



Water Quality in Anchialine Pools of Kaloko-Honokōhau National Historical Park

Summary Report 2008-2011

Natural Resource Data Series NPS/PACN/NRDS—2014/661



ON THE COVER

An anchialine pool at Kaloko-Honokōhau NHP showing sediment introduced by high wave events and colonized by non-native *Batis maritima*.

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Abstract

This Natural Resource Data Series Report (NRDS) presents data collected from anchialine pools in Kaloko-Honokōhau National Historical Park on the west coast of the island of Hawai'i, Hawaii. This is a summary or "data report" as described in the Water Quality Vital Signs Monitoring Protocol for the Pacific Island Network Version 1.0, Natural Resource Report NPS/PACN/NRR-2011/418. This report is restricted to data presentation and limited description. The data presented in this report will be analyzed for the establishment of expected parameter value ranges and long-term trends in future reports published in the NPS Natural Resource Technical Report (NRTR) series. The purpose of collecting data on Vital Signs is to provide park managers information on current conditions and temporal trends in ecosystem health. Four anchialine "fixed site" pools were sampled quarterly, and 52 "temporary site" pools were sampled one to three times, from 2008 through 2011. During this time no major ecological events were detected in pools. Relatively minor algal blooms may have occurred in 2011 in HA_Kaloko_119 and HA_Kealak_084 as indicated by chlorophyll. Elevated nitrogen concentrations were observed in HA_Kaloko_119 in 2009. There was no evidence of biogeochemical alteration caused by the tsunami of March 11, 2011. Conditions in HA_Kealak_084 were notably different from other pools, but consistent with the presence of abundant macroalgae.

Acknowledgments

We thank Kathy Billings, Sallie Beavers, and the staff of Kaloko-Honokōhau NHP for their cooperation and on-site logistical support.

List of Units and Acronyms

°C	Degrees Centigrade
$\mu\text{g} \cdot \text{L}^{-1}$	Micrograms per Liter
$\mu\text{gP} \cdot \text{L}^{-1}$	Micrograms of Phosphorus per Liter
$\text{mS} \cdot \text{cm}^{-1}$	Milli-Siemens per Centimeter
Chl	Chlorophyll
CO_2	Carbon dioxide
HAVO	Hawaii Volcanoes National Park
I&M	Inventory and Monitoring Program of the National Park Service
KAHO	Kaloko-Honokōhau National Historical Park
$\text{mg} \cdot \text{L}^{-1}$	Milligrams per Liter
$\text{mgN} \cdot \text{L}^{-1}$	Milligrams of Nitrogen per Liter
n	Number of measurements or samples
NHP	National Historical Park
NO_2	Nitrite
NO_3	Nitrate
NPS	National Park Service
NRDS	Natural Resource Data Series Report
NRTR	Natural Resource Technical Report
NTU	Nephelometric Turbidity Units
ODO	Optical Dissolved Oxygen
ODOsat	Optical Dissolved Oxygen in terms of saturation
PACN	Pacific Island Inventory and Monitoring Network
ppt	Parts Per Thousand
SD	Standard Deviation
SE	Standard Error
SpC	Specific conductivity
TDN	Total Dissolved Nitrogen
TDP	Total Dissolved Phosphorus
Temp	Temperature
Turb	Turbidity
UHH	University of Hawai'i at Hilo

Introduction

Water quality is widely used as an indicator of aquatic ecosystem condition. The National Park Service (NPS) has designated water quality as a “Vital Sign”, or an indicator of physical, chemical, biological elements or ecosystem processes selected to represent the overall health or condition of natural resources within parks. Water quality is one Vital Sign monitored by the NPS Inventory and Monitoring (I&M) Pacific Island Network (PACN). This report presents data collected under the PACN water quality protocol (Jones et al. 2011) on anchialine pools in Kaloko-Honokōhau National Historical Park on the island of Hawai’i, Hawaii, between 2007-2011.

Anchialine pools are spatially distinct waterbodies subject to tides and fed both by freshwater and seawater groundwater inputs (Holthuis 1973). While anchialine pools have no regular overland input of water, and no direct connection to the sea, exceptional events like tsunamis can introduce water to anchialine pools. Within this broad definition, the geomorphology of anchialine pools is quite variable, including pools in caves, pools in open pits, and pools at the surface. Size, canopy cover, substrate including lava, sand, or organic sediment, extent of macrophyte vegetation, periphyton, or other algae, presence of fish and/or native shrimp, exposure to sunlight, and alteration by humans, both historical and contemporary, vary greatly between pools. The Kona coast of the big island of Hawai’i, Hawaii, USA has a large number of anchialine pools.

This report is a Natural Resource Data Series Report (NRDS), defined by the NPS as an annual or periodic data summary report for long-term monitoring projects. NRDSs are intended only for the release of basic data sets and summaries, with minimal interpretation. This report is one part of the I&M reporting process. Data presented in this report will be incorporated into future I&M trend-analysis reports to be published as NPS Natural Resource Technical Reports (NRTR).

The mission of the I&M Program is to provide data to inform management decisions and support the NPS mission of preserving the natural resources of parks unimpaired for the enjoyment of future generations (16 U.S.C. §1). The purpose of collecting data on Vital Signs is to provide park managers information on current conditions and temporal trends in ecosystem health. The primary purposes of the water monitoring protocol are to characterize the ecosystem and identify existing problems, and identify temporal trends especially with regard to emerging problems. Park managers can use this information to respond to resource conditions and evaluate management actions.

Methods

Water was collected for nutrient analyses, a sonde was used to measure limnological parameters, and weather conditions were recorded. Data were collected using methods described in version 1.0 of the PACN water quality protocol (Jones et al. 2011). There are no inland water quality criteria for anchialine pools under §11-54-5.1b of the State of Hawaii Department of Health Water Quality Standards (Hawaii 2012).

Sample Sites

Kaloko-Honokōhau National Historical Park is located on the Kona coast of the big island of Hawai'i (Figs. 1-8). Park-designated site names are used primarily in this report while I&M-designated site names are used secondarily. Site names used by I&M are formatted to designate fixed or temporary sites ("F" or "T" respectively), park designation (KAHO), a number (e.g. 01), and habitat type ("ap" for anchialine pool); e.g. "FKAHO01_ap" (Table 1). Names for temporary sites are based on the date of sampling and not presented in this report. Fixed sites were sampled during quarterly sampling trips. A new set of four temporary sites were chosen at random for each quarterly trip. Because anchialine pools are sensitive ecological and archeological sites, their precise locations are not published here. Data were collected from May 2008 - October 2011 (Table 2).

HA_Kaloko_005 (FKAHO01_ap) is a small shallow pool exposed to direct sunlight for most of the day in an a'a lava field with no vegetation. HA_Kaloko_016 (FKAHO02_ap) is a small pool at the bottom of a pit in an a'a lava field and receives limited direct sunlight. HA_Kealak_084 (FKAHO03_ap) is several meters wide and although surrounded by sloping lava walls, is largely exposed to direct sunlight. HA_Kealak_084 supports a population of the macroalga *Ulva reticulata*. HA_Kaloko_119 (FKAHO04_ap) is a small pool about 1.5 meters deep at the bottom of an open pit several meters deep, and receives direct sunlight only for a short period of the day. This pool hosts fish, possibly the non-native mosquitofish, *Gambusia affinis*. Grasses cover the surrounding area near HA_Kaloko_119.

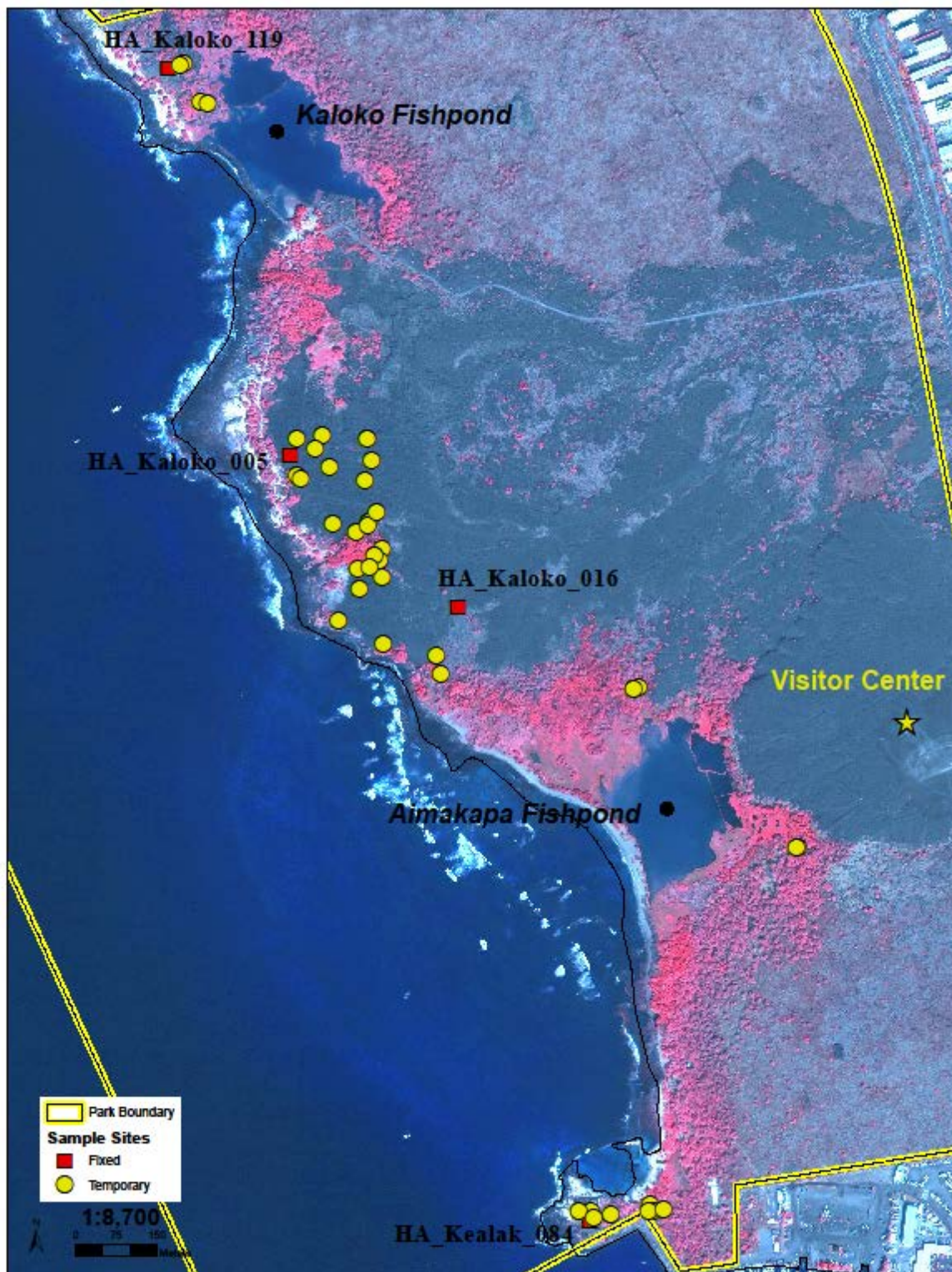


Figure 1. Sample sites in Kaloko-Honokōhau National Historical Park. This photo is a color infrared image where plants appear pink.

Table 1. Kaloko-Honokōhau NHP sampling events.

Year	Date	Personnel
2008	15-May-08	Anne Farahi, Lindsey Kramer, Rebecca Most
2008	24-Sep-08	Lindsey Kramer, Rebecca Most, Tahzay Jones
2008	14-Oct-08	Anne Farahi, Eric Brown, Lindsey Kramer, Rebecca Most, Tahzay Jones
2009	24-Feb-09	Lindsey Kramer, Rebecca Most, Sam Dewhirst
2009	28-Apr-09	Deona Naboa, Lindsey Kramer, Rebecca Most
2009	24-Jul-09	Cassandra Ogura-Yamada, Colleen McHugh, Lindsey Kramer, Rebecca Most
2009	29-Oct-09	Lindsey Kramer, Lisa Nelson
2010	19-Jan-10	Anne Farahi, Lindsey Kramer
2010	01-Feb-10	Janette Gillespie, Lindsey Kramer, Russ Gillespie
2010	14-Apr-10	Janette Gillespie, Lily Souza, Lindsey Kramer, Michelle Tomas, Russ Gillespie
2010	14-Jul-10	Brianne Billups, Colleen McHugh, Lindsey Kramer, Russ Gillespie
2010	19-Nov-10	Anne Farahi, Lindsey Kramer, M. Jerolaman
2011	24-Jan-11	Lindsey Kramer, M. Jerolaman, Russ Gillespie, Tim Knaus
2011	28-Apr-11	Anne Farahi, M. Jerolaman
2011	09-Aug-11	Anne Farahi, Danielle Gross, Sallie Beavers, Tonnie Casey
2011	27-Oct-11	Anne Farahi, Danielle Gross, Joe Bybee

Water Collection

Water was collected using a new or acid-washed 140 cc syringe just below the stream surface to avoid disturbance of sediment on the bottom or collection of floating material. This water was then discarded away from the collection location to rinse the syringe. Water was again collected using the rinsed syringe. An in-line filter holder and 0.7 µm filter were then placed on the syringe. Filtered water was used to rinse each sample bottle three times, for a total of 50ml per bottle, discarding water between each rinse. The filter assembly was removed, water again was drawn into the syringe, and a filter assembly was placed onto the syringe to input 140ml of filtered water into each sample bottle. Three 140ml samples were taken at each sample site. Sample bottles were placed on ice in the field inside an insulated backpack. Samples were transported to Hawai'i Volcanoes National Park on the day of collection and then frozen, or deposited into a freezer on the day of collection and later transported while frozen to Hawaii Volcanoes National Park. Samples were then delivered to the EPSCoR Analytical Laboratory at the University of Hawai'i at Hilo (UHH) Marine Science Department, 200 W. Kawili St., Hilo, Hawaii 96720 for chemical analysis. Samples were analyzed for total dissolved phosphorous (TDP), total dissolved nitrogen (TDN) and nitrate + nitrite (NO₃ + NO₂).

Limnological Parameters and General Conditions

A YSI 6600 Multiparameter Sonde was calibrated a few days before commencing field sampling. The sonde was used to measure temperature (°C), specific conductivity (SpC) in milli-Siemens per centimeter (mS cm⁻¹), pH, optical dissolved oxygen in milligrams per liter (mg · L⁻¹, ODO), chlorophyll in micrograms per liter (µg · L⁻¹), and turbidity in nephelometric turbidity units (NTU). The sonde also reported salinity in parts per thousand (ppt) calculated from SpC, dissolved oxygen in percent saturation (% ODOsat) calculated from ODO, and temperature. The

sonde was placed under the surface of the water at a sample site for ten minutes with readings taken every 30 seconds. The mean and variance of stable values, excluding initial readings prior to reaching stability, over this time period is reported. Minimum analytical detection limits were $15.0 \mu\text{gP} \cdot \text{L}^{-1}$ for total dissolved phosphorus (TDP), $0.070 \text{ mgN} \cdot \text{L}^{-1}$ for total dissolved nitrogen (TDN), and $1.0 \mu\text{gN} \cdot \text{L}^{-1}$ for nitrate + nitrite ($\text{NO}_3 + \text{NO}_2$).

Environmental conditions, canopy cover, and water depth were estimated. Average wind speed over three minutes and wind direction were measured using a Kestrel wind speed device. Global positioning system coordinates and site elevation were recorded. Photographs of sample sites were also taken.

Data Analysis, Management, and Quality Control

Environmental parameters, habitat descriptions, and general observations were recorded on datasheets in the field. Datasheets were stored at park offices, scanned, and uploaded to PACN servers. All data including results of laboratory analyses were entered into PACN databases. Data were downloaded from the YSI 650 control unit and uploaded to databases. Accuracy of data entry into databases was verified by comparing database entries to the original datasheets by a person who did not enter the data into databases. Data were then certified by the PACN freshwater program lead at the time, either Tazhay Jones or David Raikow. Data determined to be unreliable were flagged in databases, removed from further consideration. Data were explored visually by plotting time-series and boxplots. Data that deviated from regular temporal patterns were identified. Corroboration between related parameters and field notes was used to identify possible causes of deviation from regular temporal patterns. Statistical analysis of water quality data followed recommendations by the USGS (Helsel and Hirsch 2002) as described in the protocol (Jones et al. 2011).

Measurements from a series of water samples or sonde readings taken at an individual site within minutes of each other were expected to be normally distributed around the true value of the parameter, because the parameter should not change appreciably over the 10 minutes required to take multiple samples or readings. Variation in sample values should be most influenced by external factors. Therefore the mean and the standard error are reported for individual sampling events because the accuracy of the estimate of the mean is of interest (Tables 7-17). Non-normal distributions, however, are generally expected when summarizing limnological conditions over a time period such as a year due to censoring (values cannot drop below zero or have a minimum analytical detection limit) and positive skewness (having infrequent high values) (Helsel and Hirsch 2002). Therefore the median and standard deviation are reported for annual summaries, because the variance of the parameter over the study period is of interest (Tables 3-6). The median equals the mean in normally-distributed parameters. For the purposes of descriptive statistics, values below detection limits were assigned values equal to one-half of the detection limit. Standard deviation was not calculated for sets of data with $n \leq 2$.

Within boxplots, the upper edge of the box indicates the third quartile (Q3, upper quartile, or 75th percentile), and the lower edge indicates the first quartile (Q1, lower quartile, or 25th percentile, Fig. 2). Within the box, the line indicates the median (Q2, or 50th percentile). The whiskers extend up or down until the maximum or minimum value within 1.5 IQRs (inter-

quartile range, or $Q_3 - Q_1$). Data outside 1.5 IQRs are displayed as dots, and considered outliers. If there are no outliers the box or whiskers display the entire range of data.

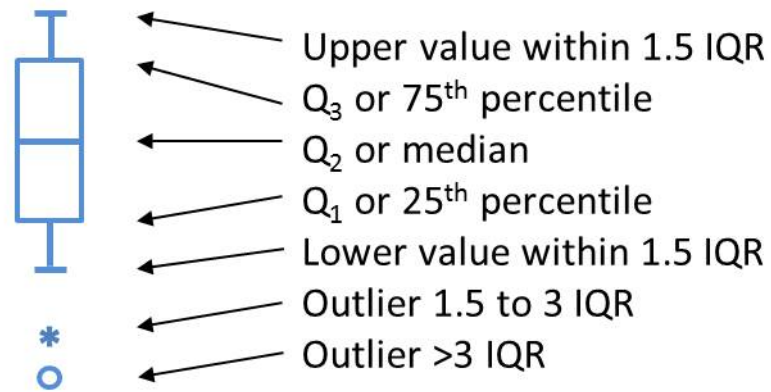


Figure 2. Box plot explanation.

Results

Fixed sites in Kaloko-Honokōhau NHP were sampled up to 14 times from 2008 to 2011, while temporary sites were sampled one to three times. Results for fixed sites are presented in summaries by year (Tables 2-5, Figs. 10-20) and parameter (Tables 6-16). Annual summaries present the minimum, maximum, median, and variance as standard deviation of all individual measurements at each site across an entire year. Parameter summaries present stable sonde readings and nutrient concentrations from each site and sampling event as mean and standard error of the mean. Temporary sites are summarized by individual sampling event. Box plots display individual replicate data lumped from all sampling events within a year. Data missing from tables 6-16 were due to probe failure or the pool not being sampled on that date.

HA_Kaloko_005 (FKAHO01_ap)

2008: No notable events were observed.
2009: No notable events were observed.
2010: No notable events were observed.
2011: No notable events were observed.

HA_Kaloko_016 (FKAHO02_ap)

2008: No notable events were observed.
2009: No notable events were observed.
2010: No notable events were observed.
2011: No notable events were observed.

HA_Kealak_084 (FKAHO03_ap)

2008: No notable events were observed.
2009: No notable events were observed.
2010: No notable events were observed.
2011: An algal bloom may have occurred as indicated by chlorophyll.

HA_Kaloko_119 (FKAHO04_ap)

2008: No notable events were observed.
2009: Elevated dissolved nitrogen levels were measured.
2010: No notable events were observed.
2011: An algal bloom may have occurred as indicated by chlorophyll.

Table 2. 2008 summary of water quality parameters in Kaloko-Honokōhau NHP anchialine pools.

Parameter	Unit	Site	n	Minimum	Maximum	Median	SD
Total Dissolved Phosphorus	$\mu\text{gP} \cdot \text{L}^{-1}$	HA_Kaloko_005	6	55.0	83.0	63.0	9.55
		HA_Kaloko_016	6	58.0	99.0	80.5	15.04
		HA_Kealak_084	6	7.0	37.0	17.5	10.25
		HA_Kaloko_119	6	50.0	80.0	66.5	11.47
		HA_Kaloko_011	3	66.0	82.0	81.0	8.96
		HA_Kaloko_009	3	62.0	81.0	74.0	9.61
		HA_Honoko_029	3	54.0	67.0	59.0	6.56
		HA_Honoko_018	3	61.0	94.0	68.0	17.39
		HA_Kealak_083B	3	78.0	94.0	87.0	8.02
		HA_Kaloko_066	3	76.0	81.0	79.0	2.52
		HA_Kaloko_133B	3	63.0	71.0	68.0	4.04
		HA_Kaloko_128	3	49.0	59.0	50.0	5.51
Total Dissolved Nitrogen	$\text{mgN} \cdot \text{L}^{-1}$	HA_Kaloko_005	6	0.5	1.0	0.7	0.18
		HA_Kaloko_016	6	0.8	1.1	0.9	0.16
		HA_Kealak_084	6	0.1	0.3	0.2	0.04
		HA_Kaloko_119	6	0.6	1.1	0.8	0.17
		HA_Kaloko_011	3	0.8	1.0	1.0	0.12
		HA_Kaloko_009	3	0.7	1.1	0.9	0.17
		HA_Honoko_029	3	0.7	1.4	0.8	0.39
		HA_Honoko_018	3	0.5	0.9	0.6	0.22
		HA_Kealak_083B	3	0.4	0.7	0.5	0.12
		HA_Kaloko_066	3	0.9	1.1	1.1	0.11
		HA_Kaloko_133B	3	0.7	0.8	0.8	0.02
		HA_Kaloko_128	3	0.4	0.6	0.5	0.09
Nitrite + Nitrate	$\mu\text{gN} \cdot \text{L}^{-1}$	HA_Kaloko_005	6	447.0	833.0	577.5	138.27
		HA_Kaloko_016	6	410.0	979.0	716.0	200.14
		HA_Kealak_084	6	57.0	125.0	70.0	24.22
		HA_Kaloko_119	6	510.0	907.0	713.0	153.28
		HA_Kaloko_011	3	582.0	786.0	733.0	105.85
		HA_Kaloko_009	3	644.0	918.0	915.0	157.34
		HA_Honoko_029	3	445.0	549.0	502.0	52.08
		HA_Honoko_018	3	367.0	713.0	516.0	173.55
		HA_Kealak_083B	3	318.0	610.0	426.0	147.64
		HA_Kaloko_066	3	770.0	946.0	853.0	88.05
		HA_Kaloko_133B	3	630.0	643.0	633.0	6.81
		HA_Kaloko_128	3	313.0	471.0	397.0	79.05
Chlorophyll	$\mu\text{g} \cdot \text{L}^{-1}$	HA_Kaloko_005	2	0.0	0.2	0.1	
		HA_Kaloko_016	2	0.1	0.2	0.1	
		HA_Kealak_084	2	0.0	1.4	0.7	
		HA_Kaloko_119	2	0.5	0.6	0.5	
		HA_Kaloko_011	1	0.3	0.3	0.0	
		HA_Kaloko_009	1	0.1	0.1	0.0	
		HA_Honoko_029	1	0.3	0.3	0.0	
		HA_Honoko_018	1	2.1	2.1	0.0	
		HA_Kealak_083B	1	1.1	1.1	0.0	
		HA_Kaloko_066	1	0.3	0.3	0.0	
		HA_Kaloko_133B	1	0.9	0.9	0.0	
		HA_Kaloko_128	1	1.1	1.1	0.0	

Table 2. 2008 summary of water quality parameters in Kaloko-Honokōhau NHP anchialine pools (continued).

Parameter	Unit	Site	n	Minimum	Maximum	Median	SD
Dissolved Oxygen Concentration	mg · L ⁻¹	HA_Kaloko_005	2	7.5	7.8	7.7	
		HA_Kaloko_016	2	8.1	8.4	8.3	
		HA_Kealak_084	2	13.7	14.8	14.2	
		HA_Kaloko_119	2	6.1	6.3	6.2	
		HA_Kaloko_011	1	7.8	7.8	0.0	
		HA_Kaloko_009	1	7.3	7.3	0.0	
		HA_Honoko_029	1	7.4	7.4	0.0	
		HA_Honoko_018	1	3.2	3.2	0.0	
		HA_Kealak_083B	1	5.4	5.4	0.0	
		HA_Kaloko_066	1	6.1	6.1	0.0	
		HA_Kaloko_133B	1	5.3	5.3	0.0	
		HA_Kaloko_128	1	4.5	4.5	0.0	
Dissolved Oxygen Saturation	%	HA_Kaloko_005	2	90.3	94.8	92.5	
		HA_Kaloko_016	2	94.3	98.7	96.5	
		HA_Kealak_084	1	175.5	175.5	0.0	
		HA_Kaloko_119	2	74.9	75.8	75.3	
		HA_Kaloko_011	1	90.8	90.8	0.0	
		HA_Kaloko_009	1	85.9	85.9	0.0	
		HA_Honoko_029	1	85.6	85.6	0.0	
		HA_Honoko_018	1	39.4	39.4	0.0	
		HA_Kaloko_066	1	73.2	73.2	0.0	
		HA_Kaloko_133B	1	64.0	64.0	0.0	
		HA_Kaloko_128	1	56.4	56.4	0.0	
pH	none	HA_Kaloko_005	2	7.9	7.9	7.9	
		HA_Kaloko_016	2	7.9	7.9	7.9	
		HA_Kealak_084	2	8.2	8.4	8.3	
		HA_Kaloko_119	2	7.3	7.3	7.3	
		HA_Kaloko_011	1	7.8	7.8	0.0	
		HA_Kaloko_009	1	7.8	7.8	0.0	
		HA_Honoko_029	1	7.8	7.8	0.0	
		HA_Honoko_018	1	7.2	7.2	0.0	
		HA_Kealak_083B	1	7.3	7.3	0.0	
		HA_Kaloko_066	1	7.7	7.7	0.0	
		HA_Kaloko_133B	1	7.2	7.2	0.0	
		HA_Kaloko_128	1	7.2	7.2	0.0	
Salinity	ppt	HA_Kaloko_005	2	13.5	13.7	13.6	
		HA_Kaloko_016	2	7.4	9.2	8.3	
		HA_Kealak_084	2	11.6	21.4	16.5	
		HA_Kaloko_119	2	12.6	14.0	13.3	
		HA_Kaloko_011	1	7.6	7.6	0.0	
		HA_Kaloko_009	1	13.4	13.4	0.0	
		HA_Honoko_029	1	8.7	8.7	0.0	
		HA_Honoko_018	1	11.5	11.5	0.0	
		HA_Kealak_083B	1	17.3	17.3	0.0	
		HA_Kaloko_066	1	13.5	13.5	0.0	
		HA_Kaloko_133B	1	13.6	13.6	0.0	

Table 2. 2008 summary of water quality parameters in Kaloko-Honokōhau NHP anchialine pools (continued).

Parameter	Unit	Site	n	Minimum	Maximum	Median	SD
Specific conductance	mS · cm ⁻¹	HA_Kaloko_128	1	18.3	18.3	0.0	
		HA_Kaloko_005	2	22.3	22.7	22.5	
		HA_Kaloko_016	2	12.9	15.7	14.3	
		HA_Kealak_084	2	19.4	34.2	26.8	
		HA_Kaloko_119	2	21.1	23.1	22.1	
		HA_Kaloko_011	1	13.2	13.2	0.0	
		HA_Kaloko_009	1	22.2	22.2	0.0	
		HA_Honoko_029	1	14.9	14.9	0.0	
		HA_Honoko_018	1	19.3	19.3	0.0	
		HA_Kealak_083B	1	28.1	28.1	0.0	
		HA_Kaloko_066	1	22.3	22.3	0.0	
		HA_Kaloko_133B	1	22.5	22.5	0.0	
		HA_Kaloko_128	1	29.6	29.6	0.0	
Temperature	°C	HA_Kaloko_005	2	20.4	20.9	20.6	
		HA_Kaloko_016	2	19.8	20.9	20.4	
		HA_Kealak_084	2	24.6	24.9	24.8	
		HA_Kaloko_119	2	20.4	21.1	20.8	
		HA_Kaloko_011	1	20.8	20.8	0.0	
		HA_Kaloko_009	1	19.8	19.8	0.0	
		HA_Honoko_029	1	19.8	19.8	0.0	
		HA_Honoko_018	1	22.6	22.6	0.0	
		HA_Kealak_083B	1	20.6	20.6	0.0	
		HA_Kaloko_066	1	20.7	20.7	0.0	
		HA_Kaloko_133B	1	20.8	20.8	0.0	
		HA_Kaloko_128	1	21.6	21.6	0.0	
Turbidity	NTU	HA_Kaloko_005	2	0.0	0.0	0.0	
		HA_Kaloko_016	2	0.0	0.0	0.0	
		HA_Kealak_084	2	0.0	0.0	0.0	
		HA_Kaloko_119	2	0.0	0.0	0.0	
		HA_Kaloko_011	1	0.0	0.0	0.0	
		HA_Kaloko_009	1	0.0	0.0	0.0	
		HA_Honoko_029	1	0.0	0.0	0.0	
		HA_Honoko_018	1	1.2	1.2	0.0	
		HA_Kealak_083B	1	0.0	0.0	0.0	
		HA_Kaloko_066	1	0.0	0.0	0.0	
		HA_Kaloko_133B	1	0.0	0.0	0.0	

Table 3. 2009 summary of water quality parameters in Kaloko-Honokōhau NHP anchialine pools.

Parameter	Unit	Site	N	Minimum	Maximum	Median	SD
Total Dissolved Phosphorus	$\mu\text{gP} \cdot \text{L}^{-1}$	HA_Kaloko_005	12	54.0	96.3	71.4	13.20
		HA_Kaloko_016	12	66.0	121.8	99.5	17.27
		HA_Kealak_084	12	15.0	47.2	29.0	10.55
		HA_Kaloko_119	12	34.0	83.2	59.0	15.27
		HA_Kaloko_013	3	55.0	75.0	69.0	10.26
		HA_Honoko_037	3	49.0	59.0	49.0	5.77
		HA_Honoko_021	3	49.6	77.4	65.9	13.94
		HA_Honoko_020	3	97.5	104.0	101.9	3.32
		HA_Kaloko_032	3	44.0	60.0	51.0	8.02
		HA_Kealak_097	3	54.6	83.3	71.2	14.42
		HA_Kealak_85a	3	18.2	22.7	22.3	2.47
		HA_Kaloko_044	3	62.0	74.0	62.0	6.93
		HA_Kaloko_53B	3	44.0	73.0	60.0	14.53
		HA_Kaloko_009	3	76.0	82.0	80.6	3.10
		HA_Kaloko_046	3	99.5	99.6	99.5	0.04
		HA_Kaloko_053E	3	73.0	82.0	81.0	4.93
		HA_Kaloko_012	3	74.4	75.8	74.8	0.73
		HA_Kaloko_053H	3	91.3	126.5	107.6	17.59
		HA_Kaloko_118	3	59.0	75.0	69.0	8.08
Total Dissolved Nitrogen	$\text{mgN} \cdot \text{L}^{-1}$	HA_Kaloko_005	12	0.5	1.1	0.8	0.18
		HA_Kaloko_016	12	0.8	1.2	1.0	0.15
		HA_Kealak_084	12	0.1	0.3	0.2	0.06
		HA_Kaloko_119	12	0.7	2.1	1.5*	0.42
		HA_Kaloko_013	3	0.8	1.0	0.9	0.08
		HA_Honoko_037	3	0.6	0.7	0.7	0.06
		HA_Honoko_021	3	0.4	1.0	0.8	0.29
		HA_Honoko_020	3	0.9	0.9	0.9	0.02
		HA_Kaloko_032	3	0.6	0.9	0.6	0.15
		HA_Kealak_097	3	0.5	0.7	0.5	0.14
		HA_Kealak_85a	3	0.2	0.3	0.2	0.05
		HA_Kaloko_044	3	0.6	0.8	0.7	0.10
		HA_Kaloko_53B	3	0.6	0.8	0.7	0.12
		HA_Kaloko_009	3	1.0	1.1	1.0	0.04
		HA_Kaloko_046	3	1.0	1.0	1.0	0.02
		HA_Kaloko_053E	3	0.9	1.1	1.1	0.10
		HA_Kaloko_012	3	0.9	1.0	0.9	0.04
		HA_Kaloko_053H	3	0.6	1.2	0.9	0.30
		HA_Kaloko_118	3	1.9	3.0	2.6	0.57

Table 3. 2009 summary of water quality parameters in Kaloko-Honokōhau NHP anchialine pools (continued).

Parameter	Unit	Site	n	Minimum	Maximum	Median	SD
Nitrite + Nitrate	$\mu\text{gN} \cdot \text{L}^{-1}$	HA_Kaloko_005	12	505.0	994.1	714.5	179.17
		HA_Kaloko_016	12	633.5	1181.8	929.6	197.53
		HA_Kealak_084	12	18.0	152.0	93.6	40.31
		HA_Kaloko_119	12	777.2	1940.0	1360.6*	339.84
		HA_Kaloko_013	3	699.0	872.0	755.0	88.27
		HA_Honoko_037	3	386.0	400.0	399.0	7.81
		HA_Honoko_021	3	469.4	1022.3	806.7	278.71
		HA_Honoko_020	3	946.5	997.3	978.7	25.70
		HA_Kaloko_032	3	443.0	581.0	475.0	72.23
		HA_Kealak_097	3	388.0	701.3	457.8	164.46
		HA_Kealak_85a	3	88.3	97.1	95.8	4.77
		HA_Kaloko_044	3	528.0	705.0	656.0	91.39
		HA_Kaloko_53B	3	532.0	634.0	602.0	52.17
		HA_Kaloko_009	3	986.5	1041.4	999.9	28.63
		HA_Kaloko_046	3	991.2	1015.8	992.3	13.90
		HA_Kaloko_053E	3	757.0	945.0	885.0	96.03
		HA_Kaloko_012	3	939.0	962.5	943.7	12.45
		HA_Kaloko_053H	3	641.0	1311.5	890.6	338.86
		HA_Kaloko_118	3	1711.0	2744.0	2358.0	521.97
Chlorophyl-a	$\mu\text{g} \cdot \text{L}^{-1}$	HA_Kaloko_005	4	0.0	0.4	0.0	0.21
		HA_Kaloko_016	3	0.0	0.5	0.2	0.26
		HA_Kealak_084	3	0.3	0.9	0.4	0.30
		HA_Kaloko_119	4	0.0	0.9	0.2	0.41
		HA_Kaloko_013	1	0.8	0.8	0.0	
		HA_Honoko_021	1	0.0	0.0	0.0	
		HA_Honoko_020	1	0.0	0.0	0.0	
		HA_Kaloko_032	1	0.2	0.2	0.0	
		HA_Kealak_85a	1	0.7	0.7	0.0	
		HA_Kaloko_044	1	0.2	0.2	0.0	
		HA_Kaloko_53B	1	0.6	0.6	0.0	
		HA_Kaloko_009	1	0.0	0.0	0.0	
		HA_Kaloko_046	1	0.2	0.2	0.0	
		HA_Kaloko_053E	1	0.0	0.0	0.0	
		HA_Kaloko_012	1	0.0	0.0	0.0	
		HA_Kaloko_053H	1	0.2	0.2	0.0	
		HA_Kaloko_118	1	0.6	0.6	0.0	

Table 3. 2009 summary of water quality parameters in Kaloko-Honokōhau NHP anchialine pools (continued).

Parameter	Unit	Site	n	Minimum	Maximum	Median	SD
Dissolved Oxygen Concentration	mg · L ⁻¹	HA_Kaloko_005	4	7.5	8.3	7.9	0.35
		HA_Kaloko_016	4	7.5	8.4	8.0	0.39
		HA_Kealak_084	4	5.6	20.4	14.7	6.12
		HA_Kaloko_119	4	6.6	7.2	6.6	0.29
		HA_Kaloko_013	1	7.9	7.9	0.0	
		HA_Honoko_021	1	6.7	6.7	0.0	
		HA_Honoko_020	1	7.7	7.7	0.0	
		HA_Kaloko_032	1	6.6	6.6	0.0	
		HA_Kealak_097	1	9.1	9.1	0.0	
		HA_Kaloko_044	1	7.5	7.5	0.0	
		HA_Kaloko_53B	1	7.0	7.0	0.0	
		HA_Kaloko_009	1	7.5	7.5	0.0	
		HA_Kaloko_046	1	6.9	6.9	0.0	
		HA_Kaloko_053E	1	6.7	6.7	0.0	
		HA_Kaloko_012	1	8.4	8.4	0.0	
		HA_Kaloko_053H	1	7.9	7.9	0.0	
		HA_Kaloko_118	1	6.4	6.4	0.0	
Dissolved Oxygen Saturation	%	HA_Kaloko_005	4	90.9	100.4	96.5	4.42
		HA_Kaloko_016	4	87.3	96.6	93.7	4.44
		HA_Kealak_084	3	79.1	242.7	207.3	86.09
		HA_Kaloko_119	4	80.2	85.1	81.6	2.09
		HA_Kaloko_013	1	95.8	95.8	0.0	
		HA_Honoko_021	1	79.8	79.8	0.0	
		HA_Honoko_020	1	90.9	90.9	0.0	
		HA_Kaloko_032	1	76.6	76.6	0.0	
		HA_Kealak_097	1	123.8	123.8	0.0	
		HA_Kaloko_044	1	88.8	88.8	0.0	
		HA_Kaloko_53B	1	82.5	82.5	0.0	
		HA_Kaloko_009	1	88.9	88.9	0.0	
		HA_Kaloko_046	1	81.4	81.4	0.0	
		HA_Kaloko_053E	1	80.3	80.3	0.0	
		HA_Kaloko_012	1	104.7	104.7	0.0	
		HA_Kaloko_053H	1	91.5	91.5	0.0	
		HA_Kaloko_118	1	75.7	75.7	0.0	

Table 3. 2009 summary of water quality parameters in Kaloko-Honokōhau NHP anchialine pools (continued).

Parameter	Unit	Site	n	Minimum	Maximum	Median	SD
pH	none	HA_Kaloko_005	4	7.8	8.1	7.9	0.11
		HA_Kaloko_016	4	7.8	8.1	7.9	0.11
		HA_Kealak_084	4	7.8	9.0	8.4	0.53
		HA_Kaloko_119	4	7.4	7.6	7.5	0.14
		HA_Kaloko_013	1	7.9	7.9	0.0	
		HA_Honoko_037	1	8.2	8.2	0.0	
		HA_Honoko_021	1	7.7	7.7	0.0	
		HA_Honoko_020	1	7.8	7.8	0.0	
		HA_Kaloko_032	1	7.7	7.7	0.0	
		HA_Kealak_097	1	7.7	7.7	0.0	
		HA_Kealak_85a	1	8.1	8.1	0.0	
		HA_Kaloko_044	1	7.9	7.9	0.0	
		HA_Kaloko_53B	1	7.9	7.9	0.0	
		HA_Kaloko_009	1	7.8	7.8	0.0	
		HA_Kaloko_046	1	7.8	7.8	0.0	
		HA_Kaloko_053E	1	7.9	7.9	0.0	
		HA_Kaloko_012	1	7.9	7.9	0.0	
		HA_Kaloko_053H	1	7.8	7.8	0.0	
		HA_Kaloko_118	1	7.4	7.4	0.0	
Salinity	ppt	HA_Kaloko_005	4	13.6	15.0	14.0	0.58
		HA_Kaloko_016	4	9.7	10.4	10.2	0.33
		HA_Kealak_084	4	21.8	23.8	23.6	0.93
		HA_Kaloko_119	4	14.2	15.1	14.8	0.35
		HA_Kaloko_013	1	13.1	13.1	0.0	
		HA_Honoko_037	1	9.5	9.5	0.0	
		HA_Honoko_021	1	13.6	13.6	0.0	
		HA_Honoko_020	1	12.0	12.0	0.0	
		HA_Kaloko_032	1	11.6	11.6	0.0	
		HA_Kealak_097	1	15.0	15.0	0.0	
		HA_Kealak_85a	1	25.3	25.3	0.0	
		HA_Kaloko_044	1	13.8	13.8	0.0	
		HA_Kaloko_53B	1	12.2	12.2	0.0	
		HA_Kaloko_009	1	14.0	14.0	0.0	
		HA_Kaloko_046	1	13.5	13.5	0.0	
		HA_Kaloko_053E	1	12.2	12.2	0.0	
		HA_Kaloko_012	1	13.5	13.5	0.0	
		HA_Kaloko_053H	1	9.4	9.4	0.0	
		HA_Kaloko_118	1	14.1	14.1	0.0	

Table 3. 2009 summary of water quality parameters in Kaloko-Honokōhau NHP anchialine pools (continued).

Parameter	Unit	Site	n	Minimum	Maximum	Median	SD
Specific Conductance	mS · cm ⁻¹	HA_Kaloko_005	4	22.5	24.6	23.2	0.89
		HA_Kaloko_016	4	16.5	17.6	17.3	0.52
		HA_Kealak_084	4	34.7	37.7	37.3	1.37
		HA_Kaloko_119	4	23.5	24.7	24.3	0.53
		HA_Kaloko_013	1	21.7	21.7	0.0	
		HA_Honoko_037	1	16.2	16.2	0.0	
		HA_Honoko_021	1	22.6	22.6	0.0	
		HA_Honoko_020	1	20.0	20.0	0.0	
		HA_Kaloko_032	1	19.4	19.4	0.0	
		HA_Kealak_097	1	24.7	24.7	0.0	
		HA_Kealak_85a	1	39.8	39.8	0.0	
		HA_Kaloko_044	1	22.9	22.9	0.0	
		HA_Kaloko_53B	1	20.4	20.4	0.0	
		HA_Kaloko_009	1	23.2	23.2	0.0	
		HA_Kaloko_046	1	22.3	22.3	0.0	
		HA_Kaloko_053E	1	20.4	20.4	0.0	
		HA_Kaloko_012	1	22.4	22.4	0.0	
		HA_Kaloko_053H	1	16.1	16.1	0.0	
		HA_Kaloko_118	1	23.2	23.2	0.0	
Temperature	°C	HA_Kaloko_005	4	20.1	21.8	20.8	0.73
		HA_Kaloko_016	4	19.3	20.4	20.0	0.55
		HA_Kealak_084	4	25.0	28.4	26.5	1.46
		HA_Kaloko_119	4	19.7	22.2	20.7	1.05
		HA_Kaloko_013	1	20.8	20.8	0.0	
		HA_Honoko_037	1	21.2	21.2	0.0	
		HA_Honoko_021	1	20.2	20.2	0.0	
		HA_Honoko_020	1	19.9	19.9	0.0	
		HA_Kaloko_032	1	19.4	19.4	0.0	
		HA_Kealak_097	1	26.5	26.5	0.0	
		HA_Kealak_85a	1	27.0	27.0	0.0	
		HA_Kaloko_044	1	19.9	19.9	0.0	
		HA_Kaloko_53B	1	19.5	19.5	0.0	
		HA_Kaloko_009	1	19.8	19.8	0.0	
		HA_Kaloko_046	1	19.5	19.5	0.0	
		HA_Kaloko_053E	1	19.4	19.4	0.0	
		HA_Kaloko_012	1	22.2	22.2	0.0	
		HA_Kaloko_053H	1	19.8	19.8	0.0	
		HA_Kaloko_118	1	19.5	19.5	0.0	

Table 3. 2009 summary of water quality parameters in Kaloko-Honokōhau NHP anchialine pools (continued).

Parameter	Unit	Site	n	Minimum	Maximum	Median	SD
Turbidity	NTU	HA_Kaloko_005	4	0.0	0.0	0.0	0.00
		HA_Kaloko_016	4	0.0	0.0	0.0	0.00
		HA_Kealak_084	4	0.0	1.6	0.0	0.80
		HA_Kaloko_119	4	0.0	0.0	0.0	0.00
		HA_Kaloko_013	1	0.0	0.0	0.0	
		HA_Honoko_037	1	2.0	2.0	0.0	
		HA_Honoko_021	1	0.0	0.0	0.0	
		HA_Honoko_020	1	0.0	0.0	0.0	
		HA_Kaloko_032	1	0.0	0.0	0.0	
		HA_Kealak_85a	1	0.2	0.2	0.0	
		HA_Kaloko_044	1	0.0	0.0	0.0	
		HA_Kaloko_53B	1	0.0	0.0	0.0	
		HA_Kaloko_009	1	0.0	0.0	0.0	
		HA_Kaloko_046	1	0.0	0.0	0.0	
		HA_Kaloko_053E	1	0.0	0.0	0.0	
		HA_Kaloko_012	1	0.0	0.0	0.0	
		HA_Kaloko_053H	1	0.0	0.0	0.0	
		HA_Kaloko_118	1	0.0	0.0	0.0	

* Elevated nitrogen levels.

Table 4. 2010 summary of water quality parameters in Kaloko-Honokōhau NHP anchialine pools.

Parameter	Unit	Loc_Name	N	Minimum	Maximum	Median	SD
Total Dissolved Phosphorus	$\mu\text{gP} \cdot \text{L}^{-1}$	HA_Kaloko_005	12	63.0	96.0	76.5	8.27
		HA_Kaloko_016	12	75.0	122.0	96.5	15.07
		HA_Kealak_084	12	15.0	52.0	22.5	14.06
		HA_Kaloko_119	12	44.0	80.0	61.0	9.73
		HA_Honoko_039	3	46.0	62.0	51.0	8.19
		HA_Kaloko_062	3	55.0	77.0	72.0	11.53
		HA_Kaloko_049	3	74.0	80.0	75.0	3.22
		HA_Kaloko_061	3	72.0	73.0	73.0	0.58
		HA_Kaloko_050	3	65.0	69.0	69.0	2.31
		HA_Kaloko_007	3	70.0	90.0	77.0	10.15
		HA_Kealak_088	3	38.0	61.0	58.0	12.50
		HA_Kaloko_055	3	43.0	86.0	71.0	21.83
		HA_Kaloko_057E	3	69.0	71.0	69.0	1.16
		HA_Kealak_083C	3	42.0	50.0	46.0	4.00
		HA_Kaloko_058	3	77.0	127.0	95.0	25.33
		HA_Kealak_095	3	91.0	139.0	121.0	24.25
		HA_Kealak_099	3	161.0	279.0	226.0	59.10
		HA_Kaloko_129	3	44.0	61.0	54.0	8.54
		HA_Kealak_096	3	91.0	120.0	98.0	15.13
Total Dissolved Nitrogen	$\text{mgN} \cdot \text{L}^{-1}$	HA_Kaloko_005	12	0.6	1.0	0.8	0.13
		HA_Kaloko_016	12	0.7	1.1	0.8	0.16
		HA_Kealak_084	12	0.2	0.4	0.3	0.08
		HA_Kaloko_119	12	0.8	1.2	1.0	0.16
		HA_Honoko_039	3	0.4	0.6	0.6	0.11
		HA_Kaloko_062	3	0.7	1.0	0.9	0.15
		HA_Kaloko_049	3	0.5	0.7	0.6	0.06
		HA_Kaloko_061	3	0.7	0.7	0.7	0.03
		HA_Kaloko_050	3	0.9	1.0	1.0	0.06
		HA_Kaloko_007	3	0.5	0.8	0.6	0.16
		HA_Kealak_088	3	0.4	0.6	0.6	0.13
		HA_Kaloko_055	3	0.6	1.0	0.9	0.21
		HA_Kaloko_057E	3	1.0	1.0	1.0	0.03
		HA_Kealak_083C	3	0.4	0.5	0.4	0.06
		HA_Kaloko_058	3	0.5	1.2	0.8	0.30
		HA_Kealak_095	3	0.5	0.7	0.7	0.11
		HA_Kealak_099	3	1.2	3.2	2.5	0.98
		HA_Kaloko_129	3	0.4	0.7	0.6	0.16
		HA_Kealak_096	3	0.6	0.9	0.6	0.18

Table 4. 2010 summary of water quality parameters in Kaloko-Honokōhau NHP anchialine pools (continued).

Parameter	Unit	Site	n	Minimum	Maximum	Median	SD
Nitrite + Nitrate	$\mu\text{gN} \cdot \text{L}^{-1}$	HA_Kaloko_005	12	613.0	990.0	769.5	131.44
		HA_Kaloko_016	12	648.0	1080.0	788.0	181.03
		HA_Kealak_084	12	10.0	178.0	67.5	71.60
		HA_Kaloko_119	12	600.0	1042.0	854.5	163.29
		HA_Honoko_039	3	280.0	489.0	465.0	114.37
		HA_Kaloko_062	3	641.0	948.0	884.0	161.96
		HA_Kaloko_049	3	547.0	630.0	595.0	41.67
		HA_Kaloko_061	3	697.0	734.0	706.0	19.30
		HA_Kaloko_050	3	858.0	933.0	932.0	43.02
		HA_Kaloko_007	3	487.0	761.0	576.0	139.78
		HA_Kealak_088	3	308.0	496.0	427.0	95.10
		HA_Kaloko_055	3	627.0	980.0	976.0	202.66
		HA_Kaloko_057E	3	986.0	990.0	988.0	2.00
		HA_Kealak_083C	3	315.0	398.0	321.0	46.29
		HA_Kaloko_058	3	604.0	1049.0	736.0	228.55
		HA_Kealak_095	3	249.0	487.0	367.0	119.00
		HA_Kealak_099	3	805.0	2149.0	1952.0	725.81
		HA_Kaloko_129	3	342.0	538.0	511.0	106.23
		HA_Kealak_096	3	391.0	641.0	401.0	141.54
Chlorophyll	$\mu\text{g} \cdot \text{L}^{-1}$	HA_Kaloko_005	4	0.0	0.4	0.0	0.19
		HA_Kaloko_016	3	0.0	0.1	0.0	0.06
		HA_Kealak_084	2	0.6	3.0	1.8	
		HA_Kaloko_119	4	0.0	1.9	0.4	0.91
		HA_Honoko_039	1	1.2	1.2	0.0	
		HA_Kaloko_067	1	0.0	0.0	0.0	
		HA_Kaloko_062	1	0.2	0.2	0.0	
		HA_Kaloko_049	1	0.1	0.1	0.0	
		HA_Kaloko_061	1	0.0	0.0	0.0	
		HA_Kaloko_050	1	0.0	0.0	0.0	
		HA_Kaloko_007	1	0.0	0.0	0.0	
		HA_Kealak_088	1	1.5	1.5	0.0	
		HA_Kaloko_055	1	0.0	0.0	0.0	
		HA_Kaloko_057E	1	0.0	0.0	0.0	
		HA_Kealak_083C	1	1.1	1.1	0.0	
		HA_Kaloko_058	1	0.0	0.0	0.0	
		HA_Kaloko_129	1	0.0	0.0	0.0	
		HA_Kealak_096	1	3.1	3.1	0.0	

Table 4. 2010 summary of water quality parameters in Kaloko-Honokōhau NHP anchialine pools (continued).

Parameter	Unit	Site	n	Minimum	Maximum	Median	SD
Dissolved Oxygen Concentration	mg · L ⁻¹	HA_Kaloko_005	4	8.2	8.9	8.6	0.33
		HA_Kaloko_016	4	8.2	8.2	8.2	0.03
		HA_Kealak_084	4	14.6	24.6	16.7	4.59
		HA_Kaloko_119	4	5.7	11.5	6.5	2.69
		HA_Honoko_039	1	7.7	7.7	0.0	
		HA_Kaloko_067	1	8.1	8.1	0.0	
		HA_Kaloko_062	1	7.2	7.2	0.0	
		HA_Kaloko_049	1	7.0	7.0	0.0	
		HA_Kaloko_061	1	7.6	7.6	0.0	
		HA_Kaloko_050	1	7.3	7.3	0.0	
		HA_Kaloko_007	1	9.2	9.2	0.0	
		HA_Kealak_088	1	4.1	4.1	0.0	
		HA_Kaloko_055	1	7.8	7.8	0.0	
		HA_Kaloko_057E	1	7.5	7.5	0.0	
		HA_Kealak_083C	1	4.3	4.3	0.0	
		HA_Kaloko_058	1	7.5	7.5	0.0	
		HA_Kealak_095	1	4.8	4.8	0.0	
		HA_Kealak_099	1	2.9	2.9	0.0	
		HA_Kaloko_129	1	4.9	4.9	0.0	
		HA_Kealak_096	1	3.4	3.4	0.0	
Dissolved Oxygen Saturation	%	HA_Kaloko_005	4	100.3	108.2	105.8	3.49
		HA_Kaloko_016	4	95.0	96.6	95.9	0.74
		HA_Kealak_084	4	202.3	341.4	221.7	65.65
		HA_Kaloko_119	3	71.2	79.0	76.2	3.99
		HA_Honoko_039	1	95.8	95.8	0.0	
		HA_Kaloko_067	1	94.6	94.6	0.0	
		HA_Kaloko_062	1	83.7	83.7	0.0	
		HA_Kaloko_049	1	82.9	82.9	0.0	
		HA_Kaloko_061	1	88.6	88.6	0.0	
		HA_Kaloko_050	1	85.8	85.8	0.0	
		HA_Kaloko_007	1	114.0	114.0	0.0	
		HA_Kealak_088	1	55.9	55.9	0.0	
		HA_Kaloko_055	1	92.5	92.5	0.0	
		HA_Kaloko_057E	1	87.5	87.5	0.0	
		HA_Kealak_083C	1	54.3	54.3	0.0	
		HA_Kaloko_058	1	89.5	89.5	0.0	
		HA_Kealak_095	1	59.3	59.3	0.0	
		HA_Kealak_099	1	35.0	35.0	0.0	
		HA_Kealak_096	1	41.9	41.9	0.0	

Table 4. 2010 summary of water quality parameters in Kaloko-Honokōhau NHP anchialine pools (continued).

Parameter	Unit	Site	n	Minimum	Maximum	Median	SD
pH	none	HA_Kaloko_005	4	7.8	7.9	7.8	0.03
		HA_Kaloko_016	4	7.8	7.9	7.8	0.05
		HA_Kealak_084	4	8.3	9.3	8.6	0.47
		HA_Kaloko_119	4	7.4	7.7	7.4	0.14
		HA_Honoko_039	1	7.3	7.3	0.0	
		HA_Kaloko_067	1	7.8	7.8	0.0	
		HA_Kaloko_062	1	7.7	7.7	0.0	
		HA_Kaloko_049	1	7.7	7.7	0.0	
		HA_Kaloko_061	1	7.8	7.8	0.0	
		HA_Kaloko_050	1	7.8	7.8	0.0	
		HA_Kaloko_007	1	7.8	7.8	0.0	
		HA_Kealak_088	1	7.4	7.4	0.0	
		HA_Kaloko_055	1	7.8	7.8	0.0	
		HA_Kaloko_057E	1	7.8	7.8	0.0	
		HA_Kealak_083C	1	7.8	7.8	0.0	
		HA_Kaloko_058	1	7.7	7.7	0.0	
		HA_Kealak_095	1	7.1	7.1	0.0	
		HA_Kealak_099	1	6.9	6.9	0.0	
		HA_Kaloko_129	1	7.4	7.4	0.0	
		HA_Kealak_096	1	7.0	7.0	0.0	
Salinity	ppt	HA_Kaloko_005	4	12.2	14.3	13.9	0.95
		HA_Kaloko_016	4	9.0	9.8	9.6	0.39
		HA_Kealak_084	4	19.1	22.2	21.4	1.33
		HA_Kaloko_119	4	11.5	14.5	13.7	1.31
		HA_Honoko_039	1	10.1	10.1	0.0	
		HA_Kaloko_067	1	9.8	9.8	0.0	
		HA_Kaloko_062	1	11.3	11.3	0.0	
		HA_Kaloko_049	1	14.1	14.1	0.0	
		HA_Kaloko_061	1	11.1	11.1	0.0	
		HA_Kaloko_050	1	13.4	13.4	0.0	
		HA_Kaloko_007	1	13.8	13.8	0.0	
		HA_Kealak_088	1	22.1	22.1	0.0	
		HA_Kaloko_055	1	12.8	12.8	0.0	
		HA_Kaloko_057E	1	12.6	12.6	0.0	
		HA_Kealak_083C	1	18.3	18.3	0.0	
		HA_Kaloko_058	1	12.1	12.1	0.0	
		HA_Kealak_095	1	13.8	13.8	0.0	
		HA_Kealak_099	1	13.6	13.6	0.0	
		HA_Kaloko_129	1	19.2	19.2	0.0	
		HA_Kealak_096	1	13.8	13.8	0.0	

Table 4. 2010 summary of water quality parameters in Kaloko-Honokōhau NHP anchialine pools (continued).

Parameter	Unit	Site	n	Minimum	Maximum	Median	SD
Specific Conductance	mS · cm ⁻¹	HA_Kaloko_005	4	20.3	23.5	23.0	1.44
		HA_Kaloko_016	4	15.4	16.7	16.3	0.61
		HA_Kealak_084	4	30.8	35.2	34.2	1.91
		HA_Kaloko_119	4	19.2	23.8	22.7	2.00
		HA_Honoko_039	1	17.2	17.2	0.0	
		HA_Kaloko_067	1	16.6	16.6	0.0	
		HA_Kaloko_062	1	19.0	19.0	0.0	
		HA_Kaloko_049	1	23.3	23.3	0.0	
		HA_Kaloko_061	1	18.6	18.6	0.0	
		HA_Kaloko_050	1	22.1	22.1	0.0	
		HA_Kaloko_007	1	22.9	22.9	0.0	
		HA_Kealak_088	1	35.1	35.1	0.0	
		HA_Kaloko_055	1	21.3	21.3	0.0	
		HA_Kaloko_057E	1	21.0	21.0	0.0	
		HA_Kealak_083C	1	29.5	29.5	0.0	
		HA_Kaloko_058	1	20.3	20.3	0.0	
		HA_Kealak_095	1	22.8	22.8	0.0	
		HA_Kealak_099	1	22.5	22.5	0.0	
		HA_Kaloko_129	1	30.9	30.9	0.0	
		HA_Kealak_096	1	22.8	22.8	0.0	
Temperature	°C	HA_Kaloko_005	4	20.9	21.7	21.5	0.36
		HA_Kaloko_016	4	19.9	20.7	20.2	0.31
		HA_Kealak_084	4	22.4	26.0	25.3	1.63
		HA_Kaloko_119	4	20.0	23.0	22.1	1.39
		HA_Honoko_039	1	23.3	23.3	0.0	
		HA_Kaloko_067	1	19.9	19.9	0.0	
		HA_Kaloko_062	1	19.6	19.6	0.0	
		HA_Kaloko_049	1	19.3	19.3	0.0	
		HA_Kaloko_061	1	19.6	19.6	0.0	
		HA_Kaloko_050	1	19.4	19.4	0.0	
		HA_Kaloko_007	1	22.2	22.2	0.0	
		HA_Kealak_088	1	24.2	24.2	0.0	
		HA_Kaloko_055	1	20.0	20.0	0.0	
		HA_Kaloko_057E	1	19.4	19.4	0.0	
		HA_Kealak_083C	1	21.5	21.5	0.0	
		HA_Kaloko_058	1	20.4	20.4	0.0	
		HA_Kealak_095	1	21.4	21.4	0.0	
		HA_Kealak_099	1	21.4	21.4	0.0	
		HA_Kaloko_129	1	22.6	22.6	0.0	
		HA_Kealak_096	1	21.1	21.1	0.0	

Table 4. 2010 summary of water quality parameters in Kaloko-Honokōhau NHP anchialine pools (continued).

Parameter	Unit	Site	n	Minimum	Maximum	Median	SD
Turbidity	NTU	HA_Kaloko_005	4	0.0	1.3	0.7	0.59
		HA_Kaloko_016	4	0.3	1.3	0.8	0.40
		HA_Kealak_084	3	0.4	0.7	0.5	0.19
		HA_Kaloko_119	4	0.0	1.3	0.3	0.61
		HA_Honoko_039	1	1.8	1.8	0.0	
		HA_Kaloko_067	1	1.2	1.2	0.0	
		HA_Kaloko_062	1	0.8	0.8	0.0	
		HA_Kaloko_049	1	0.8	0.8	0.0	
		HA_Kaloko_061	1	1.1	1.1	0.0	
		HA_Kaloko_050	1	0.1	0.1	0.0	
		HA_Kaloko_007	1	0.6	0.6	0.0	
		HA_Kealak_088	1	0.0	0.0	0.0	
		HA_Kaloko_055	1	0.1	0.1	0.0	
		HA_Kaloko_057E	1	1.4	1.4	0.0	
		HA_Kealak_083C	1	0.1	0.1	0.0	
		HA_Kaloko_058	1	0.6	0.6	0.0	
		HA_Kealak_099	1	1.1	1.1	0.0	
		HA_Kaloko_129	1	0.3	0.3	0.0	
		HA_Kealak_096	1	0.0	0.0	0.0	

Table 5. 2011 summary of water quality parameters in Kaloko-Honokōhau NHP anchialine pools.

Parameter	Unit	Loc_Name	N	Minimum	Maximum	Median	SD
Total Dissolved Phosphorus	$\mu\text{gP} \cdot \text{L}^{-1}$	HA_Kaloko_005	12	67.0	103.2	90.0	11.10
		HA_Kaloko_016	9	89.5	132.1	119.8	12.86
		HA_Kealak_084	11	27.3	56.7	41.9	9.72
		HA_Kaloko_119	12	49.7	87.3	81.8	11.13
		HA_Honoko_039	3	76.9	95.0	93.1	9.95
		HA_Honoko_029	3	75.1	85.5	80.7	5.18
		HA_Kaloko_046	3	100.3	103.7	102.5	1.72
		HA_Kealak_083C	3	54.4	93.6	79.9	19.88
		HA_Kaloko_007	3	58.7	77.2	71.5	9.43
		HA_Kaloko_050	3	109.0	128.5	125.1	10.42
		HA_Kealak_085A	3	15.0	20.6	17.9	2.79
		HA_Kaloko_009	3	75.8	87.6	87.6	6.85
		HA_Kaloko_032	3	114.2	119.0	117.5	2.45
		HA_Kaloko_011	3	89.9	105.8	101.9	8.28
		HA_Kaloko_053H	3	119.6	135.6	122.8	8.45
		HA_Honoko_037	3	85.6	122.4	118.2	20.13
		HA_Kaloko_062	3	99.6	145.8	105.9	25.07
		HA_Kaloko_066	3	96.2	107.1	101.1	5.44
		HA_Kealak_096	3	108.4	114.6	111.5	3.10
Total Dissolved Nitrogen	$\text{mgN} \cdot \text{L}^{-1}$	HA_Kaloko_005	12	0.5	1.1	0.8	0.21
		HA_Kaloko_016	9	0.6	1.3	1.2	0.23
		HA_Kealak_084	12	0.1	0.7	0.2	0.23
		HA_Kaloko_119	12	0.6	1.3	1.2	0.24
		HA_Honoko_039	3	0.7	0.8	0.8	0.02
		HA_Honoko_029	3	0.4	0.7	0.5	0.17
		HA_Kaloko_046	3	1.1	1.1	1.1	0.01
		HA_Kealak_083C	3	0.2	0.3	0.2	0.02
		HA_Kaloko_007	3	0.5	0.7	0.5	0.09
		HA_Kaloko_050	3	1.0	1.4	1.4	0.25
		HA_Kealak_085A	3	0.3	0.3	0.3	0.01
		HA_Kaloko_009	3	0.7	0.8	0.7	0.08
		HA_Kaloko_032	3	1.0	1.1	1.0	0.05
		HA_Kaloko_011	3	1.0	1.3	1.0	0.16
		HA_Kaloko_053H	3	1.4	1.5	1.4	0.04
		HA_Honoko_037	3	1.0	1.1	1.0	0.03
		HA_Kaloko_062	3	1.1	1.2	1.1	0.03
		HA_Kaloko_066	3	1.1	1.1	1.1	0.02
		HA_Kealak_096	3	0.8	0.9	0.8	0.04

Table 5. 2011 summary of water quality parameters in Kaloko-Honokōhau NHP anchialine pools (continued).

Parameter	Unit	Site	n	Minimum	Maximum	Median	SD
Nitrite + Nitrate	$\mu\text{gN} \cdot \text{L}^{-1}$	HA_Kaloko_005	12	451.4	1003.4	725.6	193.79
		HA_Kaloko_016	9	514.2	1187.0	1164.1	234.04
		HA_Kealak_084	12	21.2	188.3	42.5	62.16
		HA_Kaloko_119	12	581.1	1151.6	820.3	221.37
		HA_Honoko_039	3	565.0	647.4	572.0	45.68
		HA_Honoko_029	3	442.1	703.0	444.2	150.03
		HA_Kaloko_046	3	949.5	965.2	957.6	7.88
		HA_Kealak_083C	3	147.0	152.7	147.0	3.30
		HA_Kaloko_007	3	376.0	512.4	410.5	70.89
		HA_Kaloko_050	3	897.0	1166.1	1165.6	155.19
		HA_Kealak_085A	3	36.7	65.6	40.3	15.77
		HA_Kaloko_009	3	621.2	727.1	663.6	53.29
		HA_Kaloko_032	3	994.0	1038.9	1037.6	25.58
		HA_Kaloko_011	3	853.1	1138.0	894.0	154.03
		HA_Kaloko_053H	3	1290.8	1310.9	1293.8	10.84
		HA_Honoko_037	3	988.2	1064.2	1055.1	41.49
		HA_Kaloko_062	3	1079.0	1091.0	1086.1	6.00
		HA_Kaloko_066	3	1005.4	1013.1	1011.9	4.11
		HA_Kealak_096	3	633.4	684.8	656.5	25.78
Chlorophyll	$\mu\text{g} \cdot \text{L}^{-1}$	HA_Kaloko_005	4	0.0	0.0	0.0	0.00
		HA_Kaloko_016	3	0.0	0.1	0.0	0.07
		HA_Kealak_084	4	0.5	6.1*	1.6	2.53
		HA_Kaloko_119	4	0.0	7.7*	0.2	3.80
		HA_Honoko_039	1	1.3	1.3	0.0	
		HA_Honoko_029	1	0.3	0.3	0.0	
		HA_Kaloko_046	1	4.1	4.1	0.0	
		HA_Kealak_083C	1	0.1	0.1	0.0	
		HA_Kaloko_007	1	0.4	0.4	0.0	
		HA_Kaloko_050	1	0.5	0.5	0.0	
		HA_Kaloko_009	1	0.1	0.1	0.0	
		HA_Kaloko_032	1	0.1	0.1	0.0	
		HA_Kaloko_011	1	0.3	0.3	0.0	
		HA_Kaloko_053H	1	0.0	0.0	0.0	
		HA_Honoko_037	1	0.0	0.0	0.0	
		HA_Kaloko_062	1	0.0	0.0	0.0	
		HA_Kaloko_066	1	0.1	0.1	0.0	
		HA_Kealak_096	1	1.4	1.4	0.0	

Table 5. 2011 summary of water quality parameters in Kaloko-Honokōhau NHP anchialine pools (continued).

Parameter	Unit	Site	n	Minimum	Maximum	Median	SD
Dissolved Oxygen Concentration	mg · L ⁻¹	HA_Kaloko_005	4	7.4	8.8	7.7	0.62
		HA_Kaloko_016	3	7.9	8.3	8.0	0.19
		HA_Kealak_084	4	4.2	27.8	8.3	10.62
		HA_Kaloko_119	4	6.0	6.4	6.1	0.18
		HA_Honoko_039	1	3.8	3.8	0.0	
		HA_Honoko_029	1	6.7	6.7	0.0	
		HA_Kaloko_046	1	6.7	6.7	0.0	
		HA_Kealak_083C	1	10.4	10.4	0.0	
		HA_Kaloko_007	1	7.8	7.8	0.0	
		HA_Kaloko_050	1	7.5	7.5	0.0	
		HA_Kaloko_009	1	7.5	7.5	0.0	
		HA_Kaloko_032	1	5.6	5.6	0.0	
		HA_Kaloko_011	1	10.1	10.1	0.0	
		HA_Kaloko_053H	1	8.1	8.1	0.0	
		HA_Honoko_037	1	8.9	8.9	0.0	
		HA_Kaloko_062	1	6.6	6.6	0.0	
		HA_Kaloko_066	1	6.2	6.2	0.0	
		HA_Kealak_096	1	5.8	5.8	0.0	
Dissolved Oxygen Saturation	%	HA_Kaloko_005	4	89.5	105.1	93.7	7.34
		HA_Kaloko_016	3	92.2	95.5	95.1	1.82
		HA_Kealak_084	4	51.2	376.2	118.7	143.67
		HA_Kaloko_119	4	73.2	77.5	74.2	1.88
		HA_Honoko_039	1	46.0	46.0	0.0	
		HA_Honoko_029	1	85.6	85.6	0.0	
		HA_Kaloko_046	1	82.4	82.4	0.0	
		HA_Kealak_083C	1	123.9	123.9	0.0	
		HA_Kaloko_007	1	97.7	97.7	0.0	
		HA_Kaloko_050	1	92.9	92.9	0.0	
		HA_Kaloko_009	1	89.0	89.0	0.0	
		HA_Kaloko_032	1	66.5	66.5	0.0	
		HA_Kaloko_011	1	129.6	129.6	0.0	
		HA_Kaloko_053H	1	93.3	93.3	0.0	
		HA_Honoko_037	1	109.4	109.4	0.0	
		HA_Kaloko_062	1	78.2	78.2	0.0	
		HA_Kaloko_066	1	74.8	74.8	0.0	
		HA_Kealak_096	1	72.8	72.8	0.0	

Table 5. 2011 summary of water quality parameters in Kaloko-Honokōhau NHP anchialine pools (continued).

Parameter	Unit	Site	n	Minimum	Maximum	Median	SD
pH	none	HA_Kaloko_005	4	7.9	8.3	7.9	0.21
		HA_Kaloko_016	3	7.7	8.3	7.9	0.30
		HA_Kealak_084	4	7.5	9.4	8.0	0.83
		HA_Kaloko_119	4	7.3	7.5	7.4	0.10
		HA_Honoko_039	1	7.1	7.1	0.0	
		HA_Honoko_029	1	7.8	7.8	0.0	
		HA_Kaloko_046	1	7.8	7.8	0.0	
		HA_Kealak_083C	1	8.6	8.6	0.0	
		HA_Kaloko_007	1	7.8	7.8	0.0	
		HA_Kaloko_050	1	7.8	7.8	0.0	
		HA_Kealak_085A	1	7.5	7.5	0.0	
		HA_Kaloko_009	1	7.8	7.8	0.0	
		HA_Kaloko_032	1	8.0	8.0	0.0	
		HA_Kaloko_011	1	8.0	8.0	0.0	
		HA_Kaloko_053H	1	7.8	7.8	0.0	
		HA_Honoko_037	1	8.0	8.0	0.0	
		HA_Kaloko_062	1	7.8	7.8	0.0	
		HA_Kaloko_066	1	7.7	7.7	0.0	
		HA_Kealak_096	1	7.3	7.3	0.0	
Salinity	ppt	HA_Kaloko_005	4	11.9	14.3	13.5	1.11
		HA_Kaloko_016	3	8.4	9.7	8.7	0.65
		HA_Kealak_084	3	21.9	24.1	22.6	1.13
		HA_Kaloko_119	4	5.0	14.9	14.5	4.83
		HA_Honoko_039	1	10.3	10.3	0.0	
		HA_Honoko_029	1	12.1	12.1	0.0	
		HA_Kaloko_046	1	13.6	13.6	0.0	
		HA_Kealak_083C	1	9.6	9.6	0.0	
		HA_Kaloko_007	1	12.7	12.7	0.0	
		HA_Kaloko_050	1	10.9	10.9	0.0	
		HA_Kealak_085A	1	22.9	22.9	0.0	
		HA_Kaloko_009	1	12.3	12.3	0.0	
		HA_Kaloko_032	1	13.2	13.2	0.0	
		HA_Kaloko_011	1	9.8	9.8	0.0	
		HA_Kaloko_053H	1	8.8	8.8	0.0	
		HA_Honoko_037	1	10.2	10.2	0.0	
		HA_Kaloko_062	1	12.9	12.9	0.0	
		HA_Kaloko_066	1	12.6	12.6	0.0	
		HA_Kealak_096	1	15.1	15.1	0.0	

Table 5. 2011 summary of water quality parameters in Kaloko-Honokōhau NHP anchialine pools (continued).

Parameter	Unit	Site	n	Minimum	Maximum	Median	SD
Specific Conductance	mS · cm ⁻¹	HA_Kaloko_005	4	19.8	23.6	22.4	1.68
		HA_Kaloko_016	3	14.5	16.4	15.0	1.03
		HA_Kealak_084	3	34.8	38.0	36.0	1.62
		HA_Kaloko_119	4	9.0	24.4	23.9	7.57
		HA_Honoko_039	1	17.5	17.5	0.0	
		HA_Honoko_029	1	20.3	20.3	0.0	
		HA_Kaloko_046	1	22.6	22.6	0.0	
		HA_Kealak_083C	1	16.4	16.4	0.0	
		HA_Kaloko_007	1	21.2	21.2	0.0	
		HA_Kaloko_050	1	18.5	18.5	0.0	
		HA_Kealak_085A	1	36.3	36.3	0.0	
		HA_Kaloko_009	1	20.5	20.5	0.0	
		HA_Kaloko_032	1	21.9	21.9	0.0	
		HA_Kaloko_011	1	16.7	16.7	0.0	
		HA_Kaloko_053H	1	15.1	15.1	0.0	
		HA_Honoko_037	1	17.3	17.3	0.0	
		HA_Kaloko_062	1	21.5	21.5	0.0	
		HA_Kaloko_066	1	21.0	21.0	0.0	
		HA_Kealak_096	1	24.8	24.8	0.0	
Temperature	°C	HA_Kaloko_005	4	20.2	22.2	20.9	0.85
		HA_Kaloko_016	3	19.6	21.9	19.9	1.26
		HA_Kealak_084	4	22.8	28.9	24.9	2.62
		HA_Kaloko_119	4	20.4	23.9	20.9	1.61
		HA_Honoko_039	1	21.9	21.9	0.0	
		HA_Honoko_029	1	24.4	24.4	0.0	
		HA_Kaloko_046	1	21.9	21.9	0.0	
		HA_Kealak_083C	1	21.4	21.4	0.0	
		HA_Kaloko_007	1	23.2	23.2	0.0	
		HA_Kaloko_050	1	22.5	22.5	0.0	
		HA_Kealak_085A	1	23.8	23.8	0.0	
		HA_Kaloko_009	1	19.9	19.9	0.0	
		HA_Kaloko_032	1	19.7	19.7	0.0	
		HA_Kaloko_011	1	25.4	25.4	0.0	
		HA_Kaloko_053H	1	19.5	19.5	0.0	
		HA_Honoko_037	1	23.0	23.0	0.0	
		HA_Kaloko_062	1	19.6	19.6	0.0	
		HA_Kaloko_066	1	20.9	20.9	0.0	
		HA_Kealak_096	1	22.4	22.4	0.0	

Table 5. 2011 summary of water quality parameters in Kaloko-Honokōhau NHP anchialine pools (continued).

Parameter	Unit	Site	n	Minimum	Maximum	Median	SD
Turbidity	NTU	HA_Kaloko_005	4	0.0	0.4	0.0	0.21
		HA_Kaloko_016	3	0.0	0.5	0.0	0.29
		HA_Kealak_084	4	0.0	3.7	0.2	1.78
		HA_Kaloko_119	4	0.0	0.5	0.1	0.23
		HA_Honoko_039	1	0.0	0.0	0.0	
		HA_Honoko_029	1	0.0	0.0	0.0	
		HA_Kaloko_046	1	0.9	0.9	0.0	
		HA_Kealak_083C	1	0.0	0.0	0.0	
		HA_Kaloko_007	1	0.0	0.0	0.0	
		HA_Kaloko_050	1	0.0	0.0	0.0	
		HA_Kaloko_009	1	0.0	0.0	0.0	
		HA_Kaloko_032	1	7.2	7.2	0.0	
		HA_Kaloko_011	1	0.0	0.0	0.0	
		HA_Kaloko_053H	1	0.0	0.0	0.0	
		HA_Honoko_037	1	8.3	8.3	0.0	
		HA_Kaloko_062	1	0.0	0.0	0.0	
		HA_Kaloko_066	1	0.0	0.0	0.0	
		HA_Kealak_096	1	0.7	0.7	0.0	

*Possible planktonic algal bloom.

Summaries by parameter

Total Dissolved Phosphorus

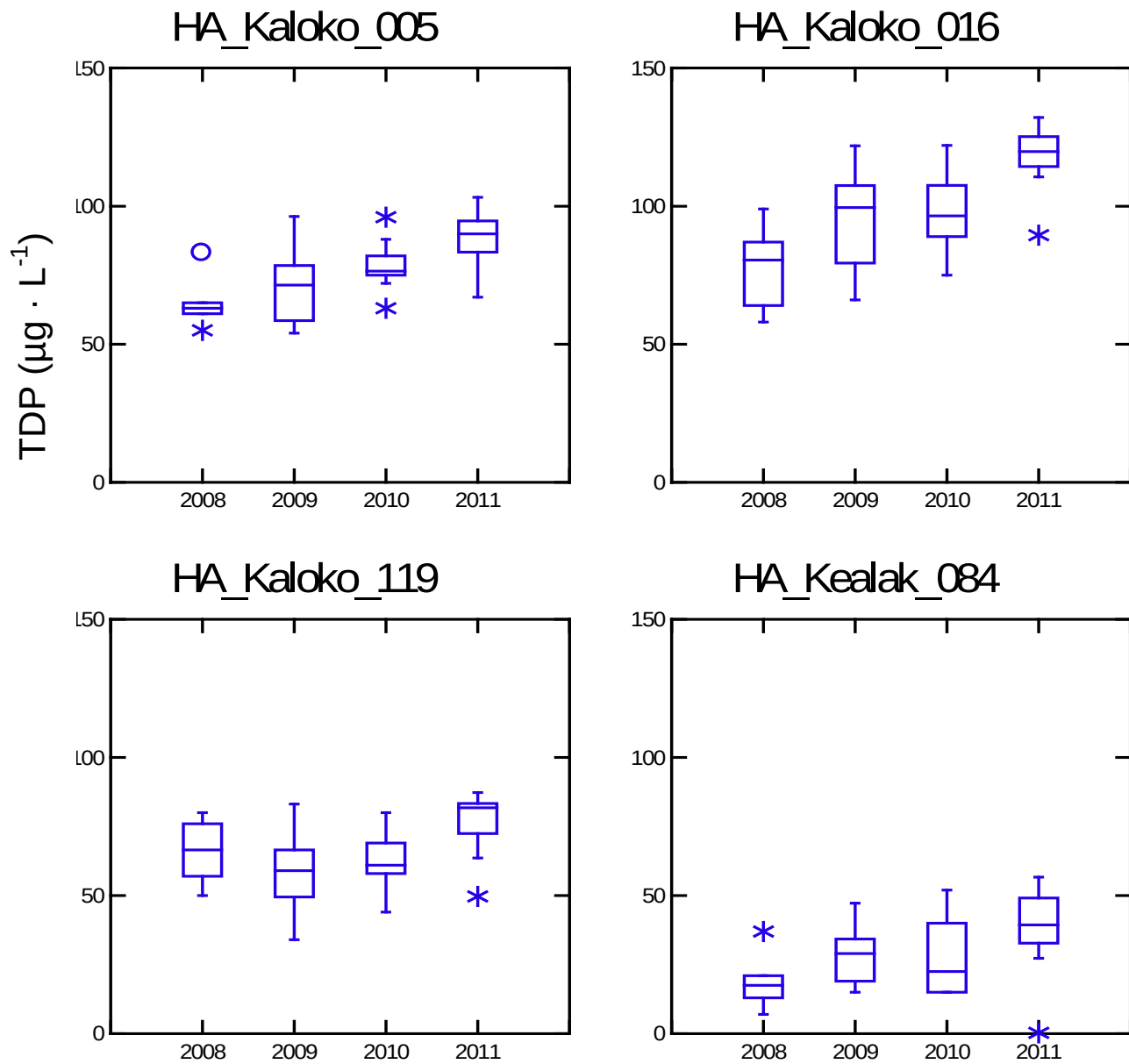


Figure 3. Box plots of Total Dissolved Phosphorus in Kaloko-Honokōhau NHP anchialine pools.

Table 6. Mean Total Dissolved Phosphorus (TDP, $\mu\text{gP} \cdot \text{L}^{-1}$) in Kaloko-Honokōhau NHP anchialine pools.

Date	HA_Kaloko_005 (FKAHO01_ap)			HA_Kaloko_016 (FKAHO02_ap)			HA_Kealak_084 (FKAHO03_ap)			HA_Kaloko_119 (FKAHO04_ap)		
	TDP	SE ¹	n	TDP	SE ¹	n	TDP	SE ¹	n	TDP	SE ¹	n
5/15/2008	69.7	6.8	3	69.7	8.8	3	11.7	2.4	3	73.0	5.1	3
10/27/2008	60.3	2.9	3	86.7	6.2	3	26.0	5.5	3	59.0	5.9	3
2/26/2009	56.7	2.2	3	85.7	7.1	3	18.0	3.0	3	37.7	2.3	3
4/28/2009	69.7	4.2	3	79.7	9.9	3	31.3	2.4	3	63.3	3.3	3
7/24/2009	70.1	7.0	3	102.0	1.3	3	23.3	4.9	3	58.4	0.6	3
10/29/2009	86.3	5.2	3	115.0	3.5	3	40.7	4.3	3	75.4	6.3	3
1/19/2010	75.3	1.8	3	96.7	0.9	3	15.0	0.0	3	60.7	0.3	3
4/14/2010	71.3	4.3	3	86.3	6.1	3	15.0	0.0	3	52.0	4.0	3
7/16/2010	88.0	4.6	3	111.3	5.8	3	45.0	3.8	3	65.7	5.2	3
11/19/2010	78.7	2.7	3	96.0	13.6	3	35.0	3.2	3	72.7	4.1	3
1/24/2011	88.7	2.2	3	129.6	2.2	3	37.8	10.5	2	82.1	0.4	3
4/28/2011	99.1	3.1	3	119.5	1.1	3	41.1	3.0	3	81.5	1.9	3
8/12/2011	82.0	7.6	3	104.8	7.7	3	34.1	1.4	3	60.2	5.3	3
10/27/2011	82.6	7.7	3							83.9	2.5	3
10/31/2011							53.7	2.0	3			

¹SE = Standard Error

Total Dissolved Nitrogen

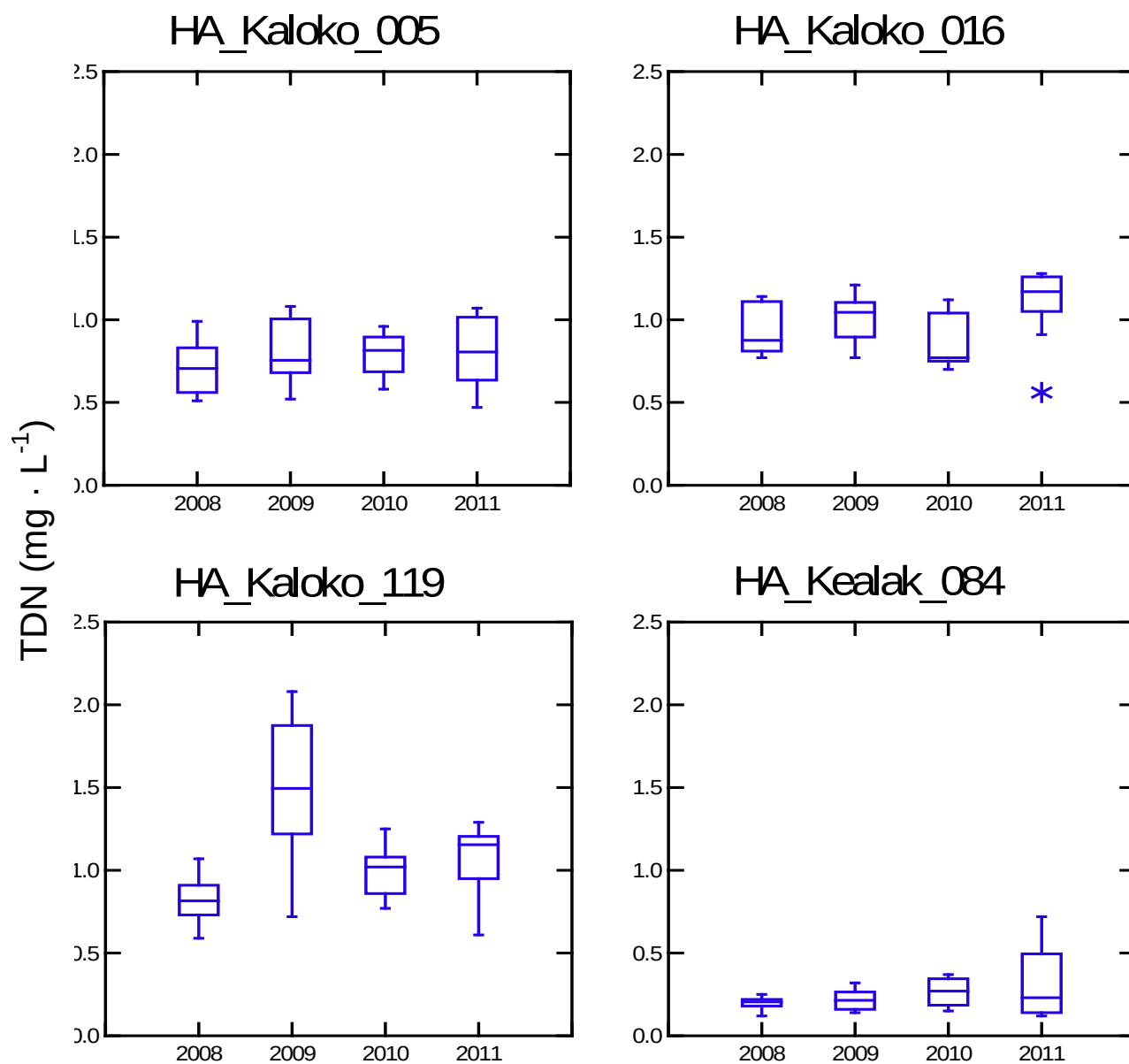


Figure 4. Box plots of Total Dissolved Nitrogen in Kaloko-Honokōhau NHP anachialine pools.

Table 7. Mean Total Dissolved Nitrogen (TDN, $\text{mgN} \cdot \text{L}^{-1}$) in Kaloko-Honokōhau NHP anchialine pools.

	HA_Kaloko_005 (FKAHO01_ap)			HA_Kaloko_016 (FKAHO02_ap)			HA_Kealak_084 (FKAHO03_ap)			HA_Kaloko_119 (FKAHO04_ap)		
Date	TDN	SE ¹	n	TDN	SE ¹	n	TDN	SE ¹	n	TDN	SE ¹	n
5/15/2008	0.80	0.10	3	0.94	0.09	3	0.21	0.01	3	0.85	0.05	3
10/27/2008	0.63	0.10	3	0.92	0.11	3	0.18	0.04	3	0.80	0.14	3
2/26/2009	0.70	0.03	3	0.96	0.10	3	0.21	0.06	3	2.00*	0.04	3
4/28/2009	0.89	0.11	3	0.97	0.12	3	0.26	0.03	3	1.60*	0.11	3
7/24/2009	0.88	0.13	3	1.13	0.04	3	0.20	0.04	3	1.40*	0.05	3
10/29/2009	0.77	0.14	3	0.98	0.06	3	0.21	0.03	3	0.94	0.12	3
1/19/2010	0.91	0.03	3	1.08	0.02	3	0.16	0.01	3	1.04	0.03	3
4/14/2010	0.76	0.09	3	0.85	0.09	3	0.23	0.02	3	1.12	0.12	3
7/16/2010	0.84	0.06	3	0.72	0.02	3	0.29	0.02	3	0.89	0.08	3
11/19/2010	0.67	0.03	3	0.83	0.07	3	0.36	0.00	3	0.95	0.08	3
1/24/2011	0.70	0.06	3	1.18	0.01	3	0.13	0.01	3	1.15	0.00	3
4/28/2011	1.03	0.02	3	1.27	0.01	3	0.69	0.02	3	1.27	0.01	3
8/12/2011	0.66	0.08	3	0.84	0.15	3	0.16	0.01	3	0.69	0.05	3
10/27/2011	0.79	0.17	3							1.14	0.02	3
10/31/2011							0.31	0.01	3			

¹SE = Standard Error

*Elevated concentrations

Nitrate + Nitrite

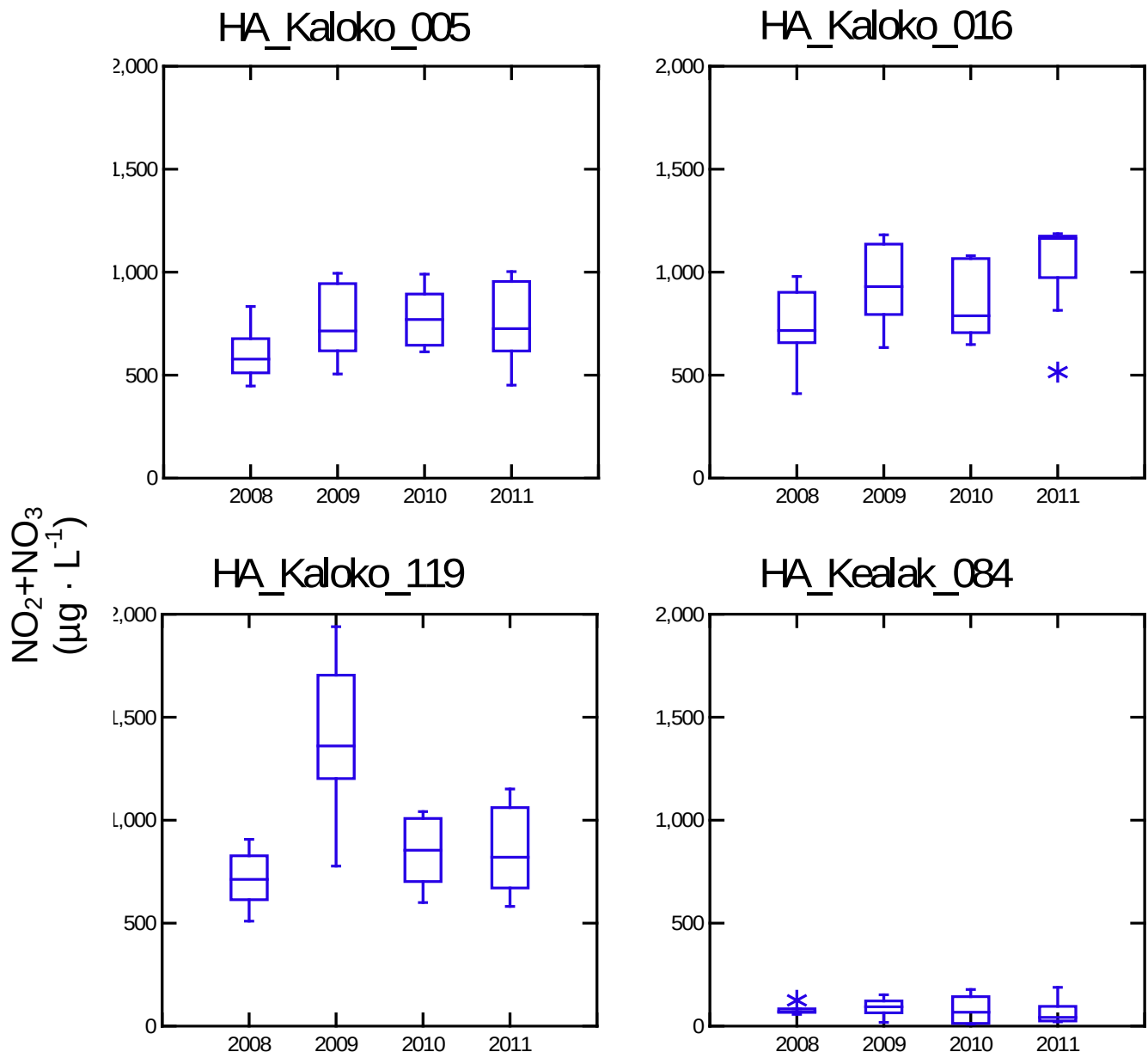


Figure 5. Box plots of nitrate + nitrite in Kaloko-Honokōhau NHP anchialine pools.

Table 8. Mean nitrate + nitrite ($\text{NO}_3 + \text{NO}_2$, $\mu\text{gN} \cdot \text{L}^{-1}$) in Kaloko-Honokōhau NHP anchialine pools.

	HA_Kaloko_005 (FKAHO01_ap)			HA_Kaloko_016 (FKAHO02_ap)			HA_Kealak_084 (FKAHO03_ap)			HA_Kaloko_119 (FKAHO04_ap)		
Date	$\text{NO}_3 + \text{NO}_2$	SE^1	n	$\text{NO}_3 + \text{NO}_2$	SE^1	n	$\text{NO}_3 + \text{NO}_2$	SE^1	n	$\text{NO}_3 + \text{NO}_2$	SE^1	n
5/15/2008	653.7	94.7	3	656.3	142.0	3	74.0	5.1	3	751.0	63.9	3
10/27/2008	554.0	66.9	3	803.7	88.2	3	83.7	21.0	3	677.0	118.9	3
2/26/2009	580.3	38.3	3	792.6	84.7	3	54.7	28.6	3	1860.0*	46.2	3
4/28/2009	781.0	66.6	3	841.3	126.4	3	85.3	20.3	3	1392.0*	118.8	3
7/24/2009	867.7	116.8	3	1176.1	3.12	3	117.7	20.9	3	1379.7*	37.7	3
10/29/2009	752.9	132.5	3	975.5	64.8	3	101.2	15.2	3	1014.9*	119.0	3
1/19/2010	892.3	1.9	3	1071.0	7.1	3	15.7	0.7	3	953.0	55.6	3
4/14/2010	781.7	73.5	3	882.0	106.9	3	11.0	0.6	3	949.0	91.5	3
7/16/2010	807.7	91.9	3	673.0	25.0	3	123.0	2.5	3	710.0	72.0	3
11/19/2010	631.3	9.4	3	774.7	67.3	3	169.3	5.2	3	803.3	105.7	3
1/24/2011	670.8	44.5	3	1181.3	3.4	3	24.2	1.1	3	1147.3	2.2	3
4/28/2011	965.0	18.8	3	1164.0	4.5	3	31.2	6.3	3	677.8	6.7	3
8/12/2011	611.9	71.8	3	767.2	134.6	3	50.0	7.1	3	638.5	51.0	3
10/27/2011	727.4	159.4	3							951.7	25.7	3
10/31/2011							166.3	19.1	3			

¹SE = Standard Error

*Elevated concentrations

Chlorophyll

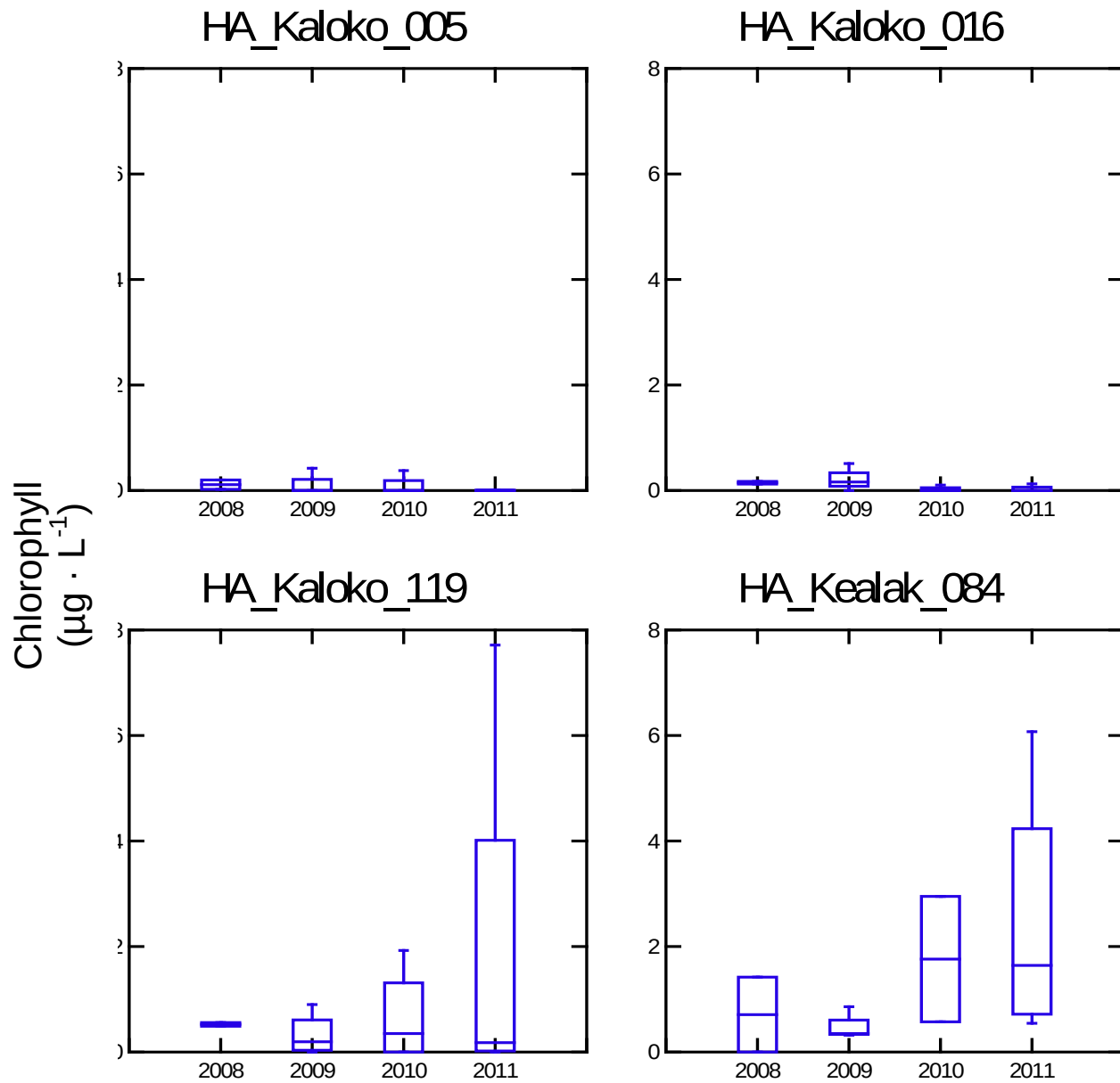


Figure 6. Box plots of chlorophyll in Kaloko-Honokōhau NHP anchialine pools.

Table 9. Mean chlorophyll (Chl, $\mu\text{g} \cdot \text{L}^{-1}$) in Kaloko-Honokōhau NHP anchialine pools.

	HA_Kaloko_005 (FKAHO01_ap)			HA_Kaloko_016 (FKAHO02_ap)			HA_Kealak_084 (FKAHO03_ap)			HA_Kaloko_119 (FKAHO04_ap)		
Date	Chl	SE ¹	n	Chl	SE ¹	n	Chl	SE ¹	n	Chl	SE ¹	n
5/15/2008	0.20	0.10	8	0.12	0.08	8	1.42	0.10	7	0.49	0.06	14
10/27/2008	0.02	0.12	10	0.17	0.17	8	0.00	0.00	12	0.56	0.08	11
2/26/2009	0.42	0.08	9							0.07	0.06	10
4/28/2009	0.00	0.00	11	0.51	0.08	15	0.32	0.09	15	0.32	0.07	12
7/24/2009	0.00	0.00	14	0.00	0.00	13	0.35	0.07	12	0.00	0.00	12
10/29/2009	0.00	0.00	11	0.16	0.12	12	0.86	0.11	18	0.90	0.10	18
1/19/2010	0.00	0.00	11	0.00	0.00	17	2.95	0.26	15	0.00	0.00	16
4/14/2010	0.00	0.00	12	0.00	0.00	10				0.70	0.06	13
7/16/2010	0.00	0.00	14	0.10	0.00	16	0.57	0.09	18	0.00	0.00	15
11/19/2010	0.38	0.08	13							1.93	0.09	15
1/24/2011	0.00	0.00	9	0.00	0.00	12	2.39	0.38	16	0.00	0.00	13
4/28/2011	0.00	0.00	15	0.00	0.00	13	6.07*	0.27	15	7.71*	0.11	14
8/12/2011	0.01	0.07	15	0.12	0.06	13	0.55	0.07	13	0.31	0.13	14
10/27/2011	0.00	0.00	16							0.04	0.06	14
10/31/2011							0.89	0.19	10			

¹SE = Standard Error

*Possible planktonic algal bloom

Oxygen Concentration

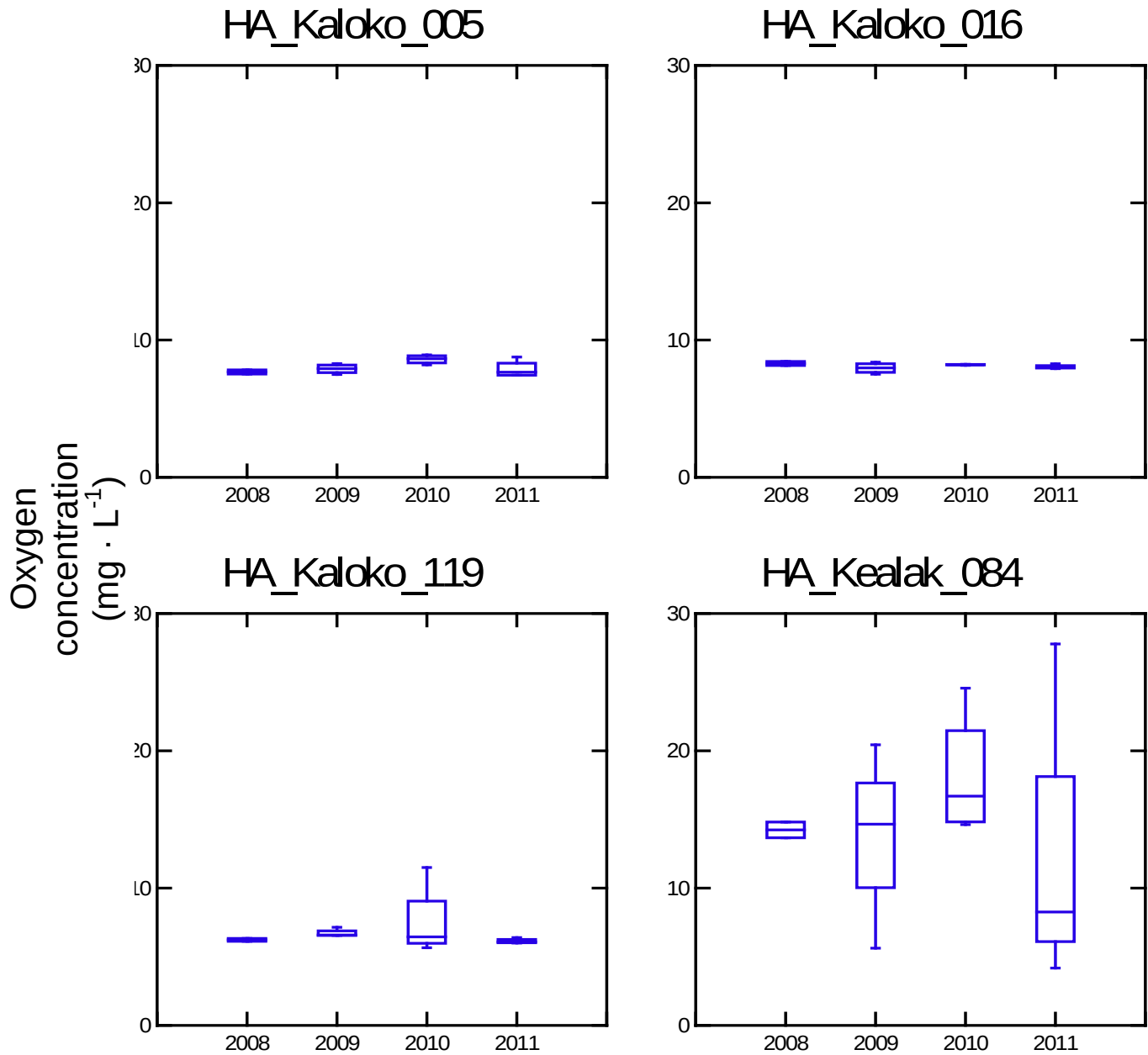


Figure 7. Box plots of oxygen concentration in Kaloko-Honokōhau NHP anchialine pools.

Table 10. Mean oxygen concentration (ODO, mg · L⁻¹) in Kaloko-Honokōhau NHP anchialine pools.

	HA_Kaloko_005 (FKAHO01_ap)			HA_Kaloko_016 (FKAHO02_ap)			HA_Kealak_084 (FKAHO03_ap)			HA_Kaloko_119 (FKAHO04_ap)		
Date	ODO	SE ¹	n	ODO	SE ¹	n	ODO	SE ¹	n	ODO	SE ¹	n
5/15/2008	7.52	0.02	8	8.14	0.02	8	13.67	0.08	7	6.34	0.04	14
10/27/2008	7.82	0.01	10	8.43	0.02	8	14.82	0.12	12	6.13	0.01	11
2/26/2009	8.28	0.02	9	8.38	0.01	14	20.44	0.21	13	7.15	0.04	10
4/28/2009	7.76	0.00	11	7.51	0.02	15	14.87	0.17	15	6.62	0.02	12
7/24/2009	8.07	0.01	14	8.16	0.01	13	5.63	0.17	12	6.55	0.03	12
10/29/2009	7.48	0.02	11	7.77	0.02	12	14.44	0.07	18	6.55	0.01	18
1/19/2010	8.91	0.02	11	8.15	0.00	17	24.56	0.33	15	6.60	0.01	16
4/14/2010	8.78	0.01	12	8.21	0.01	10	18.38	0.42	23	6.30	0.06	13
7/16/2010	8.48	0.01	14	8.21	0.00	16	14.63	0.13	18	11.50	0.09	15
11/19/2010	8.18	0.00	13	8.22	0.01	21	15.02	0.21	12	5.66	0.05	15
1/24/2011	8.75	0.01	9	8.27	0.01	12	27.78	0.51	16	6.40	0.02	13
4/28/2011	7.43	0.04	15	7.99	0.02	13	4.18	0.01	15	6.00	0.06	14
8/12/2011	7.86	0.01	15	7.91	0.00	13	8.48	0.03	13	6.05	0.01	14
10/27/2011	7.44	0.02	16							6.12	0.03	14
10/31/2011							8.04	0.01	10			

¹SE = Standard Error

Oxygen Saturation

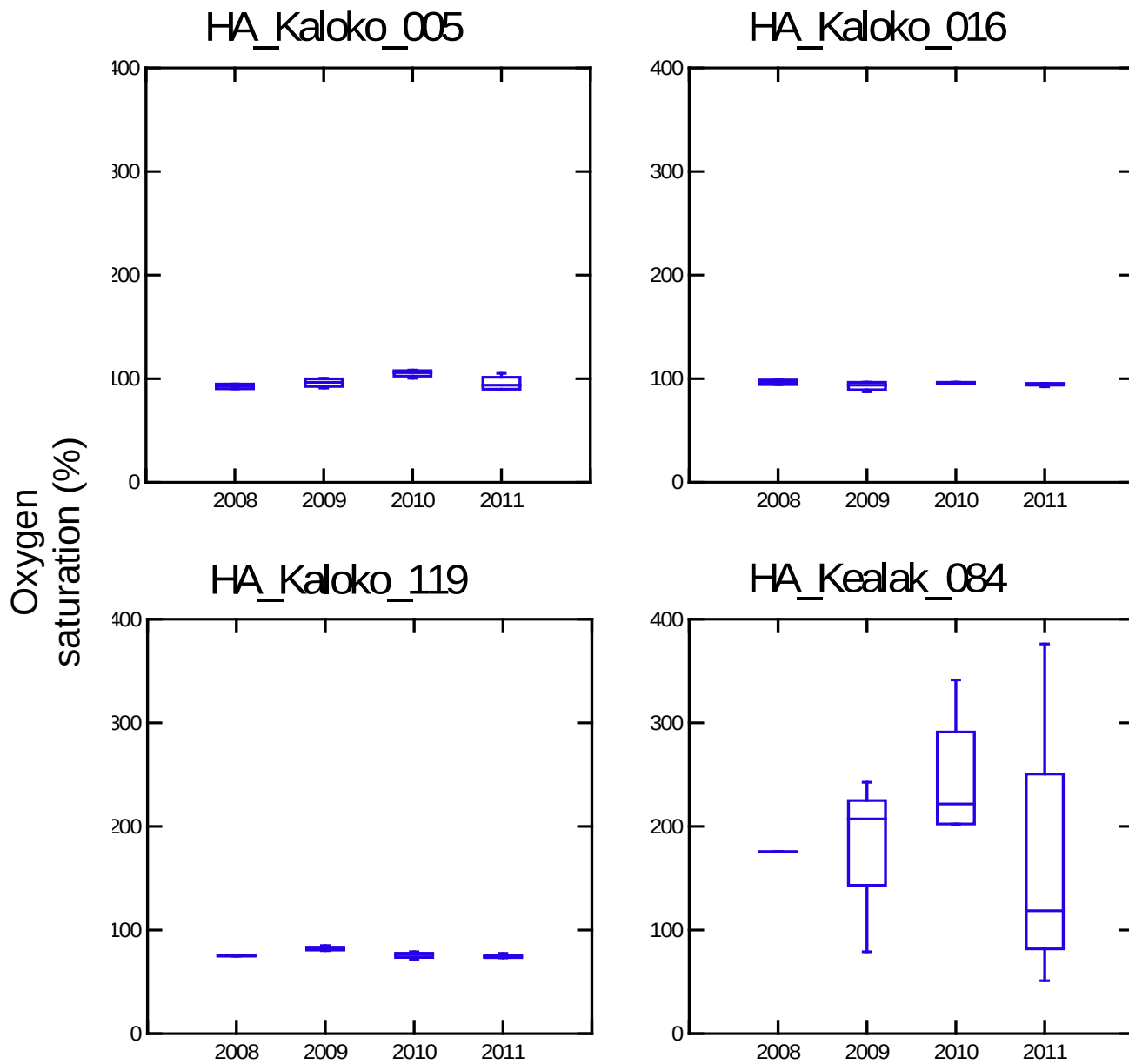


Figure 8. Box plots of oxygen saturation in Kaloko-Honokōhau NHP anchialine pools.

Table 11. Mean oxygen saturation (%) in Kaloko-Honokōhau NHP anchialine pools.

Date	HA_Kaloko_005 (FKAHO01_ap)			HA_Kaloko_016 (FKAHO02_ap)			HA_Kealak_084 (FKAHO03_ap)			HA_Kaloko_119 (FKAHO04_ap)		
	%	SE ¹	n	%	SE ¹	n	%	SE ¹	n	%	SE ¹	n
5/15/2008	90.3	0.3	8	94.3	0.3	8	175.5	1.0	7	75.8	0.5	14
10/27/2008	94.8	0.2	10	98.7	0.2	8				74.9	0.1	11
2/26/2009	99.1	0.2	9	96.6	0.2	14				85.1	0.4	10
4/28/2009	93.9	0.0	11	87.3	0.3	15	242.7	11.1	15	81.2	0.6	12
7/24/2009	100.4	0.2	14	96.3	0.1	13	79.1	2.4	12	82.1	0.3	12
10/29/2009	90.9	0.2	11	91.2	0.2	12	207.3	1.0	18	80.2	0.2	18
1/19/2010	108.2	0.3	11	95.0	0.1	17	341.4	4.4	15	79.0	0.1	16
4/14/2010	107.1	0.2	12	95.5	0.2	10	240.9	5.4	23	76.2	0.7	13
7/16/2010	104.6	0.1	14	96.3	0.1	16	202.5	1.8	18			
11/19/2010	100.3	0.0	13	96.6	0.1	21	202.3	2.7	12	71.2	0.5	15
1/24/2011	105.1	0.2	9	95.5	0.2	12	376.2	6.9	16	77.5	0.2	13
4/28/2011	89.5	0.5	15	92.2	0.3	13	51.2	0.2	15	73.2	0.7	14
8/12/2011	97.4	0.1	15	95.1	0.1	13	124.9	0.4	13	73.9	0.1	14
10/27/2011	90.1	0.3	16							74.5	0.3	14
10/31/2011							112.4	0.2	10			

¹SE = Standard Error

pH

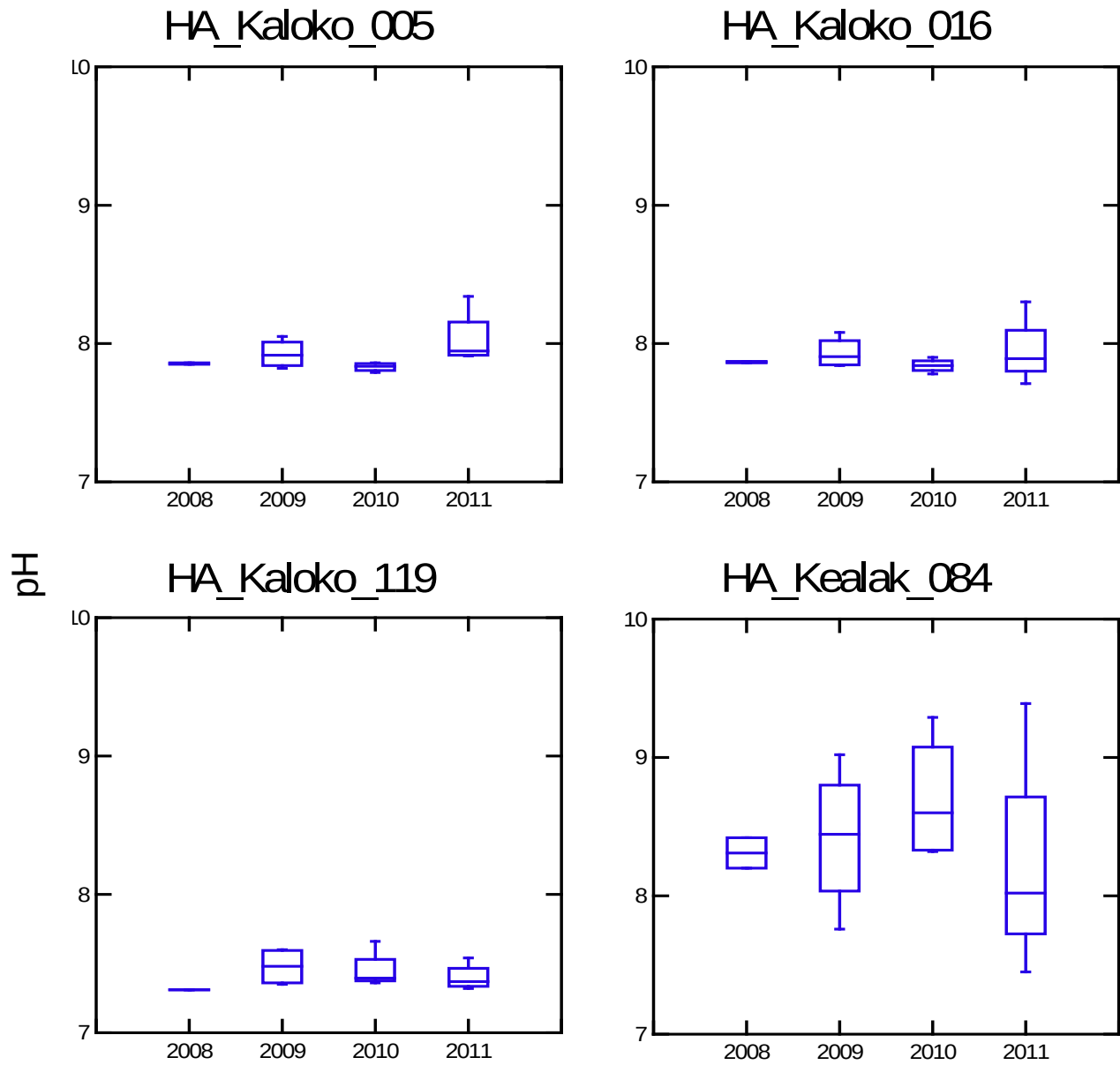


Figure 9. Box plots of pH in Kaloko-Honokōhau NHP anchialine pools.

Table 12. Mean pH in Kaloko-Honokōhau NHP anchialine pools.

	HA_Kaloko_005 (FKAHO01_ap)			HA_Kaloko_016 (FKAHO02_ap)			HA_Kealak_084 (FKAHO03_ap)			HA_Kaloko_119 (FKAHO04_ap)		
Date	pH	SE ¹	n	pH	SE ¹	n	pH	SE ¹	n	pH	SE ¹	n
5/15/2008	7.9	0.00	8	7.9	0.00	8	8.4	0.00	7	7.3	0.00	14
10/27/2008	7.9	0.00	10	7.9	0.00	8	8.2	0.03	12	7.3	0.00	11
2/26/2009	8.0	0.00	9	8.0	0.00	14	9.0	0.02	13	7.6	0.01	10
4/28/2009	8.1	0.00	11	8.1	0.00	15	8.6	0.01	15	7.6	0.00	12
7/24/2009	7.9	0.00	14	7.8	0.00	13	7.8	0.01	12	7.4	0.00	12
10/29/2009	7.8	0.00	11	7.9	0.00	12	8.3	0.01	18	7.4	0.01	18
1/19/2010	7.9	0.01	11	7.9	0.00	17	9.3	0.02	15	7.4	0.01	16
4/14/2010	7.8	0.02	12	7.8	0.01	10	8.9	0.01	23	7.4	0.00	13
7/16/2010	7.8	0.01	14	7.8	0.00	16	8.3	0.00	18	7.7	0.01	15
11/19/2010	7.9	0.01	13	7.9	0.01	21	8.3	0.01	12	7.4	0.00	15
1/24/2011	8.3	0.07	9	8.3	0.02	12	9.4	0.04	16	7.5	0.06	13
4/28/2011	7.9	0.00	15	7.9	0.00	13	7.5	0.00	15	7.4	0.02	14
8/12/2011	7.9	0.00	15	7.7	0.00	13	8.0	0.00	13	7.3	0.00	14
10/27/2011	8.0	0.00	16							7.4	0.00	14
10/31/2011							8.0	0.00	10			

¹SE = Standard Error

Salinity

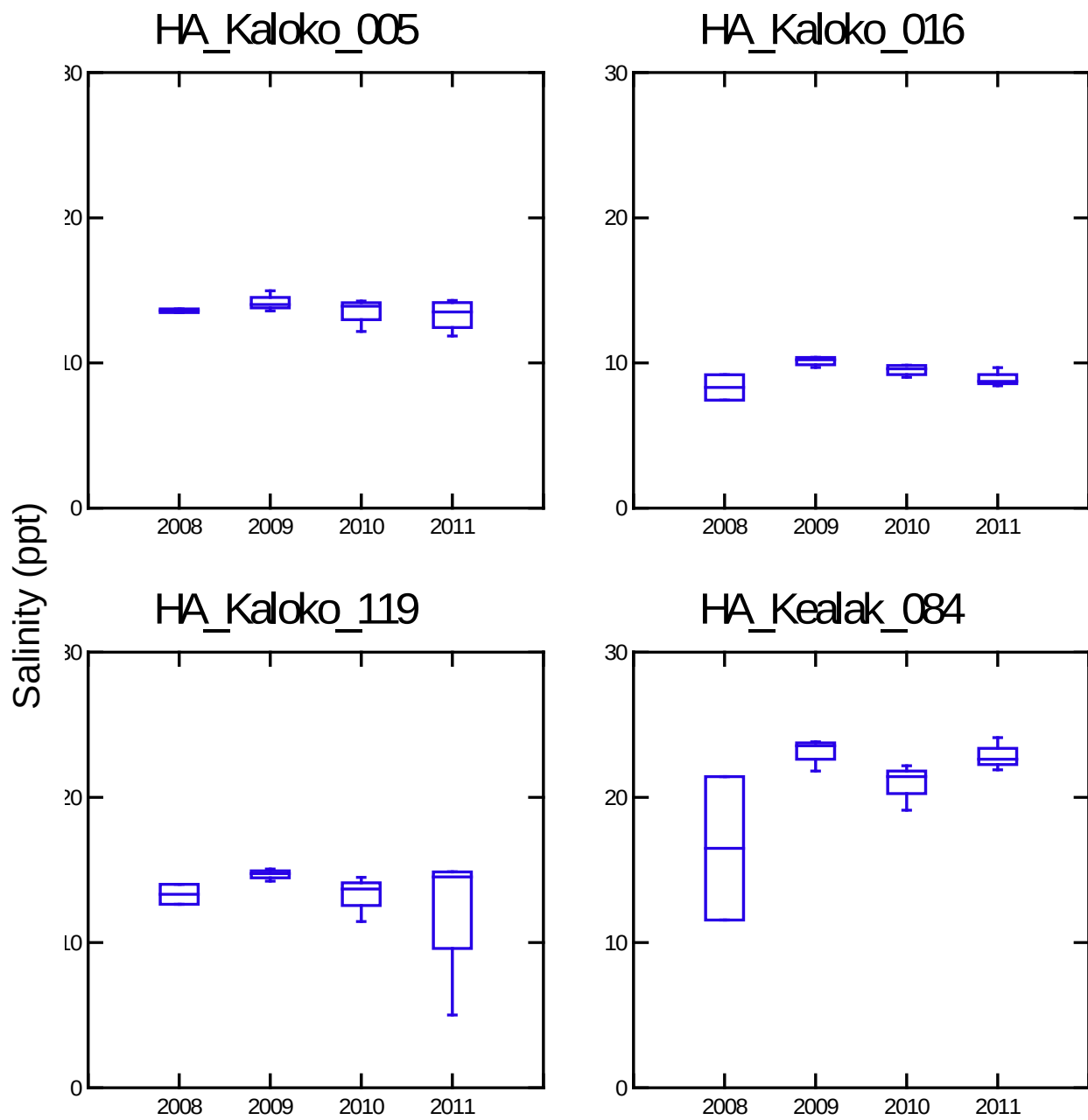


Figure 10. Box plots of salinity in Kaloko-Honokōhau NHP anchialine pools.

Table 13. Mean salinity (ppt) in Kaloko-Honokōhau NHP anchialine pools.

Date	HA_Kaloko_005 (FKAHO01_ap)			HA_Kaloko_016 (FKAHO02_ap)			HA_Kealak_084 (FKAHO03_ap)			HA_Kaloko_119 (FKAHO04_ap)		
	ppt	SE ¹	n	ppt	SE ¹	n	ppt	SE ¹	n	ppt	SE ¹	n
5/15/2008	13.5	0.00	8	9.2	0.01	8	11.6	0.01	7	12.6	0.00	14
10/27/2008	13.7	0.00	10	7.4	0.01	8	21.4	0.01	12	14.0	0.00	11
2/26/2009	14.0	0.01	9	10.1	0.00	14	21.8	0.05	13	14.2	0.01	10
4/28/2009	14.0	0.00	11	10.4	0.01	15	23.8	0.01	15	14.7	0.01	12
7/24/2009	15.0	0.00	14	10.4	0.00	13	23.4	0.01	12	14.8	0.01	12
10/29/2009	13.6	0.00	11	9.7	0.00	12	23.7	0.01	18	15.1	0.01	18
1/19/2010	14.0	0.01	11	9.8	0.01	17	21.4	0.02	15	14.5	0.00	16
4/14/2010	12.2	0.00	12	9.4	0.01	10	22.2	0.06	23	11.5	0.05	13
7/16/2010	14.3	0.00	14	9.8	0.00	16	21.4	0.00	18	13.7	0.00	15
11/19/2010	13.8	0.00	13	9.0	0.00	21	19.1	0.03	12	13.7	0.02	15
1/24/2011	14.3	0.00	9	9.7	0.00	12	21.9	0.01	16	14.9	0.01	13
4/28/2011	11.9	0.01	15	8.4	0.00	13				5.0	0.04	14
8/12/2011	13.0	0.00	15	8.7	0.00	13	22.6	0.01	13	14.2	0.00	14
10/27/2011	14.0	0.00	16							14.9	0.00	14
10/31/2011							24.1	0.00	10			

¹SE = Standard Error

Specific Conductance

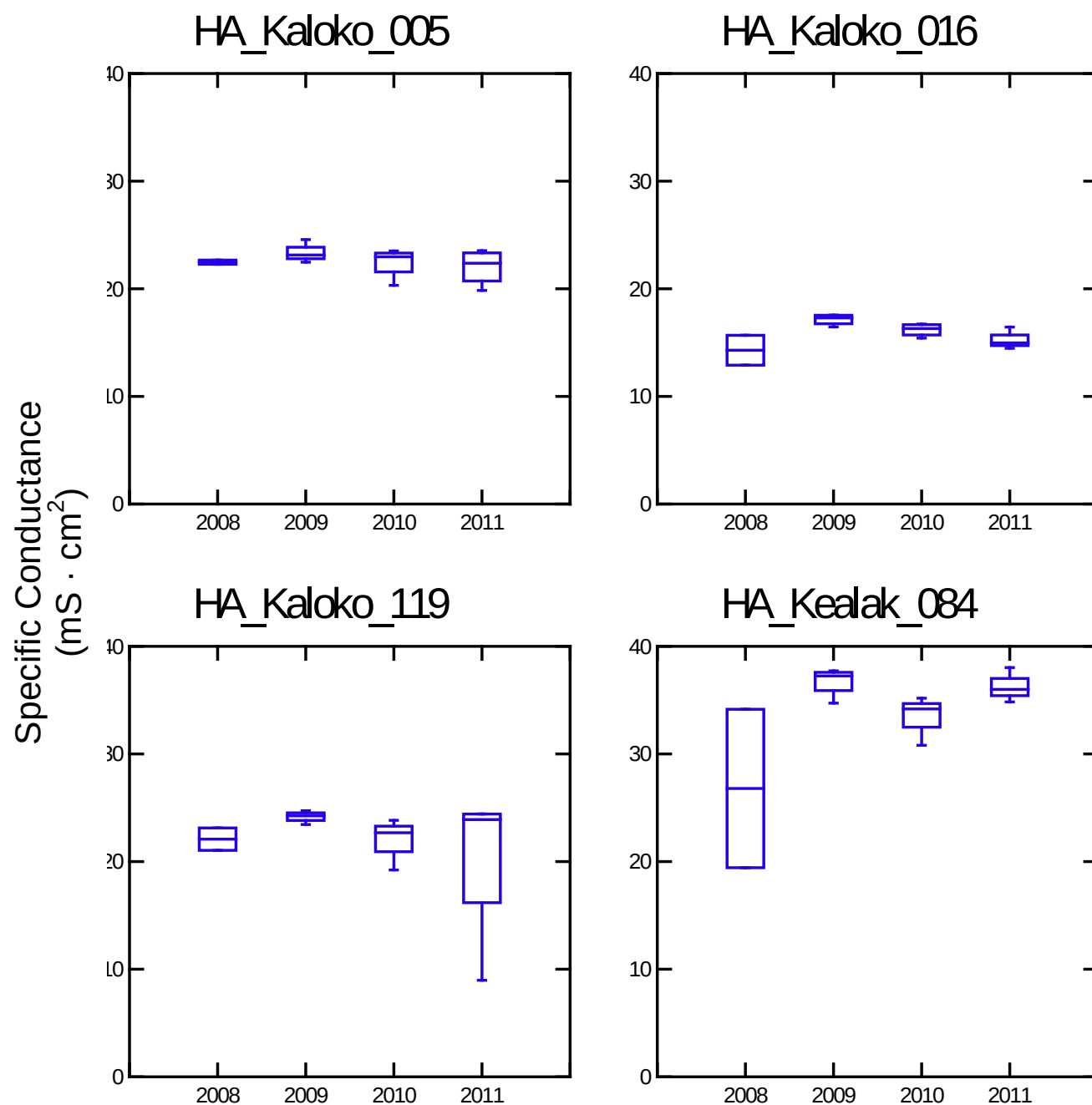


Figure 11. Box plots of specific conductance in Kaloko-Honokōhau NHP anchialine pools.

Table 14. Mean Specific Conductance SpC ($\text{mS} \cdot \text{cm}^{-1}$) in Kaloko-Honokōhau NHP anchialine pools.

Date	HA_Kaloko_005 (FKAHO01_ap)			HA_Kaloko_016 (FKAHO02_ap)			HA_Kealak_084 (FKAHO03_ap)			HA_Kaloko_119 (FKAHO04_ap)		
	SpC	SE ¹	n	SpC	SE ¹	n	SpC	SE ¹	n	SpC	SE ¹	n
5/15/2008	22.3	0.00	8	15.7	0.01	8	19.4	0.01	7	21.1	0.00	14
10/27/2008	22.7	0.00	10	12.9	0.02	8	34.2	0.01	12	23.1	0.01	11
2/26/2009	23.2	0.02	9	17.0	0.00	14	34.7	0.07	13	23.5	0.01	10
4/28/2009	23.1	0.00	11	17.6	0.02	15	37.7	0.01	15	24.2	0.00	12
7/24/2009	24.6	0.01	14	17.5	0.00	13	37.1	0.01	12	24.3	0.01	12
10/29/2009	22.5	0.00	11	16.5	0.00	12	37.4	0.02	18	24.7	0.01	18
1/19/2010	23.1	0.01	11	16.6	0.01	17	34.2	0.03	15	23.8	0.00	16
4/14/2010	20.3	0.00	12	16.0	0.02	10	35.2	0.09	23	19.2	0.07	13
7/16/2010	23.5	0.01	14	16.7	0.00	16	34.2	0.00	18	22.8	0.00	15
11/19/2010	22.8	0.00	13	15.4	0.00	21	30.8	0.05	12	22.6	0.04	15
1/24/2011	23.6	0.00	9	16.4	0.00	12	34.8	0.02	16	24.4	0.01	13
4/28/2011	19.8	0.01	15	14.5	0.00	13				9.0	0.07	14
8/12/2011	21.6	0.00	15	15.0	0.00	13	36.0	0.01	13	23.4	0.00	14
10/27/2011	23.1	0.00	16							24.4	0.00	14
10/31/2011							38.0	0.00	10			

¹SE = Standard Error

Temperature

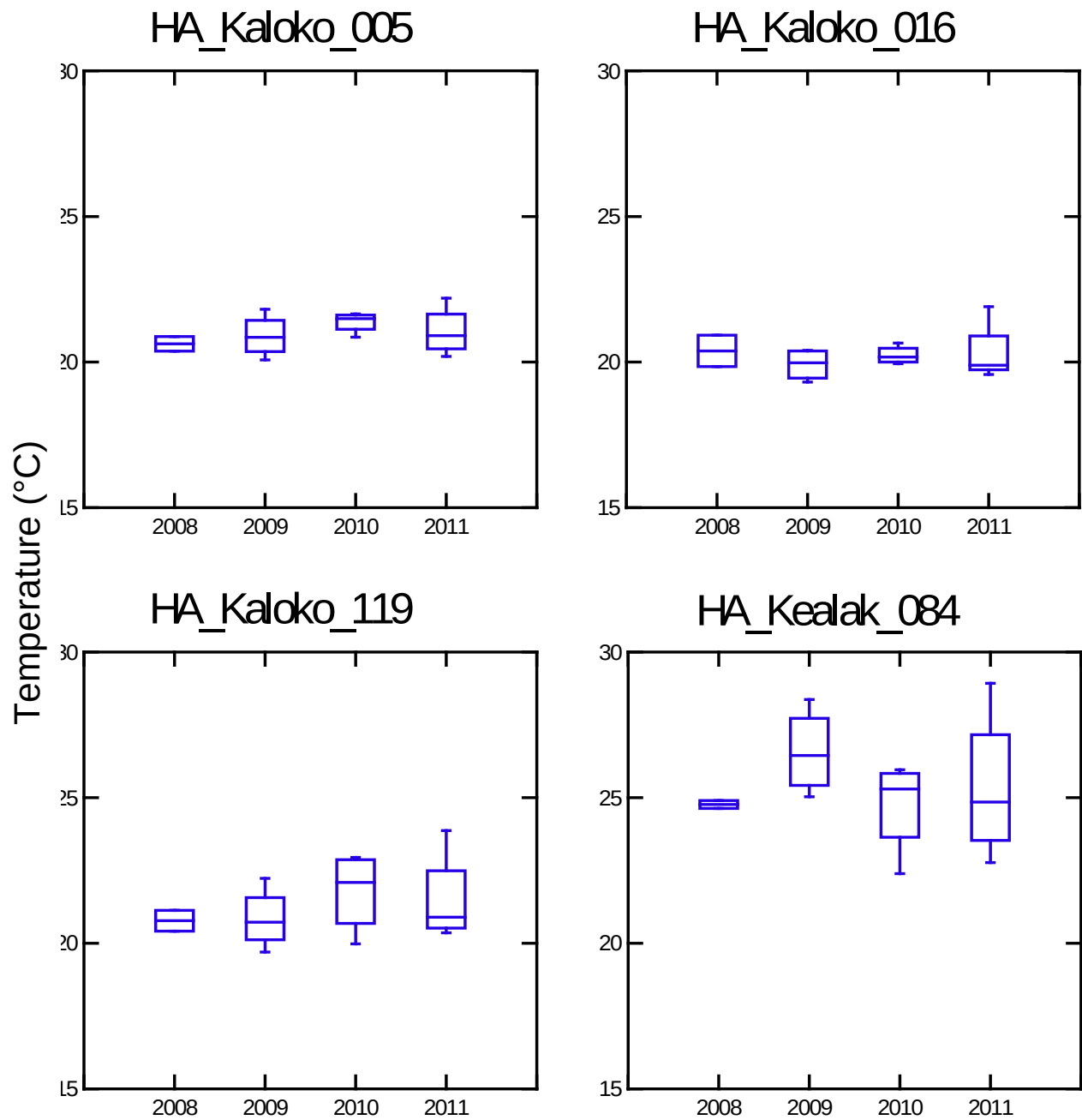


Figure 12. Box plots of temperature in Kaloko-Honokōhau NHP anchialine pools.

Table 15. Mean temperature (°C) in Kaloko-Honokōhau NHP anchialine pools.

Date	HA_Kaloko_005 (FKAHO01_ap)			HA_Kaloko_016 (FKAHO02_ap)			HA_Kealak_084 (FKAHO03_ap)			HA_Kaloko_119 (FKAHO04_ap)		
	°C	SE ¹	n	°C	SE ¹	n	°C	SE ¹	n	°C	SE ¹	n
5/15/2008	20.4	0.00	8	19.8	0.01	8	24.6	0.03	7	20.4	0.01	14
10/27/2008	20.9	0.01	10	20.9	0.01	8	24.9	0.02	12	21.1	0.03	11
2/26/2009	20.1	0.01	9	19.3	0.01	14	25.0	0.18	13	19.7	0.01	10
4/28/2009	20.6	0.01	11	19.6	0.02	15	28.4	0.01	15	20.5	0.01	12
7/24/2009	21.8	0.00	14	20.4	0.01	13	25.8	0.04	12	22.2	0.01	12
10/29/2009	21.1	0.00	11	20.4	0.01	12	27.1	0.03	18	20.9	0.01	18
1/19/2010	20.9	0.03	11	19.9	0.01	17	26.0	0.10	15	20.0	0.01	16
4/14/2010	21.7	0.03	12	20.1	0.04	10	22.4	0.01	23	21.4	0.03	13
7/16/2010	21.6	0.01	14	20.3	0.01	16	25.7	0.00	18	23.0	0.03	15
11/19/2010	21.4	0.01	13	20.7	0.02	21	24.9	0.04	12	22.8	0.04	15
1/24/2011	20.2	0.02	9	19.6	0.00	12	24.3	0.01	16	20.4	0.02	13
4/28/2011	21.1	0.03	15	19.9	0.01	13	22.8	0.01	15	23.9	0.02	14
8/12/2011	22.2	0.01	15	21.9	0.04	13	28.9	0.04	13	21.1	0.01	14
10/27/2011	20.7	0.00	16							20.7	0.01	14
10/31/2011							25.4	0.00	10			

¹SE = Standard Error

Turbidity

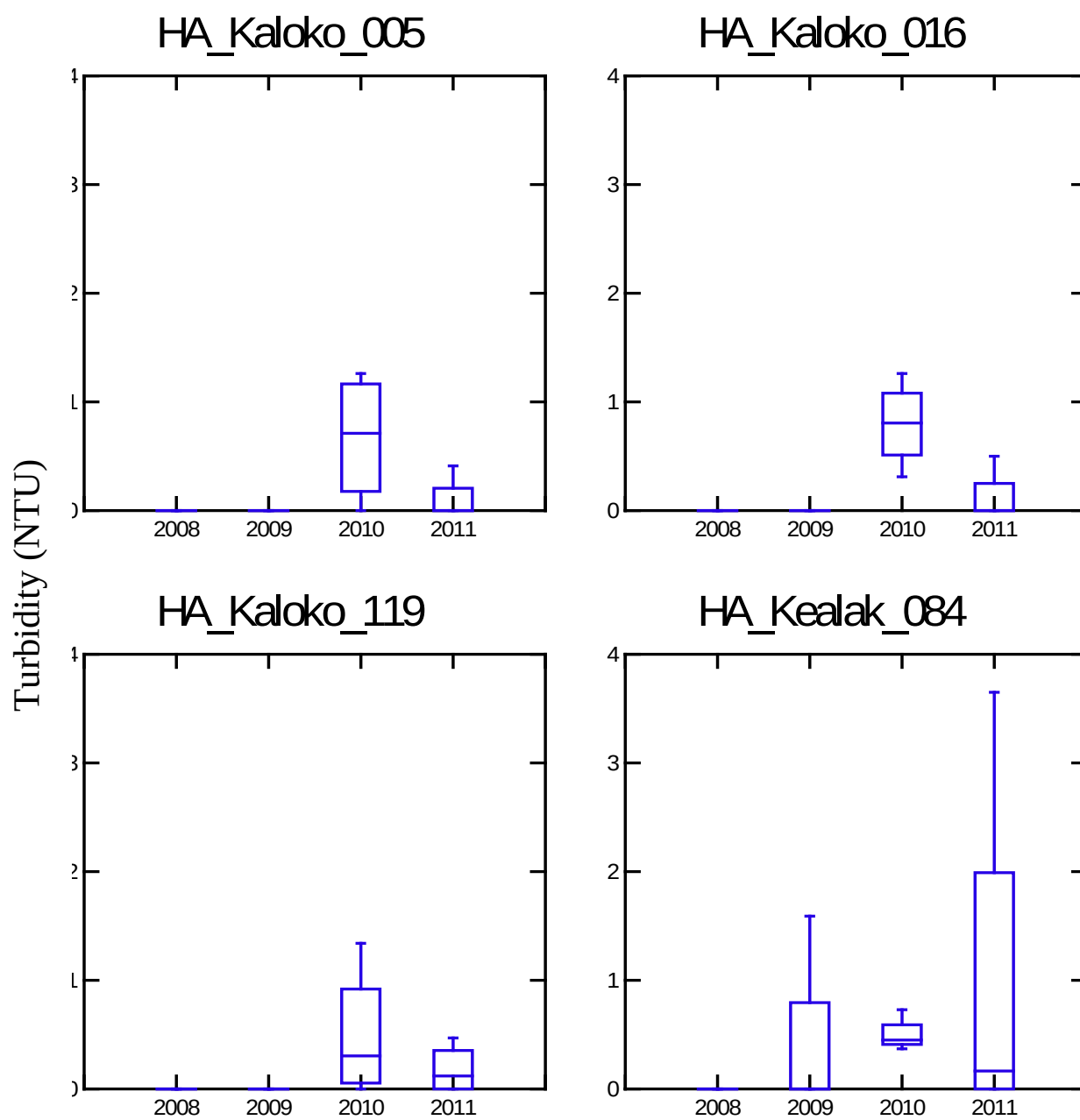


Figure 13. Box plots of turbidity in Kaloko-Honokōhau NHP anchialine pools.

Table 16. Mean turbidity (NTU) in Kaloko-Honokōhau NHP anchialine pools.

	HA_Kaloko_005 (FKAHO01_ap)			HA_Kaloko_016 (FKAHO02_ap)			HA_Kealak_084 (FKAHO03_ap)			HA_Kaloko_119 (FKAHO04_ap)		
Date	NTU	SE ¹	n	NTU	SE ¹	n	NTU	SE ¹	n	NTU	SE ¹	n
5/15/2008	0.0	0.0	8	0.0	0.0	8	0.0	0.0	7	0.0	0.0	14
10/27/2008	0.0	0.0	10	0.0	0.0	8	0.0	0.0	12	0.0	0.0	11
2/26/2009	0.0	0.0	9	0.0	0.0	14	0.0	0.0	13	0.0	0.0	10
4/28/2009	0.0	0.0	11	0.0	0.0	15	1.6	0.5	15	0.0	0.0	12
7/24/2009	0.0	0.0	14	0.0	0.0	13	0.0	0.0	12	0.0	0.0	12
10/29/2009	0.0	0.0	11	0.0	0.0	12	0.0	0.0	18	0.0	0.0	18
1/19/2010	0.0	0.0	11	0.3	0.1	17				0.1	0.1	16
4/14/2010	1.1	0.1	12	0.9	0.1	10	0.4	0.1	23	0.5	0.2	13
7/16/2010	0.4	0.1	14	0.7	0.0	16	0.7	0.1	18	0.0	0.0	15
11/19/2010	1.3	0.1	13	1.3	0.1	21	0.5	0.2	12	1.3	0.1	15
1/24/2011	0.4	0.1	9	0.5	0.1	12	0.0	0.0	16	0.5	0.1	13
4/28/2011	0.0	0.0	15	0.0	0.0	13	3.7	0.1	15	0.2	0.0	14
8/12/2011	0.0	0.0	15	0.0	0.0	13	0.0	0.0	13	0.0	0.0	14
10/27/2011	0.0	0.0	16							0.0	0.0	14
10/31/2011							0.3	0.1	10			

¹SE = Standard Error

Discussion

Four “fixed site” anchialine pools were sampled quarterly, and 52 “temporary site” pools were sampled one to three times, from 2008 through 2011. During this time no major ecological events were detected in pools. Relatively minor algal blooms may have occurred in 2011 in HA_Kaloko_119 and HA_Kealak_084 as indicated by chlorophyll. Elevated nitrogen concentrations were observed in HA_Kaloko_119 in 2009. There was no evidence of biogeochemical alteration caused by the tsunami of March 11, 2011.

Conditions in HA_Kealak_084 were notably different from other pools. HA_Kealak_084 regularly displays higher oxygen and pH, and lower dissolved nutrient concentrations. Such results are consistent with the presence of a vigorous population of the macroalga *Ulva reticulata*. Consumption of dissolved CO₂ by algae and macrophytes is known to alter the carbonic acid balance of waterbodies, increasing pH (Wetzel 2001). As an autotroph, algae produces oxygen, elevating concentrations. Some measured oxygen concentrations, and calculated saturations, were however extremely high. It is possible that some high measured oxygen values were higher than actual values. These data were not removed from certified data sets in order to preserve a record of high oxygen saturation.

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