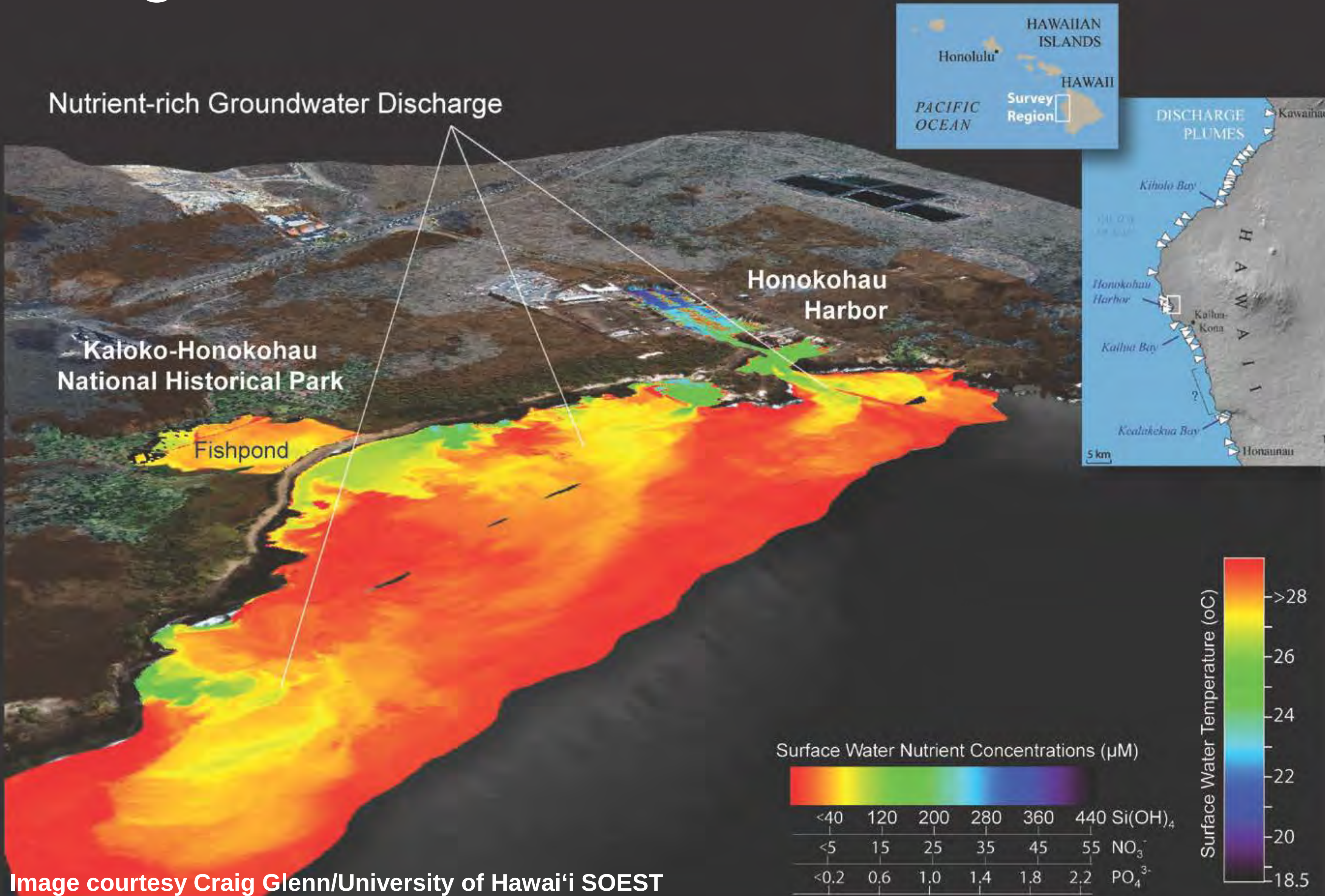
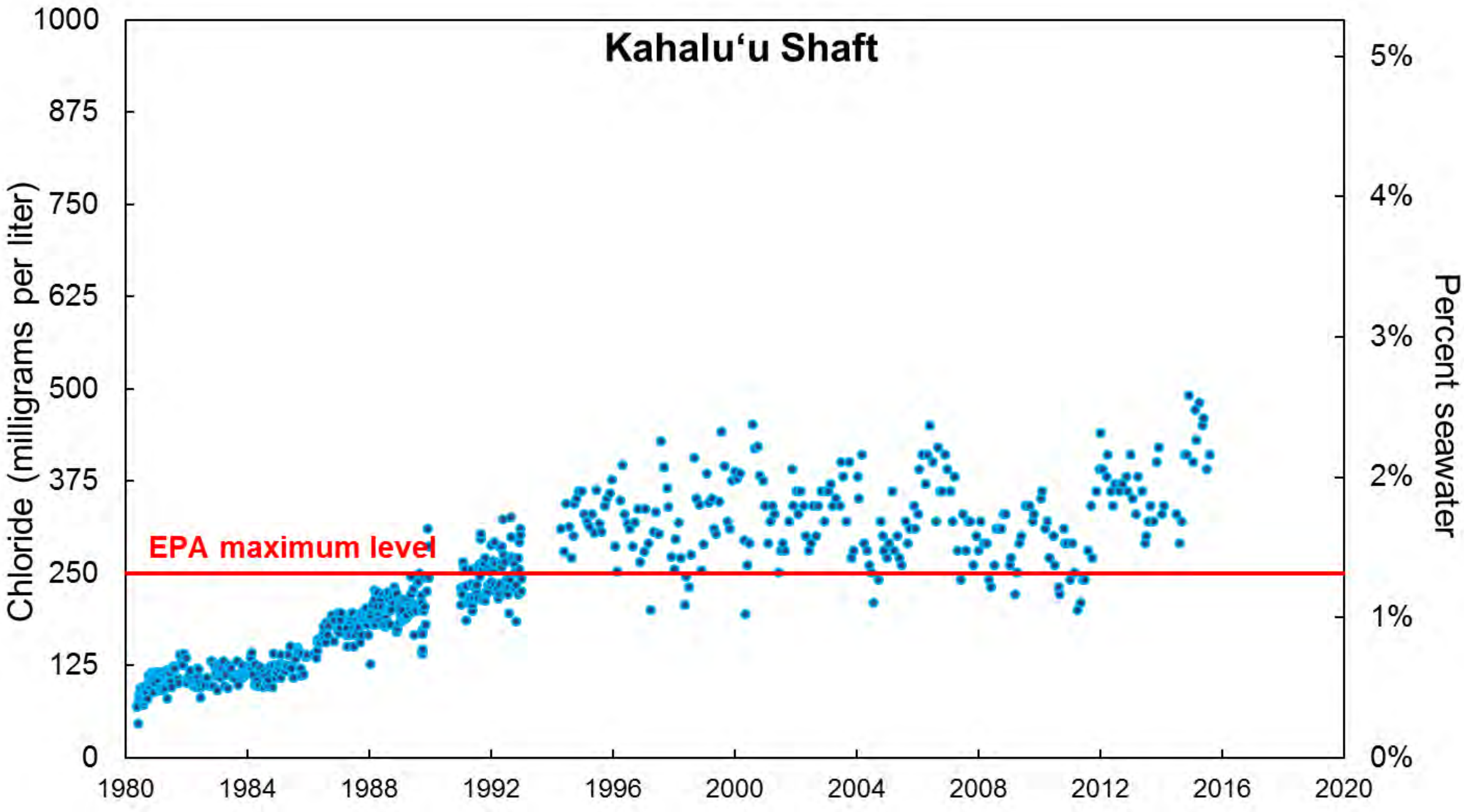


Image courtesy Craig Glenn/University of Hawai‘i SOEST

Background

- **Drinking water**



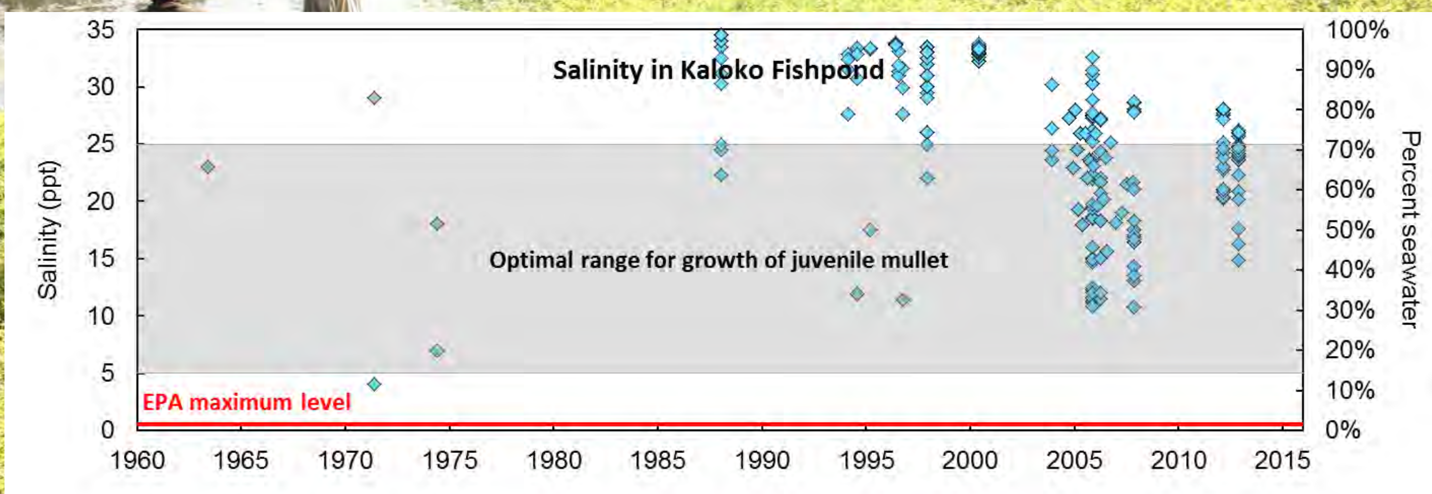
Survive, Thrive & Reproduce

- **Salinity Tolerances**
  - Culturally important native fish
  - Endangered native waterbirds
  - Proposed endangered native damselfly

- **Life-Cycle Stewardship**
  - The goal of managing resources such that species' full life cycles are sustainable over time

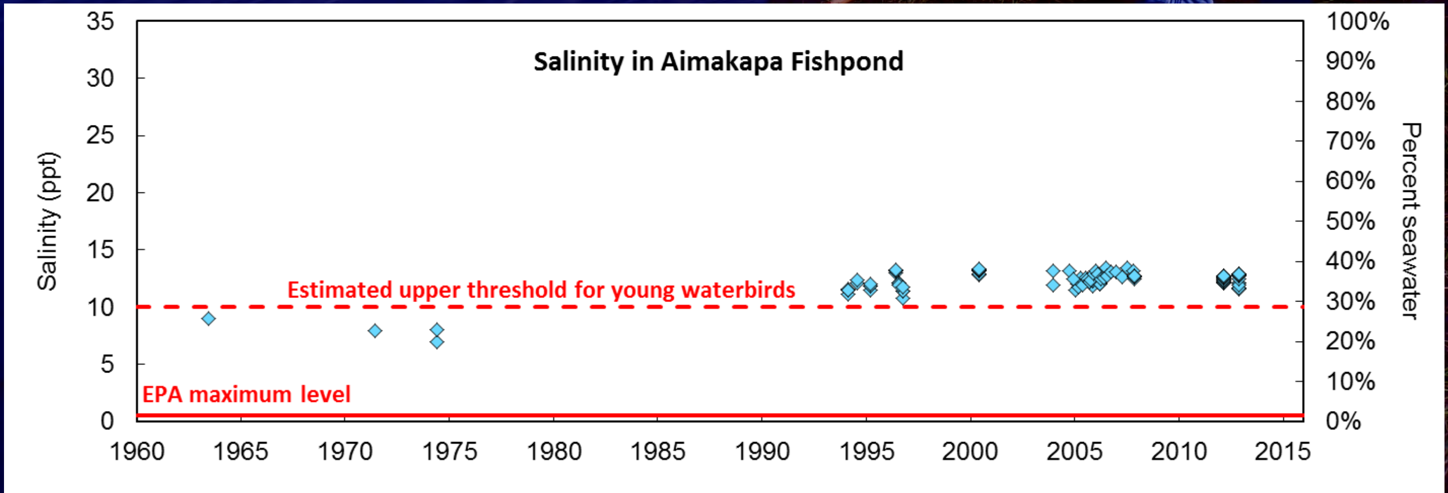
Survive, Thrive & Reproduce

- **Nursery Habitat for Juvenile Striped Mullet**
  - Numbers declining due to loss of nursery habitat
  - Optimal salinity range = 5 to 25 ppt
  - Kaloko Fishpond = 4 to 34 ppt
  - Must be able to support harvesting



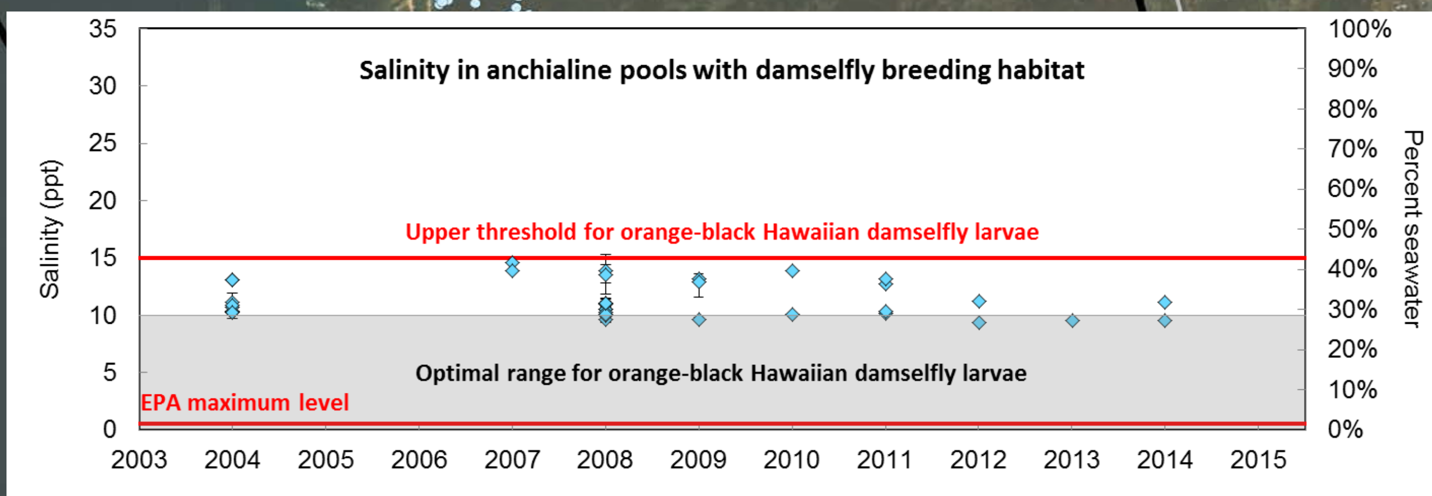
Survive, Thrive & Reproduce

- **Breeding Habitat for Endangered Waterbirds**
  - Populations declined due to loss of wetland habitat
  - Park 1 of only 2 Core Wetlands on Hawai‘i Island
  - Estimated threshold = 10 ppt
  - Aimakapa Fishpond = 7 to 14 ppt
  - Chicks require access to freshwater

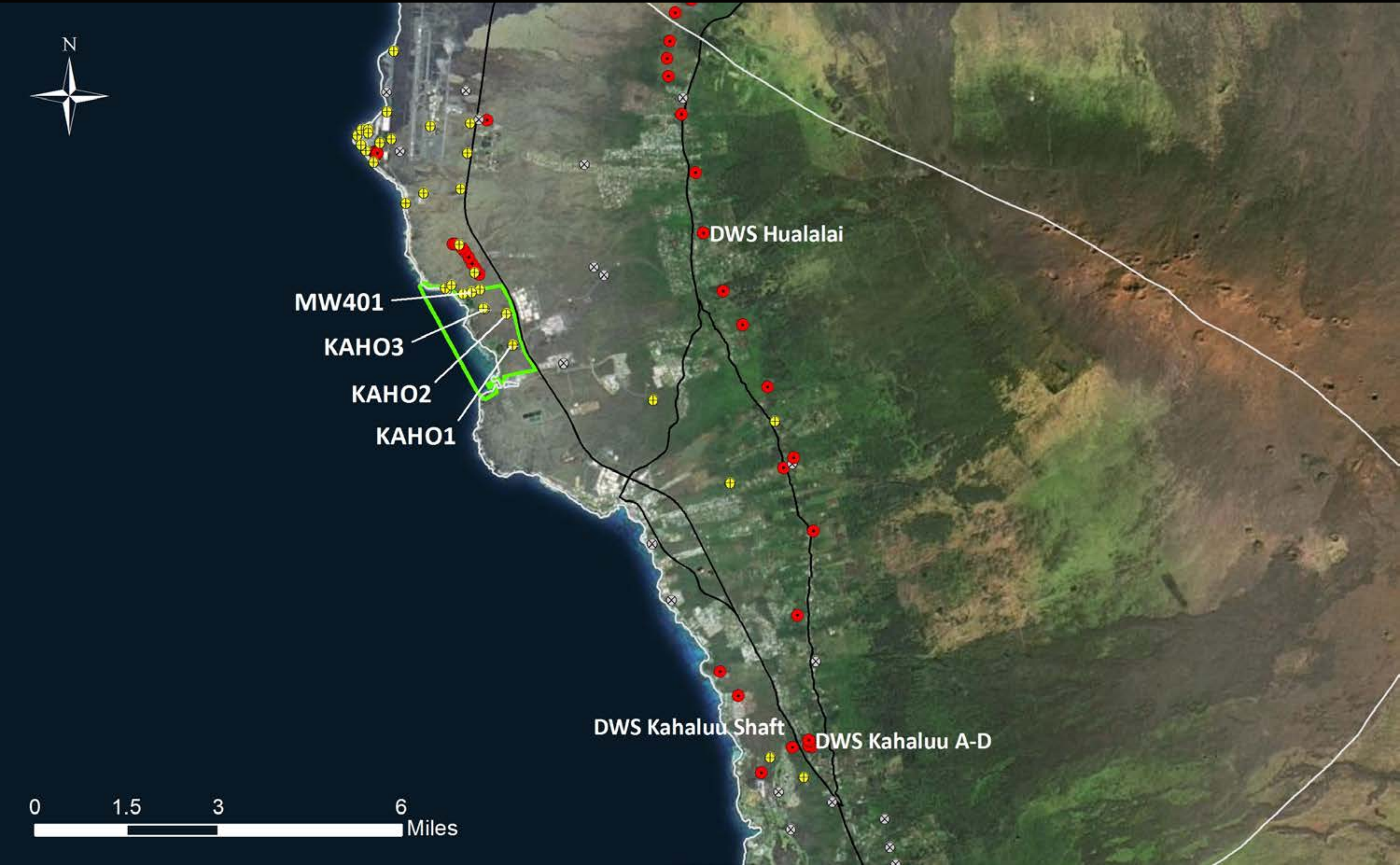


Survive, Thrive & Reproduce

- **Breeding Habitat for Proposed Endangered Orange-Black Hawaiian Damselfly**
  - Proposed endangered due to habitat loss
  - Salinity threshold = 15 ppt
  - Anchialine pools with breeding habitat = 9 to 15 ppt
  - Must be able to reproduce in the park

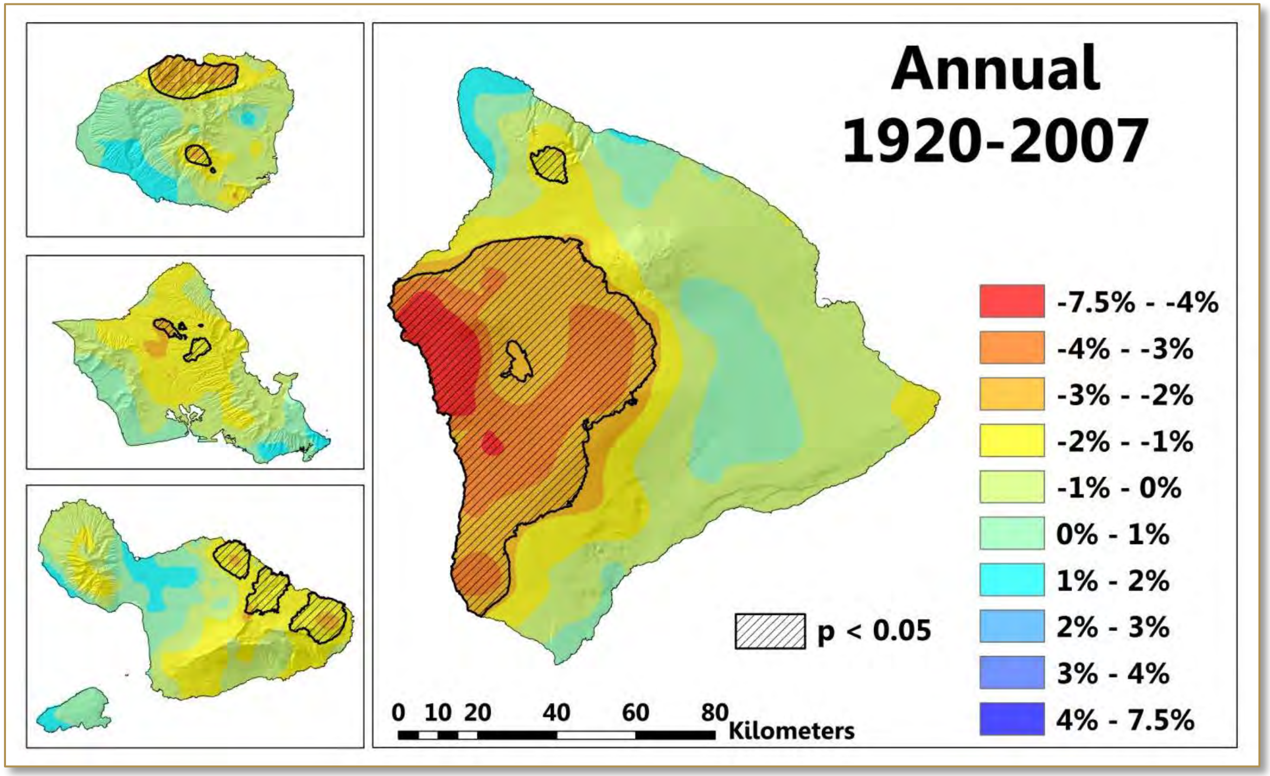


Observed Changes



Observed Changes

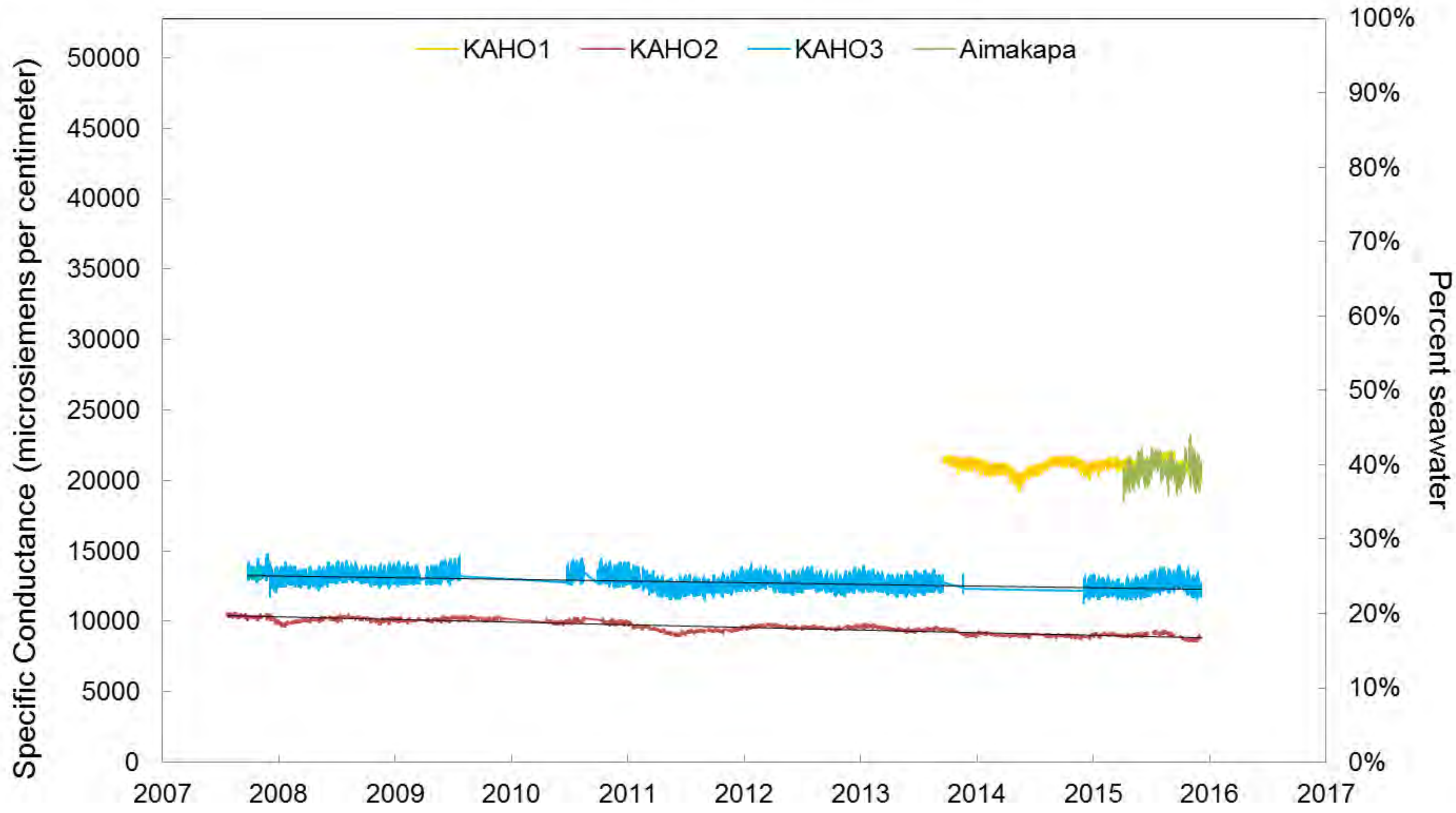
- Drought – high risk & high vulnerability
- Declining Rainfall



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

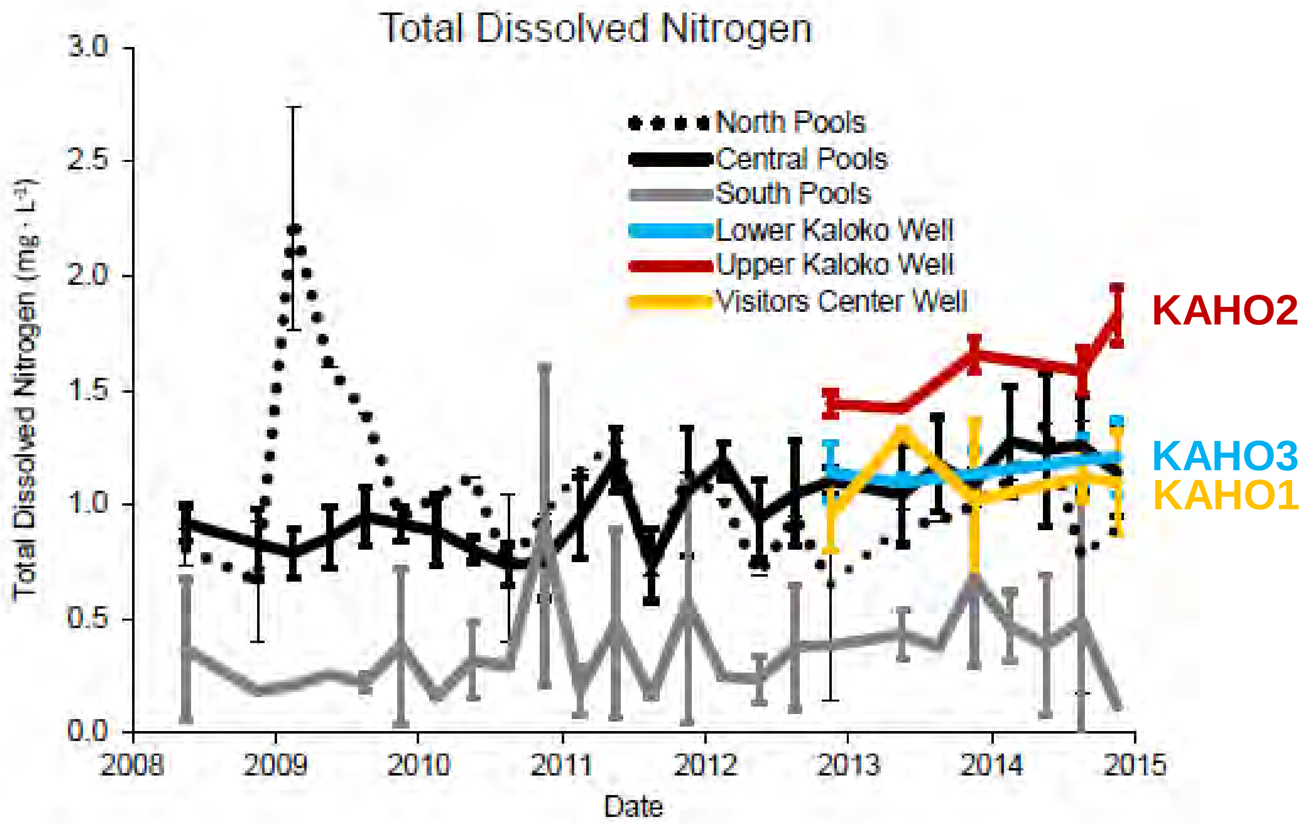
Observed Changes

- Salinity in the Park



Observed Changes

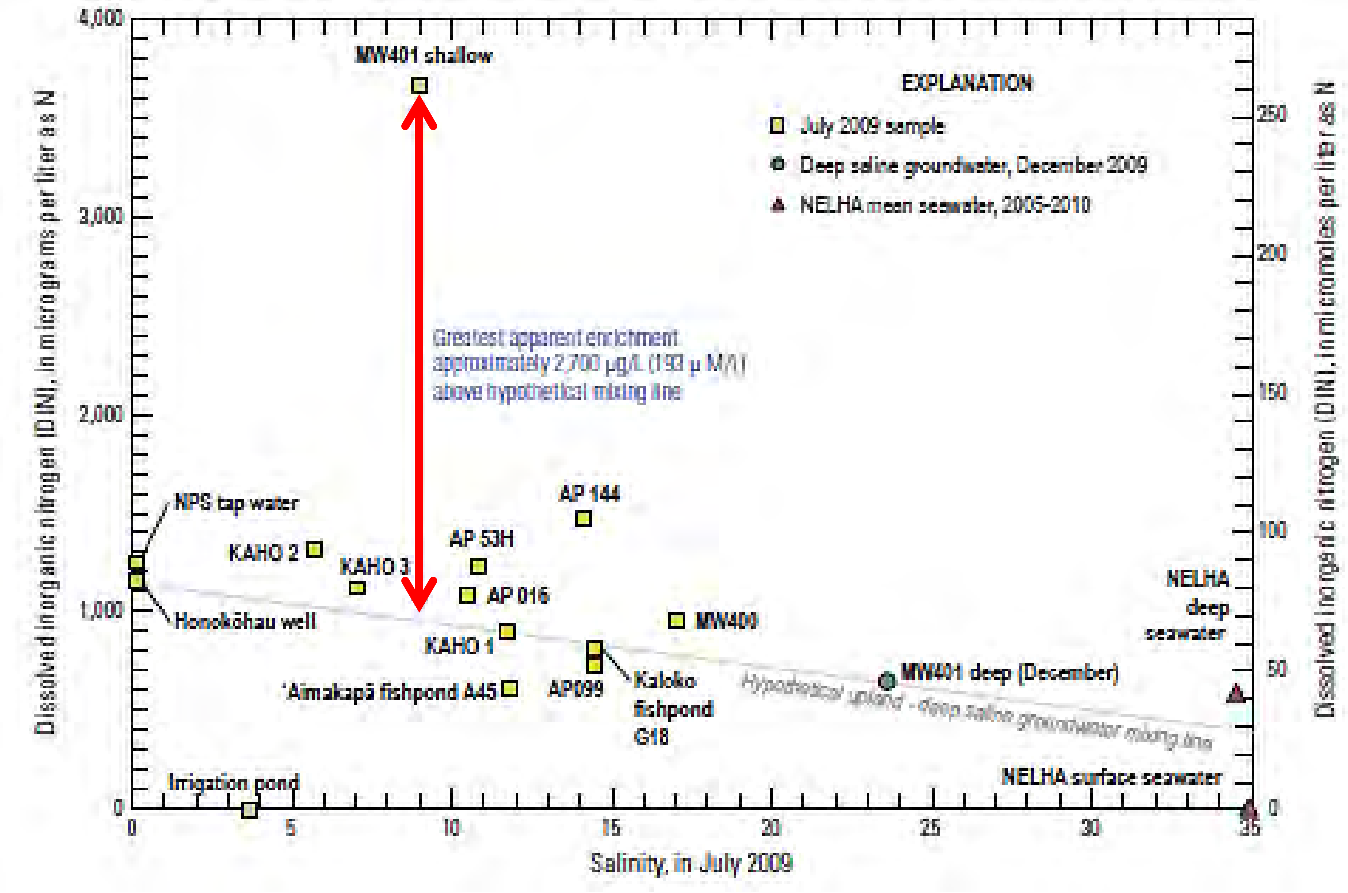
- Nutrient Pollution in the Park



(Raikow & Farahi 2016: https://irma.nps.gov/DataStore/Reference/Profile/2227770)

Observed Changes

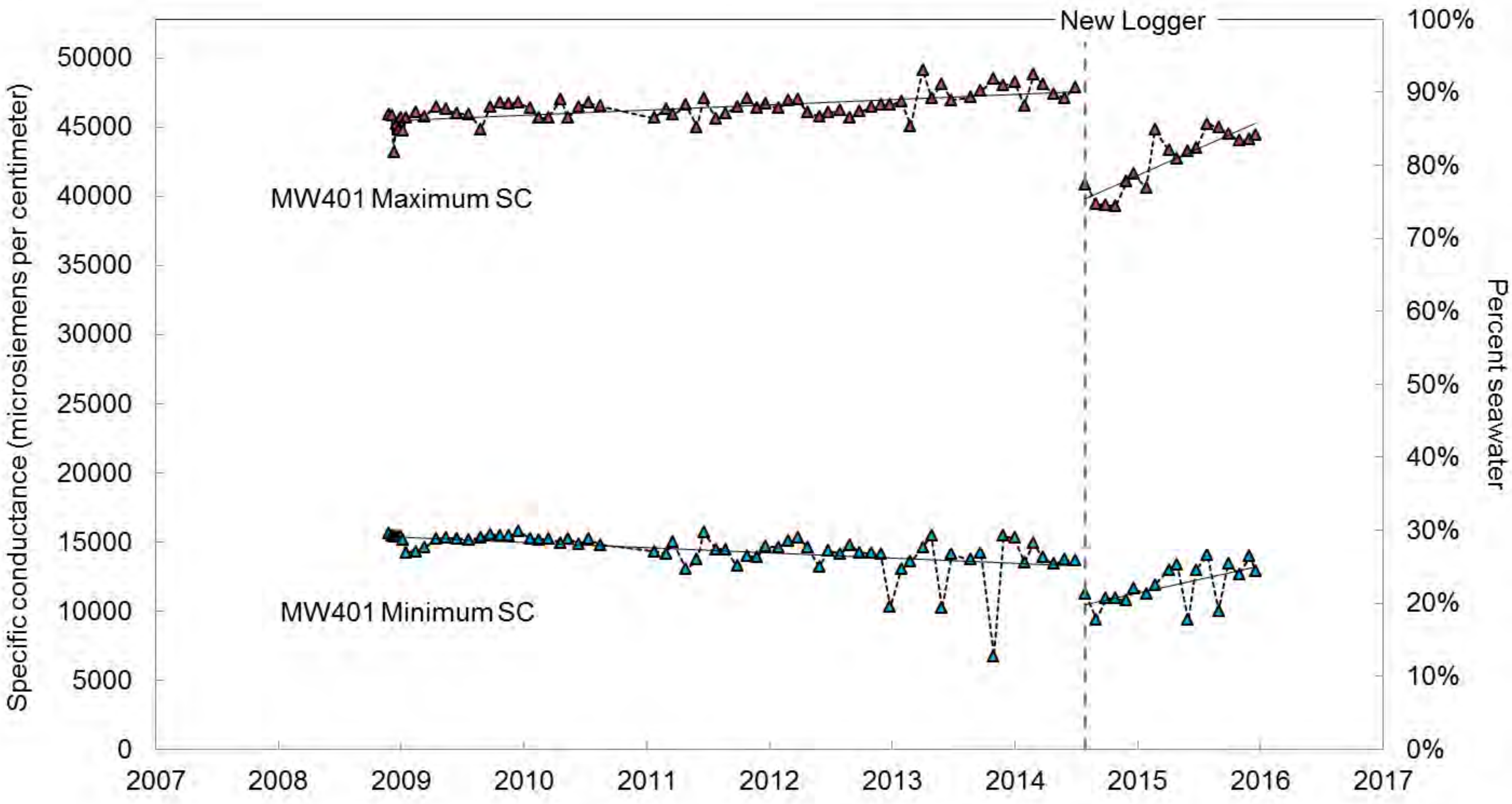
- Nutrient Pollution on the Boundary



(Hunt 2014)

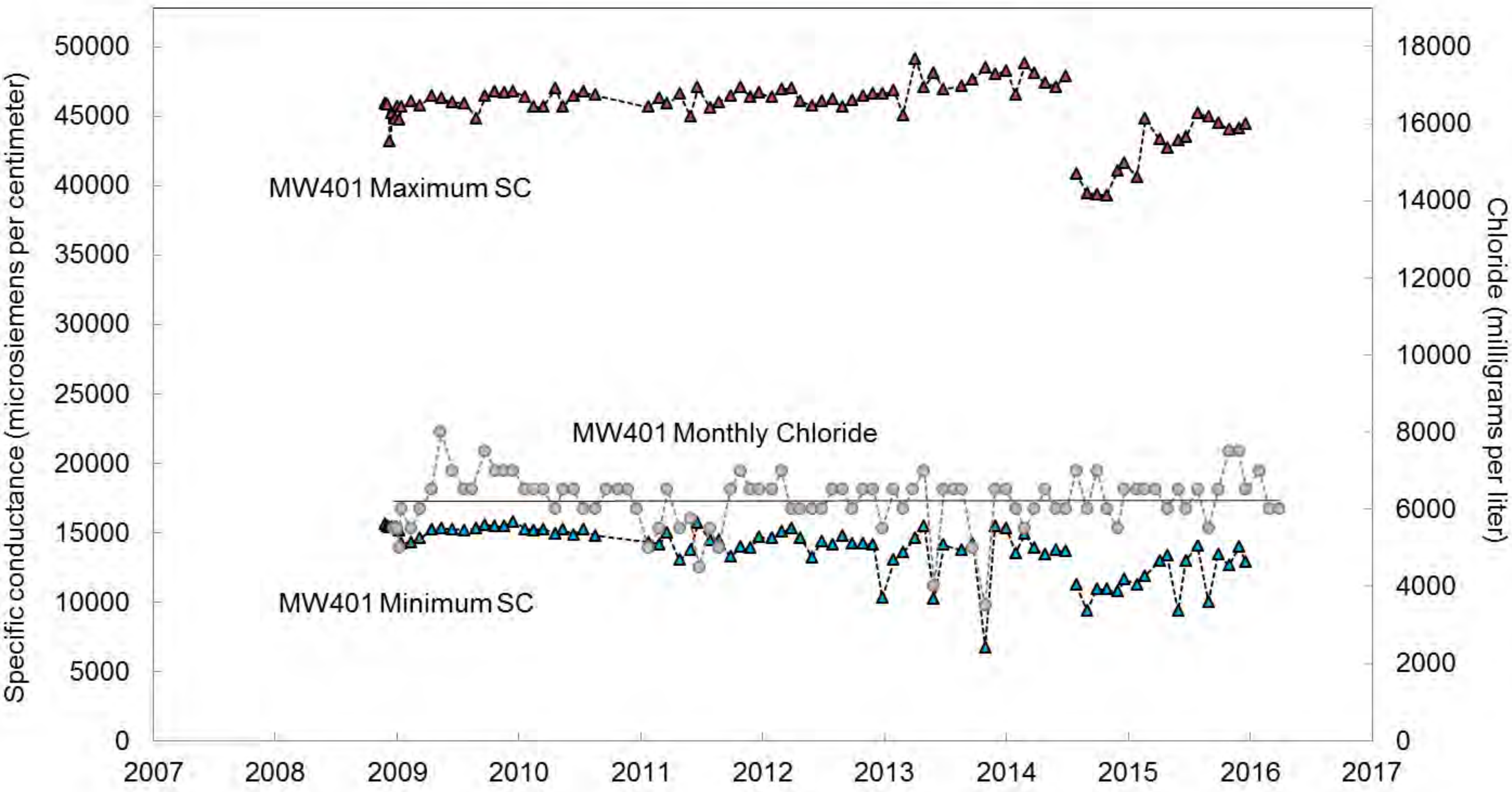
Observed Changes

- Salinity on the Boundary



Observed Changes

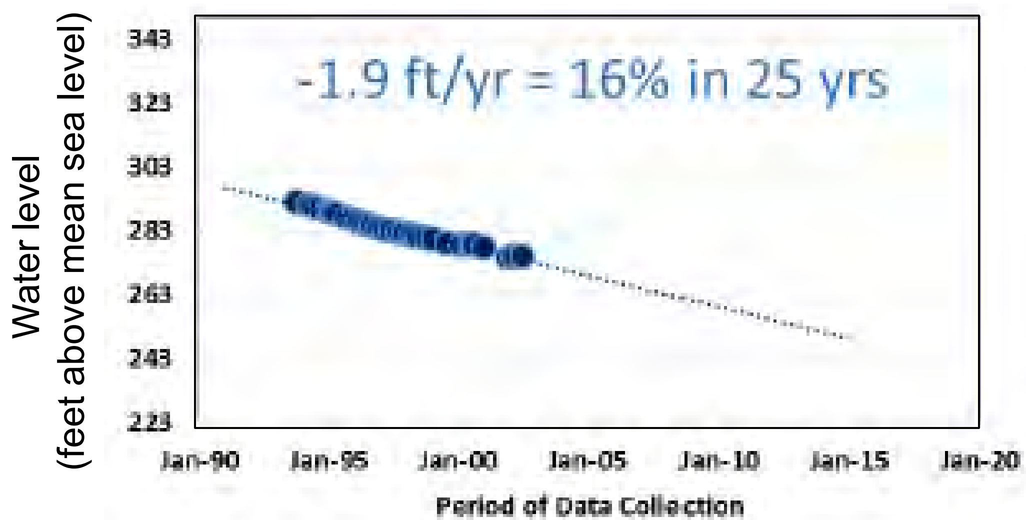
- Salinity on the Boundary



Observed Changes

- Declining Water Levels in Inland Aquifer

Hualalai Deepwell



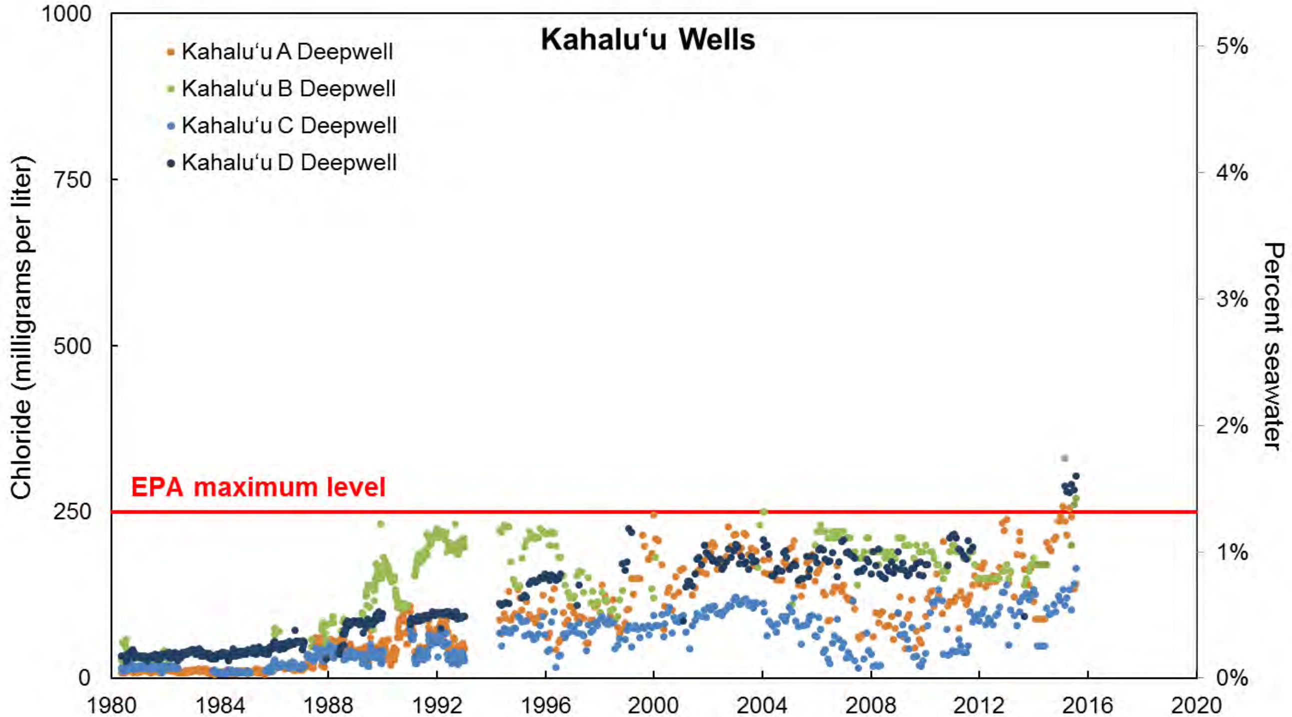
(Draft Findings of Fact, CWRM, 2014)

Hualalai Deepwell Pumpage < 1 million gallons per day

Keauhou Aquifer System pumpage = 15 million gallons per day

Observed Changes

- Saltwater Intrusion in Coastal Aquifer

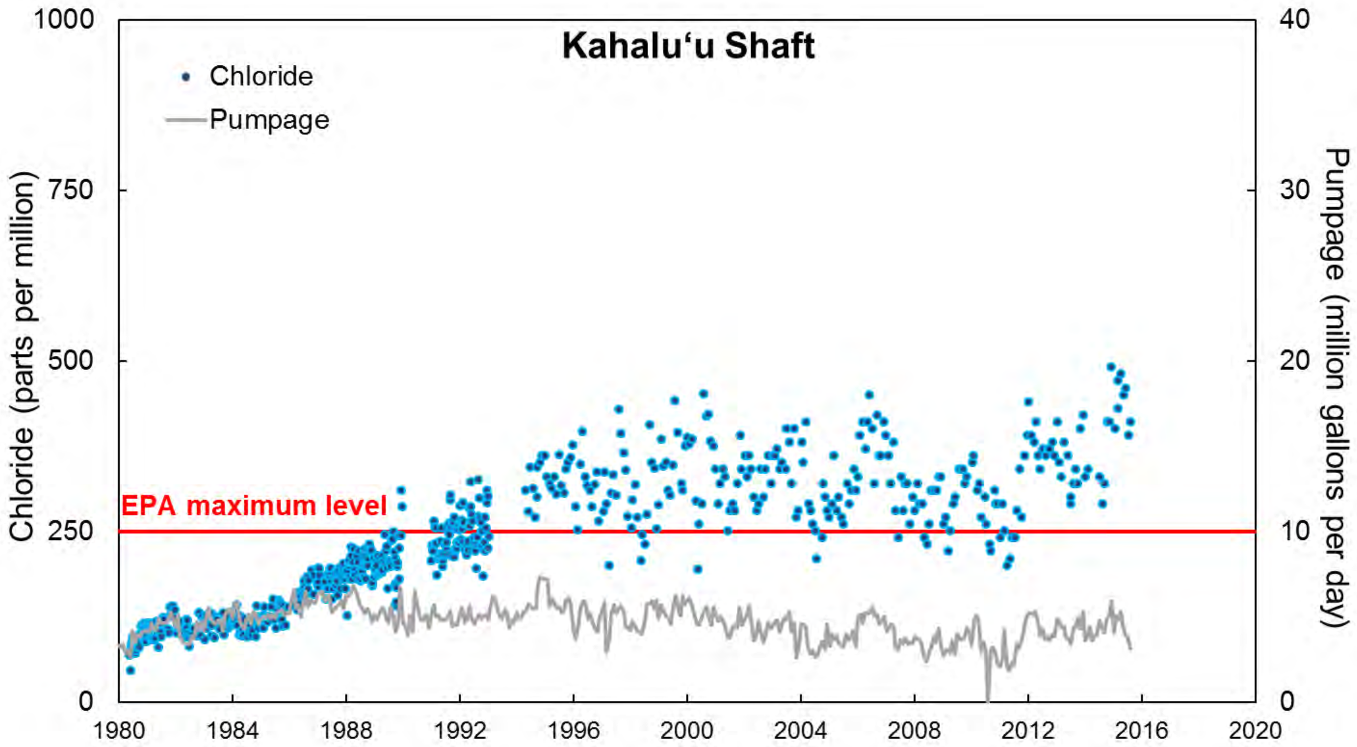


Kahalu‘u Wells Pumpage = 3 million gallons per day

Keauhou Aquifer System pumpage = 15 million gallons per day

Observed Changes

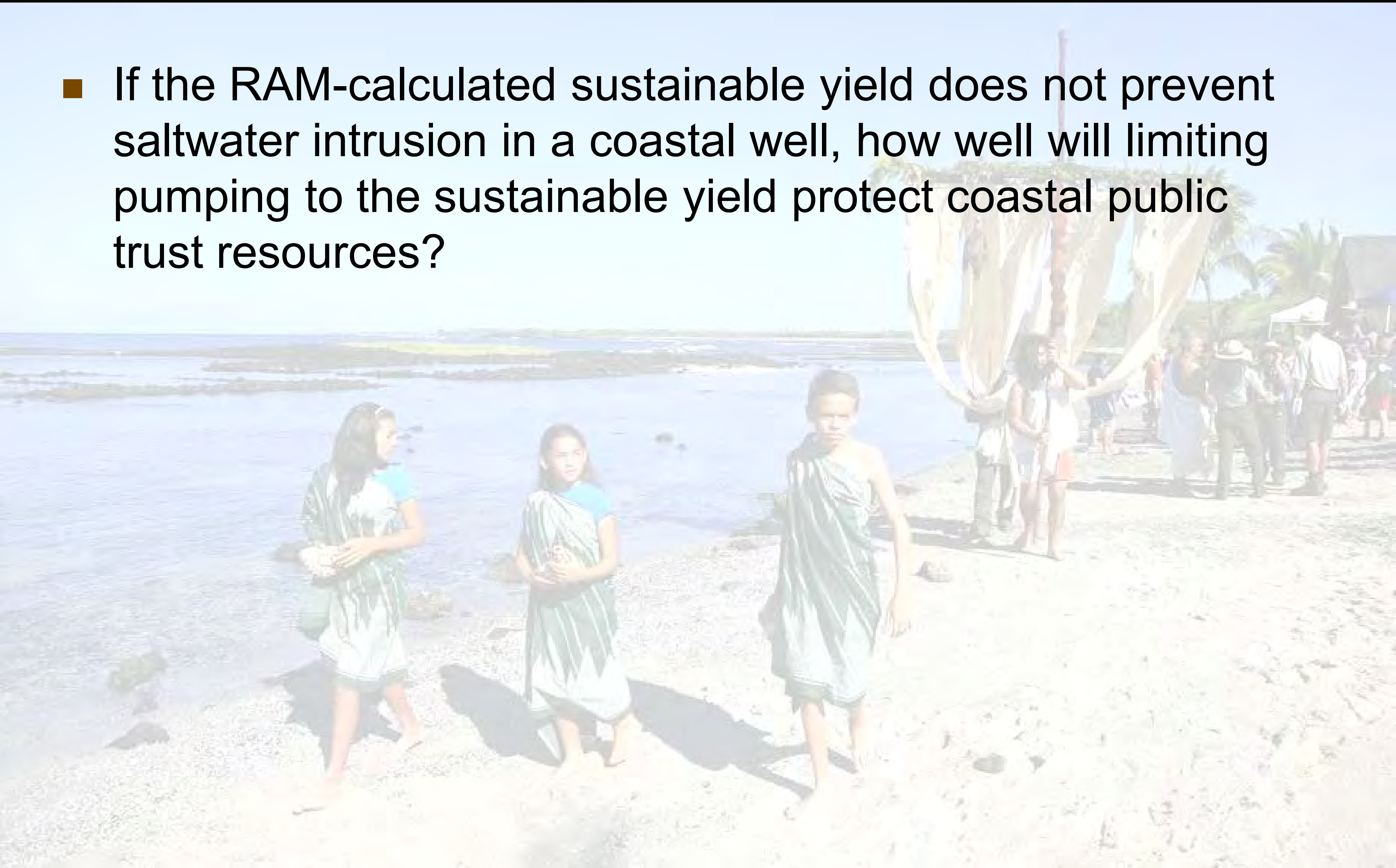
- Saltwater Intrusion in Coastal Aquifer



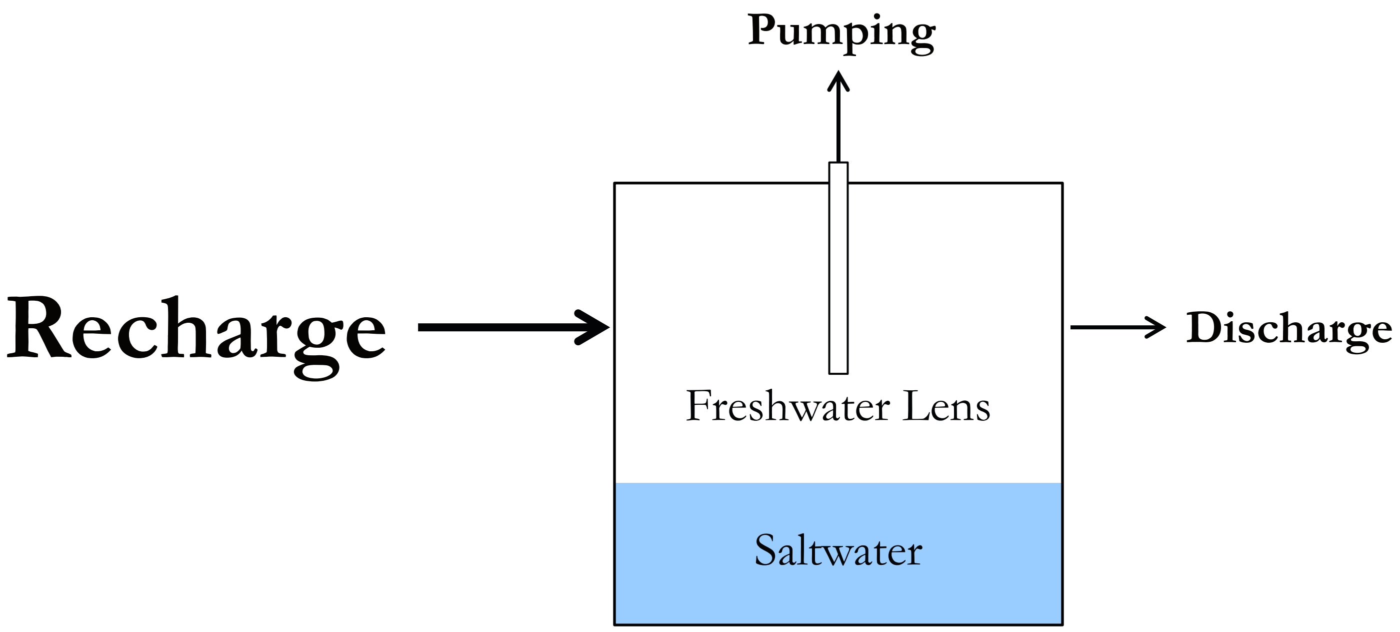
Kahalu‘u Shaft Pumpage = 4 million gallons per day
Keauhou Aquifer System pumpage = 15 million gallons per day

Sustainable Groundwater Management

- If the RAM-calculated sustainable yield does not prevent saltwater intrusion in a coastal well, how well will limiting pumping to the sustainable yield protect coastal public trust resources?



RAM-Calculated Sustainable Yield



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

The Water Budget Myth

The idea that the recharge is important in determining the magnitude of sustainable development is a myth.

(Bredehoeft 2002)

- The source of water derived from wells (Theis 1940)
- Safe yield (Lohman 1979)
- The water budget myth (Bredehoeft et al. 1982)
- Why “safe yield” is not sustainable (Sophocleous 1997)
- Safe yield and the water budget myth (Bredehoeft 1997)
- Sustainability of ground-water resources (Alley et al. 1999)
- The water budget myth revisited (Bredehoeft 2002)

Impacts of Groundwater Withdrawals

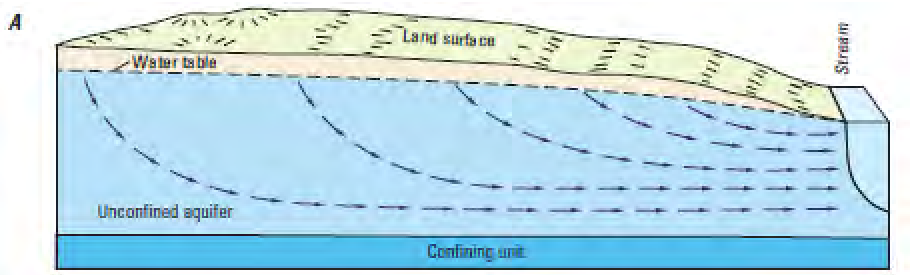
All water discharged by wells is balanced by a loss of water somewhere.

(Theis 1940)

- Where are the losses?
- Are the consequences acceptable?

Impacts of Groundwater Withdrawals

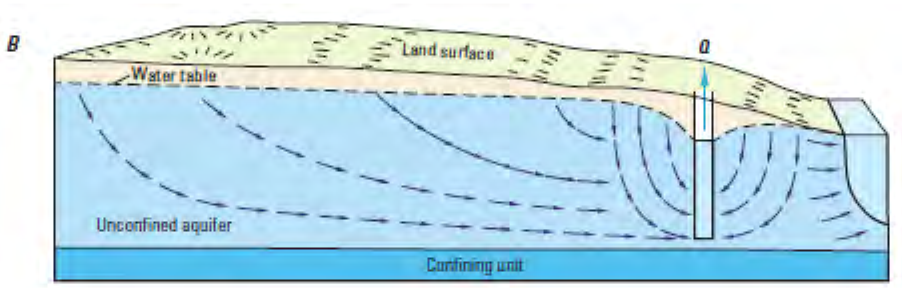
Pre-Development



(Barlow & Leake 2012)

Impacts of Groundwater Withdrawals

Removal from Storage

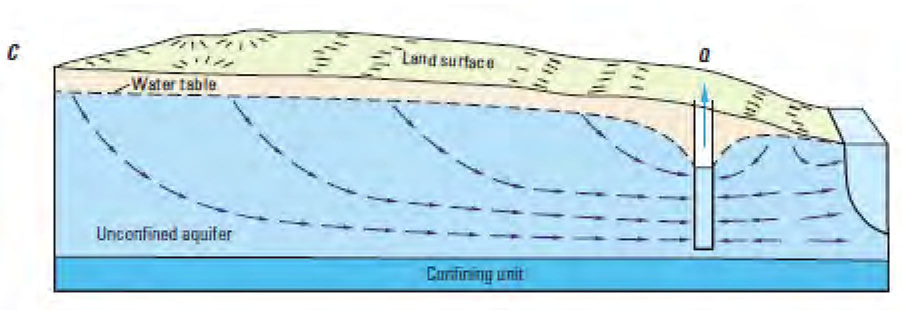


(Barlow & Leake 2012)

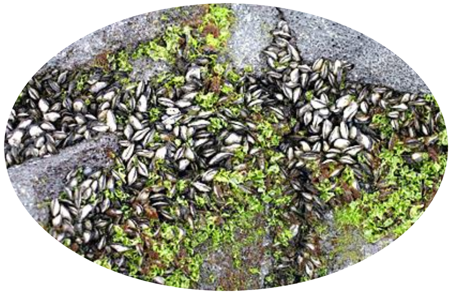
- lowered water levels
- rising saltwater

Impacts of Groundwater Withdrawals

Captured Discharge



(Barlow & Leake 2012)



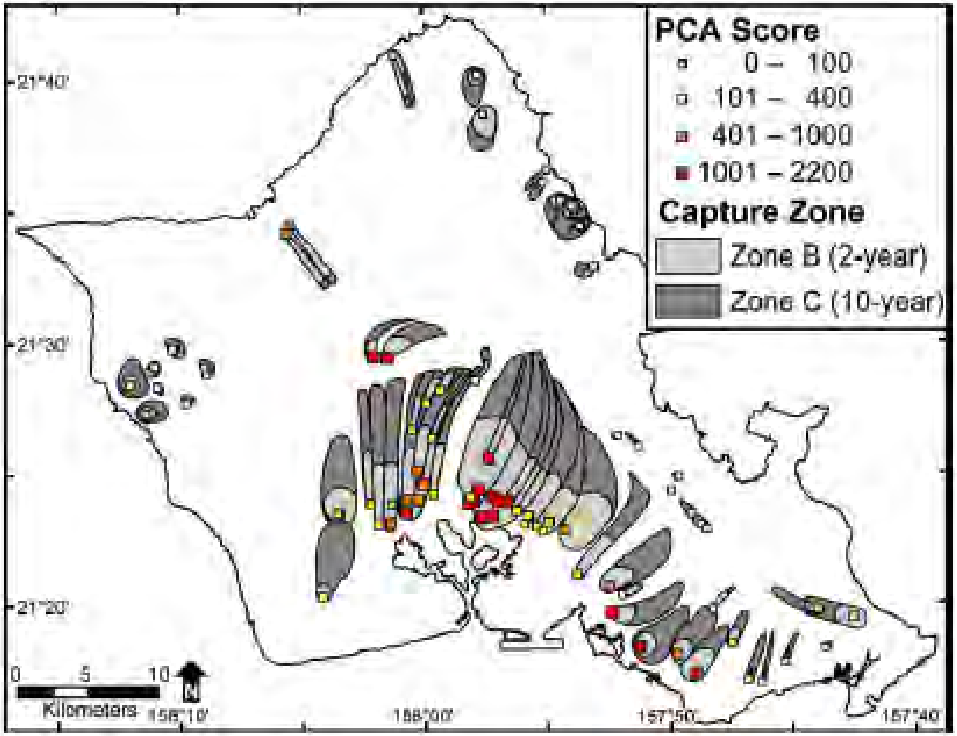
- streamflow depletion
- less freshwater discharge
- saltwater intrusion

Impacts of Groundwater Withdrawals

- Factors that affect capture:
  - Aquifer properties
  - Distance from wells to aquifer boundaries
  - Pumping rate
  - ~~Recharge~~

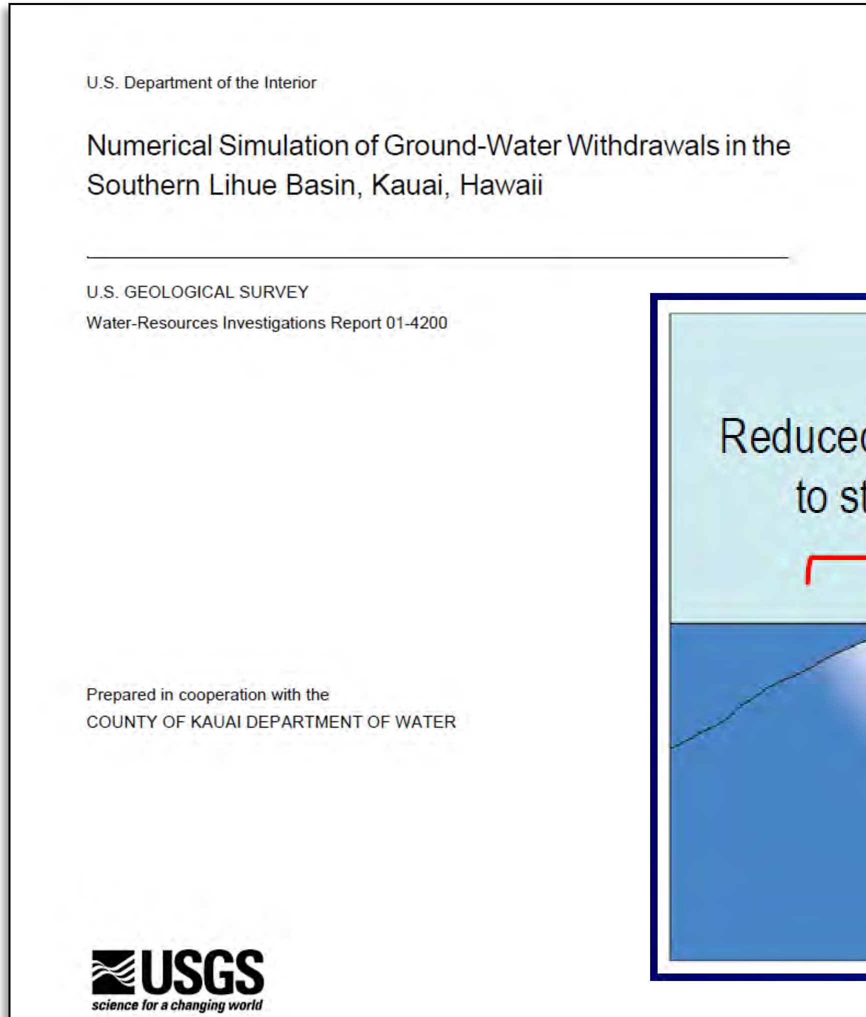
- Management actions that affect capture:
  - Change well depth or location
  - Change pumping rate

Estimating Capture



(Whittier et al. 2010)

Estimating Capture



U.S. Department of the Interior

Numerical Simulation of Ground-Water Withdrawals in the Southern Lihue Basin, Kauai, Hawaii

U.S. GEOLOGICAL SURVEY

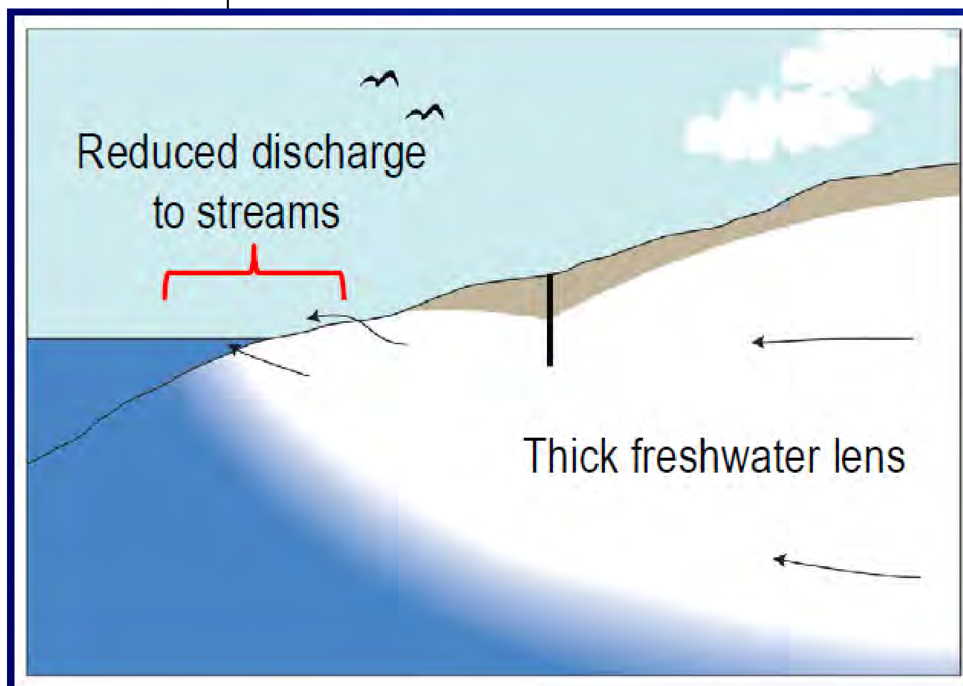
Water-Resources Investigations Report 01-4200

Prepared in cooperation with the

COUNTY OF KAUAI DEPARTMENT OF WATER

USGS

science for a changing world



(Courtesy of S. Izuka, USGS, 2015)

Summary

- The Problem:
  - Salinity at limits of survivability for public trust resources in the park
  - Saltwater intrusion, declining rainfall, and nutrient pollution are occurring
- What we can do:
  - Understand the impacts of groundwater withdrawals
    - Where will capture of freshwater occur?
    - Where will habitat loss, population decline occur?
  - Identify areas where new withdrawals will have minimal impacts on public trust resources

Mahalo

Water Resources Division

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http://www.nature.nps.gov/water/index.cfm

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