



Water Quality in Streams of National Park of American Samoa

Summary Report 2009-2011

Natural Resource Data Series NPS/NPSA/NRDS—2015/753



ON THE COVER

A stream in National Park of America Samoa
Photograph by: David Raikow

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Abstract

This Natural Resource Data Series Report (NRDS) presents data collected from Amalau Stream, Fagatuitui Stream, and Leafu Stream on the island of Tutuila, and Laufuti Stream on the island of Tau, National Park of American Samoa, in American Samoa. 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 Report (NRR) series. Lower concentrations of dissolved nutrients observed in Laufuti pools as compared to downstream flowing portions of Laufuti stream were consistent with hydrological conditions. Differences between parameter values measured in Amalau Stream forest and village sites were subtle. TDN measurements appear higher in downstream Leafu Stream village sites compared to upstream forest sites. Turbidity slightly exceeded the published water quality limit once in Fagatuitui Stream in 2010, but sampling was limited to times of low flow due to safety concerns.

Acknowledgments

We thank Jim Bacon, Sean Eagan, Visa Vaivai, and the staff of NPSA 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	Hawai'i Volcanoes National Park
I&M	Inventory and Monitoring Program of the National Park Service
$\text{mg} \cdot \text{L}^{-1}$	Milligrams per Liter
$\text{mgN} \cdot \text{L}^{-1}$	Milligrams of Nitrogen per Liter
n	Number of measurements or samples
NO ₂	Nitrite
NO ₃	Nitrate
NPS	National Park Service
NPSA	National Park of American Samoa
NRDS	Natural Resource Data Series Report
NRR	Natural Resource 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
TN	Total Nitrogen
TP	Total Phosphorus
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) in Amalau Stream, Fagatuitui Stream, and Leafu Stream on the island of Tutuila, and Laufuti Stream on the island of Tau, National Park of American Samoa, in American Samoa, between 2009-2011.

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 Reports (NRR).

Water quality criteria for streams in American Samoa are defined in American Samoa Water Quality Standards (American Samoa 2013). Streams in American Samoa fall under the category “Fresh Surface Waters”. Water quality criteria are defined for turbidity, total phosphorus, total nitrogen, and total suspended solids (Table 1). Note that dissolved nitrogen and phosphorus, which are measured here, are not equivalent to total nitrogen and total phosphorus.

The purpose of collecting data on Vital Signs is to provide park managers with information on current conditions and temporal trends in ecosystem health. Park managers can use this information to respond to resource conditions and evaluate management actions. 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).

Table 1. American Samoa--specific water criteria for fresh surface waters (American Samoa 2013).

Parameter	Median not to exceed	Not to exceed more than 10% of the time	Not to exceed more than 2% of the time
Turbidity (NTU)	5	8	12
Total Phosphorus (µg/l as P)	175	390	635
Total Nitrogen (µg/l as N)	300	650	1000
Total Suspended Solids (mg/l)	5	10	15

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).

Sample Sites

National Park of American Samoa is located on the islands of Tutuila, Tau, and Ofu. (Fig. 1). Stream sites are located on Tutuila and Tau. Site names used by I&M are formatted to designate fixed or temporary sites (“F” or “T” respectively), island (TUT = Tutuila, TAU = Tau), a number (e.g. 01), and habitat type (“fw” for freshwater); e.g. “FTAU01_fw” (Table 1). Names for temporary sites are based on the date of sampling. Sites were sampled during quarterly trips. A new set of temporary sites were chosen at random for quarterly trips. Data were collected from September 2009 to August 2011. Some sites within streams were grouped into categories to reflect differing habitat conditions that could significantly affect measured parameters. Amalau Stream sites were grouped in “forest” or “village” categories to separate sites upstream of villages and in forests and sites downstream of, or in, villages. Leafu Stream sites were divided into “forest” and “village”, but the Vatia village site is on a different tributary than the Leafu forest sites. Lafuti stream was separated into upstream “pool” sites, and downstream “lower” sites reflecting the character of the stream. Specifically, in upstream portions of Lafuti water in the stream is limited to discrete non-flowing pools within the channel when conditions are safe to enter the stream, and “lower” sites are located further downstream where water is typically always flowing.

Water Collection

Water was collected using a new or acid-washed 140cc syringe just below the surface to avoid disturbance of sediment 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 then used to rinse each sample bottle three times, for a total of 50ml per bottle, discarding water between each rinse. The filter assembly was then removed, water again was drawn into the syringe, and a filter assembly was again placed onto the syringe. 140ml of water was then filtered 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 the headquarters of National Park of American Samoa or the field station on Ofu on the day of collection and then frozen. Samples were later transported to Hawai’i Volcanoes National Park (HAVO) while frozen. Samples were delivered to the EPSCoR Analytical Laboratory at the University of Hawaii 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 ($^{\circ}\text{C}$), specific conductivity (SpC) in milli- Siemens per centimeter ($\text{mS} \cdot \text{cm}^{-1}$), pH, optical dissolved oxygen in milligrams per liter ($\text{mg} \cdot \text{L}^{-1}$, ODO), chlorophyll in micrograms per liter ($\mu\text{g} \cdot \text{L}^{-1}$), and turbidity in nephelometric turbidity units (NTU). The sonde also reported salinity in parts per thousand (ppt) calculated from SpC, and 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, during which readings were taken every 30 seconds. The mean and variance of stable values, excluding initial readings, 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. Global positioning system coordinates and site elevation were recorded. Photographs of sample sites were also taken.

Table 2. NPSA sample site locations.

I&M site designation	Stream	Decimal Degrees Latitude	Decimal Degrees Longitude
FTAU01_fw	Laufuti-Lower	-14.24976	-169.44593
FTAU02_fw	Laufuti-Lower	-14.24808	-169.44515
FTAU03_fw	Laufuti-Pool	-14.24390	-169.44681
FTAU04_fw	Laufuti-Pool	-14.24107	-169.45087
FTUT01_fw	Leafu-Village	-14.25173	-170.67611
FTUT02_fw	Leafu-Forest	-14.25140	-170.67973
FTUT03_fw	Leafu-Forest	-14.25230	-170.68261
FTUT04_fw	Fagatuitui	-14.27253	-170.71922
FTUT05_fw	Fagatuitui	-14.27393	-170.71754
FTUT06_fw	Fagatuitui	-14.27492	-170.71700
FTUT07_fw	Amalau-Village	-14.25338	-170.65835
FTUT08_fw	Amalau-Forest	-14.25636	-170.66011
TTAU0120110513	Laufuti-Lower	-14.24276	-169.44769
TTAU0120110815	Laufuti-Pool	-14.24274	-169.44765
TTAU0220110514	Laufuti-Lower	-14.23851	-169.45354
TTUT0120110506	Leafu-Forest	-14.25185	-170.68199
TTUT0120110629	Fagatuitui	-14.74560	-170.71700
TTUT0220110506	Leafu-Forest	-14.25355	-170.68445
TTUT0220110629	Fagatuitui	-14.27557	-170.71661
TTUT0320110517	Fagatuitui	-14.27603	-170.71645

Table 3. NPSA sampling events.

Year	Date	Personnel
2009	11-Sep-09	Anne Farahi, Bert Fuiava, Jim Nimz, Kazuki Kageyama, Tahzay Jones
2009	21-Dec-09	Bert Fuiava, Jim Nimz, Peter Craig
2010	04-Jan-10	Bert Fuiava, Darren Doderer, Jim Nimz, Tuilinga Inga
2010	01-Jul-10	Anne Farahi, Bert Fuiava, Chris Rillahan, Jim Nimz, Tanu Yosefa, Tim Clark
2011	04-May-11	Anne Farahi, Bert Fuiava, Carlo Caruso, Jim Nimz, Koli Nafagat, Ricky Misaalefua, Tahzay Jones, Tasi Toloa, Visa Vaivai
2011	28-Jun-11	Bert Fuiava, Tasi Toloa
2011	01-Aug-11	Bert Fuiava, Carlo Caruso, Jim Nimz, Mike Toke, Ricky Misaalefua, Tasi Toloa

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 Tahzay 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. Outlying data and 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 short time required to take multiple samples or readings. Variation in sample values should be most influenced by external factors. Therefore the arithmetic 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. Mean values of chlorophyll that were less than zero are reported with a value of zero, i.e. as non-detects. Standard deviation was not calculated for sets of data with $n \leq 2$.

Turbidity probes can return negative values when conditions are at or near zero turbidity. Negative turbidity readings were set to 0.1, the lowest value above zero for the probe. Resetting very low turbidity values to 0.1 NTU is based on the assumption that natural stream water, while often visually indistinguishable from transparent deionized (distilled) water, can never be completely particulate-free.

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. 6). 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 $Q3-Q1$). 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.

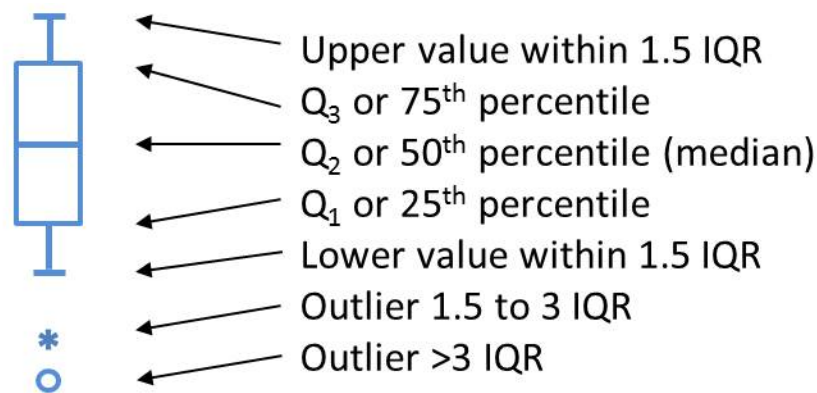


Figure 2. Box plot explanation.

Results

Fixed sites in National Park of American Samoa were sampled from 2009 to 2011. Results are presented as summaries by year (Tables 4-6) and parameter (Figs. 3-13). Annual summaries present the minimum, maximum, median, and variance as standard deviation of all individual measurements at each stream or habitat across an entire year. Box plots display individual replicate data lumped from all sampling events within a stream or habitat classification across a year.

2009

Two sampling trips were conducted in 2009. This was the start of the monitoring program at National Park of American Samoa.

Table 4. 2009 summary of water quality parameters National Park of American Samoa streams.

Parameter	Unit	Site	n ¹	Minimum ²	Maximum ²	Median ²	SD
Total Dissolved Phosphorus	$\mu\text{gP} \cdot \text{L}^{-1}$	Fagatuitui	9	42.3	90.6	82.6	15.5
		Laufuti-Lower	6	78.8	98.3	87.8	8.5
		Laufuti-Pool	3	7.5	7.5	7.5	0.0
		Leafu-Forest	12	64.0	80.0	71.1	4.4
		Leafu-Village	6	46.0	84.1	62.0	15.6
Total Dissolved Nitrogen	$\text{mgN} \cdot \text{L}^{-1}$	Fagatuitui	9	0.07	0.13	0.11	0.02
		Laufuti-Lower	6	0.10	0.25	0.16	0.08
		Laufuti-Pool	3	0.07	0.08	0.07	0.00
		Leafu-Forest	12	0.07	0.10	0.07	0.01
		Leafu-Village	6	0.07	0.20	0.13	0.04
Nitrite + Nitrate	$\mu\text{gN} \cdot \text{L}^{-1}$	Fagatuitui	9	17.0	59.0	55.1	15.2
		Laufuti-Lower	6	121.2	252.5	189.8	66.3
		Laufuti-Pool	3	5.2	7.0	6.7	1.0
		Leafu-Forest	12	6.0	44.0	11.4	10.1
		Leafu-Village	6	9.0	16.0	14.5	2.7
Chlorophyll	$\mu\text{g} \cdot \text{L}^{-1}$	Fagatuitui	2	0.2	0.5	0.4	0.2
		Laufuti-Lower	2	0.0	0.0	0.0	0.0
		Laufuti-Pool	1	0.6	0.6	0.0	
		Leafu-Forest	2	0.0	0.0	0.0	0.0
		Leafu-Village	1	0.0	0.0	0.0	
Dissolved Oxygen Concentration	$\text{mg} \cdot \text{L}^{-1}$	Fagatuitui	3	7.6	8.1	7.7	0.2
		Laufuti-Lower	2	7.6	8.6	8.1	0.7
		Laufuti-Pool	1	8.4	8.4	0.0	
		Leafu-Forest	2	8.1	8.2	8.2	0.1
		Leafu-Village	1	9.4	9.4	0.0	

Table 4 (continued). 2009 summary of water quality parameters National Park of American Samoa streams.

Dissolved Oxygen Saturation	%	Fagatuitui	3	92.2	97.4	94.0	2.6
		Laufuti-Lower	2	90.1	101.5	95.8	8.0
		Laufuti-Pool	1	95.6	95.6	0.0	
		Leafu-Forest	2	97.6	99.6	98.6	1.4
		Leafu-Village	1	110.6	110.6	0.0	
pH	none	Fagatuitui	3	7.6	8.0	7.8	0.2
		Laufuti-Lower	2	7.2	7.6	7.4	0.3
		Laufuti-Pool	1	6.7	6.7	0.0	
		Leafu-Forest	2	7.7	7.8	7.8	0.1
		Leafu-Village	1	7.6	7.6	0.0	
Salinity	ppt	Fagatuitui	3	0.1	0.1	0.1	0.0
		Laufuti-Lower	2	0.0	0.0	0.0	0.0
		Laufuti-Pool	1	0.0	0.0	0.0	
		Leafu-Forest	2	0.1	0.1	0.1	0.0
Specific conductance	mS · cm ⁻¹	Fagatuitui	3	0.06	0.07	0.07	0.01
		Laufuti-Lower	2	0.04	0.04	0.04	0.00
		Laufuti-Pool	1	0.02	0.02	0.00	
		Leafu-Forest	2	0.05	0.06	0.06	0.01
Temperature	°C	Fagatuitui	3	24.9	25.1	24.9	0.1
		Laufuti-Lower	2	23.6	23.8	23.7	0.1
		Laufuti-Pool	1	21.6	21.6	0.0	
		Leafu-Forest	2	24.7	25.0	24.8	0.1
		Leafu-Village	1	23.6	23.6	0.0	
Turbidity	NTU	Fagatuitui	3	1.2	1.8	1.4	0.3
		Laufuti-Lower	2	0.3	0.4	0.4	0.0
		Laufuti-Pool	1	0.7	0.7	0.0	
		Leafu-Forest	2	1.1	1.8	1.5	0.5
		Leafu-Village	1	2.5	2.5	0.0	

¹n = number of individual replicate samples.

²Values that exceed water quality criteria (American Samoa 2013) are shown in bold and italics.

2010

Two sampling trips were conducted in 2010, in January and June.

Table 5. 2010 summary of water quality parameters National Park of American Samoa streams.

Parameter	Unit	Site	n ¹	Minimum ²	Maximum ²	Median ²	SD
Total Dissolved Phosphorus	$\mu\text{gP} \cdot \text{L}^{-1}$	Fagatuitui	18	46.0	84.0	60.5	8.9
		Laufuti-Lower	12	32.0	153.0	79.5	27.1
		Laufuti-Pool	9	7.5	22.0	7.5	3.5
		Leafu-Forest	5	67.0	77.0	72.0	4.0
		Leafu-Village	3	67.0	70.0	69.0	1.5
		Amalau-Forest	3	146.0	160.0	155.0	7.1
		Amalau-Village	3	115.0	164.0	131.0	25.0
Total Dissolved Nitrogen	$\text{mgN} \cdot \text{L}^{-1}$	Fagatuitui	18	0.07	0.53	0.11	0.10
		Laufuti-Lower	12	0.13	1.01	0.18	0.24
		Laufuti-Pool	9	0.10	0.21	0.15	0.05
		Leafu-Forest	5	0.09	0.11	0.10	0.01
		Leafu-Village	3	0.14	0.19	0.16	0.03
		Amalau-Forest	3	0.19	0.22	0.21	0.02
		Amalau-Village	3	0.11	0.19	0.14	0.04
Nitrite + Nitrate	$\mu\text{gN} \cdot \text{L}^{-1}$	Fagatuitui	18	20.0	50.0	36.0	10.3
		Laufuti-Lower	12	38.0	289.0	131.5	70.9
		Laufuti-Pool	9	2.0	67.0	5.0	30.0
		Leafu-Forest	5	18.0	28.0	24.0	4.5
		Leafu-Village	3	38.0	39.0	38.0	0.6
		Amalau-Forest	3	102.0	109.0	104.0	3.6
		Amalau-Village	3	63.0	68.0	64.0	2.6
Chlorophyll	$\mu\text{g} \cdot \text{L}^{-1}$	Fagatuitui	5	0.8	2.2	1.0	0.6
		Laufuti-Lower	3	0.0	0.9	0.7	0.5
		Laufuti-Pool	1	3.9	3.9	0.0	
		Leafu-Forest	2	0.0	0.0	0.0	0.0
		Leafu-Village	no data				
		Amalau-Forest	1	1.0	1.0	0.0	
		Amalau-Village	1	1.0	1.0	0.0	
Dissolved Oxygen Concentration	$\text{mg} \cdot \text{L}^{-1}$	Fagatuitui	5	7.7	8.1	8.0	0.1
		Laufuti-Lower	4	6.7	8.6	8.2	0.9
		Laufuti-Pool	3	3.9	8.7	8.1	2.6
		Leafu-Forest	2	7.9	8.2	8.0	0.2
		Leafu-Village	no data				
		Amalau-Forest	1	7.9	7.9	0.0	
		Amalau-Village	1	8.0	8.0	0.0	

Table 5 (continued). 2010 summary of water quality parameters N.P. of American Samoa streams.

Dissolved Oxygen Saturation	%	Fagatuitui	5	95.2	98.1	97.0	1.1
		Laufuti-Lower	4	79.4	101.8	97.3	10.2
		Laufuti-Pool	3	46.7	104.2	94.0	30.6
		Leafu-Forest	2	95.5	98.9	97.2	2.4
		Leafu-Village	no data				
		Amalau-Forest	1	97.9	97.9	0.0	
		Amalau-Village	1	98.3	98.3	0.0	
pH	none	Fagatuitui	5	7.5	8.0	7.7	0.2
		Laufuti-Lower	2	7.3	7.8	7.5	0.3
		Laufuti-Pool	1	7.2	7.2	0.0	
		Leafu-Forest	2	7.6	10.9	9.3	2.4
		Leafu-Village	no data				
		Amalau-Forest	1	7.8	7.8	0.0	
		Amalau-Village	1	7.9	7.9	0.0	
Salinity	ppt	Fagatuitui	5	0.05	0.05	0.05	0.00
		Laufuti-Lower	4	0.04	0.08	0.04	0.02
		Laufuti-Pool	3	0.01	0.02	0.02	0.01
		Leafu-Village	no data				
		Amalau-Forest	1	0.05	0.05	0.00	
		Amalau-Village	1	0.05	0.05	0.00	
Specific conductance	mS · cm ⁻¹	Fagatuitui	5	0.10	0.11	0.10	0.00
		Laufuti-Lower	4	0.04	0.09	0.08	0.02
		Laufuti-Pool	3	0.02	0.04	0.04	0.01
		Leafu-Forest	2	0.12	0.13	0.13	0.01
		Leafu-Village	no data				
		Amalau-Forest	1	0.10	0.10	0.00	
		Amalau-Village	1	0.11	0.11	0.00	
Temperature	°C	Fagatuitui	5	25.1	25.9	25.3	0.3
		Laufuti-Lower	4	24.0	24.3	24.1	0.1
		Laufuti-Pool	3	22.7	24.5	23.9	0.9
		Leafu-Forest	2	24.8	24.9	24.9	0.1
		Leafu-Village	no data				
		Amalau-Forest	1	26.3	26.3	0.0	
		Amalau-Village	1	25.8	25.8	0.0	
Turbidity	NTU	Fagatuitui	5	3.1	8.4	5.5	2.1
		Laufuti-Lower	4	0.1	0.1	0.1	0.0
		Laufuti-Pool	1	0.1	0.1	0.0	
		Leafu-Forest	2	0.1	1.9	1.0	1.3
		Leafu-Village	no data				
		Amalau-Forest	1	1.4	1.4	0.0	
		Amalau-Village	1	1.2	1.2	0.0	

¹n = number of individual replicate samples.

²Values that exceed water quality criteria (American Samoa 2013) are shown in bold and italics.

2011

Three sampling trips were conducted in 2011, in May, June, and August.

Table 6. 2011 summary of water quality parameters National Park of American Samoa streams.

Parameter	Unit	Site	n ¹	Minimum ²	Maximum ²	Median ²	SD
Total Dissolved Phosphorus	$\mu\text{gP} \cdot \text{L}^{-1}$	Fagatuitui	27	82.3	234.7	127.6	47.96
		Laufuti-Lower	12	15.0	100.3	46.7	40.00
		Laufuti-Pool	15	7.5	46.8	7.5	13.26
		Leafu-Forest	18	64.8	104.2	81.84	11.18
		Leafu-Village	6	62.4	74.7	65.00	4.83
Total Dissolved Nitrogen	$\text{mgN} \cdot \text{L}^{-1}$	Fagatuitui	27	0.07	0.61	0.33	0.16
		Laufuti-Lower	12	0.07	0.25	0.14	0.05
		Laufuti-Pool	15	0.07	0.35	0.16	0.08
		Leafu-Forest	18	0.09	0.17	0.13	0.03
		Leafu-Village	6	0.16	0.21	0.19	0.02
Nitrite + Nitrate	$\mu\text{gN} \cdot \text{L}^{-1}$	Fagatuitui	27	1.00	290.34	147.72	90.76
		Laufuti-Lower	12	1.00	147.36	60.14	68.97
		Laufuti-Pool	15	1.00	72.03	17.82	27.03
		Leafu-Forest	18	17.71	55.02	31.87	11.09
		Leafu-Village	6	19.93	65.22	35.66	15.56
Chlorophyll	$\mu\text{g} \cdot \text{L}^{-1}$	Fagatuitui	9	1.06	3.72	1.94	0.97
		Laufuti-Lower	4	0.49	1.00	0.84	0.22
		Laufuti-Pool	5	0.80	2.20	0.99	0.58
		Leafu-Forest	6	0.27	0.80	0.50	0.20
		Leafu-Village	2	0.59	0.67	0.63	0.06
Dissolved Oxygen Concentration	$\text{mg} \cdot \text{L}^{-1}$	Fagatuitui	9	4.52	8.09	6.76	1.07
		Laufuti-Lower	4	8.13	8.72	8.42	0.27
		Laufuti-Pool	5	5.14	7.90	6.48	1.22
		Leafu-Forest	6	6.43	7.89	7.50	0.61
		Leafu-Village	2	3.76	6.41	5.09	1.87
Dissolved Oxygen Saturation	%	Fagatuitui	8	86.15	98.24	93.34	4.20
		Laufuti-Lower	4	94.25	101.49	99.75	3.42
		Laufuti-Pool	5	59.93	91.08	74.79	14.16
		Leafu-Forest	6	89.43	96.30	93.39	2.32
		Leafu-Village	2	54.41	79.77	67.09	17.93
pH	none	Fagatuitui	9	7.12	10.67	10.02	1.45
		Laufuti-Lower	4	7.15	7.92	7.56	0.34
		Laufuti-Pool	5	6.79	7.82	6.89	0.43
		Leafu-Forest	6	7.84	10.37	7.93	1.23
		Leafu-Village	2	7.61	8.69	8.15	0.76

Table 6 (continued). 2011 summary of water quality parameters National Park of American Samoa streams.

Salinity	ppt	Fagatuitui	4	0.02	0.07	0.07	0.02
		Laufuti-Lower	4	0.01	0.04	0.03	0.02
		Laufuti-Pool	5	0.01	0.03	0.02	0.01
		Leafu-Forest	4	0.06	0.07	0.06	0.01
		Leafu-Village	1	0.06	0.06	0.00	
Specific conductance	mS · cm ⁻¹	Fagatuitui	4	0.05	0.16	0.14	0.05
		Laufuti-Lower	4	0.03	0.08	0.06	0.03
		Laufuti-Pool	5	0.02	0.05	0.04	0.01
		Leafu-Forest	4	0.13	0.16	0.14	0.02
		Leafu-Village	1	0.12	0.12	0.00	
Temperature	°C	Fagatuitui	9	24.87	26.03	25.12	0.37
		Laufuti-Lower	4	22.68	23.88	23.30	0.64
		Laufuti-Pool	5	22.26	23.06	22.43	0.36
		Leafu-Forest	6	24.78	25.76	25.33	0.33
		Leafu-Village	2	26.45	26.76	26.61	0.22
Turbidity	NTU	Fagatuitui	9	0.1	3.0	0.1	0.95
		Laufuti-Lower	4	0.1	0.1	0.1	0.00
		Laufuti-Pool	5	0.1	2.2	0.1	0.92
		Leafu-Forest	6	0.1	0.3	0.1	0.08
		Leafu-Village	1	0.1	0.1	0.1	

¹n = number of individual replicate samples.

²Values that exceed water quality criteria (American Samoa 2013) are shown in bold and italics

Summaries by Parameter

Total Dissolved Phosphorus

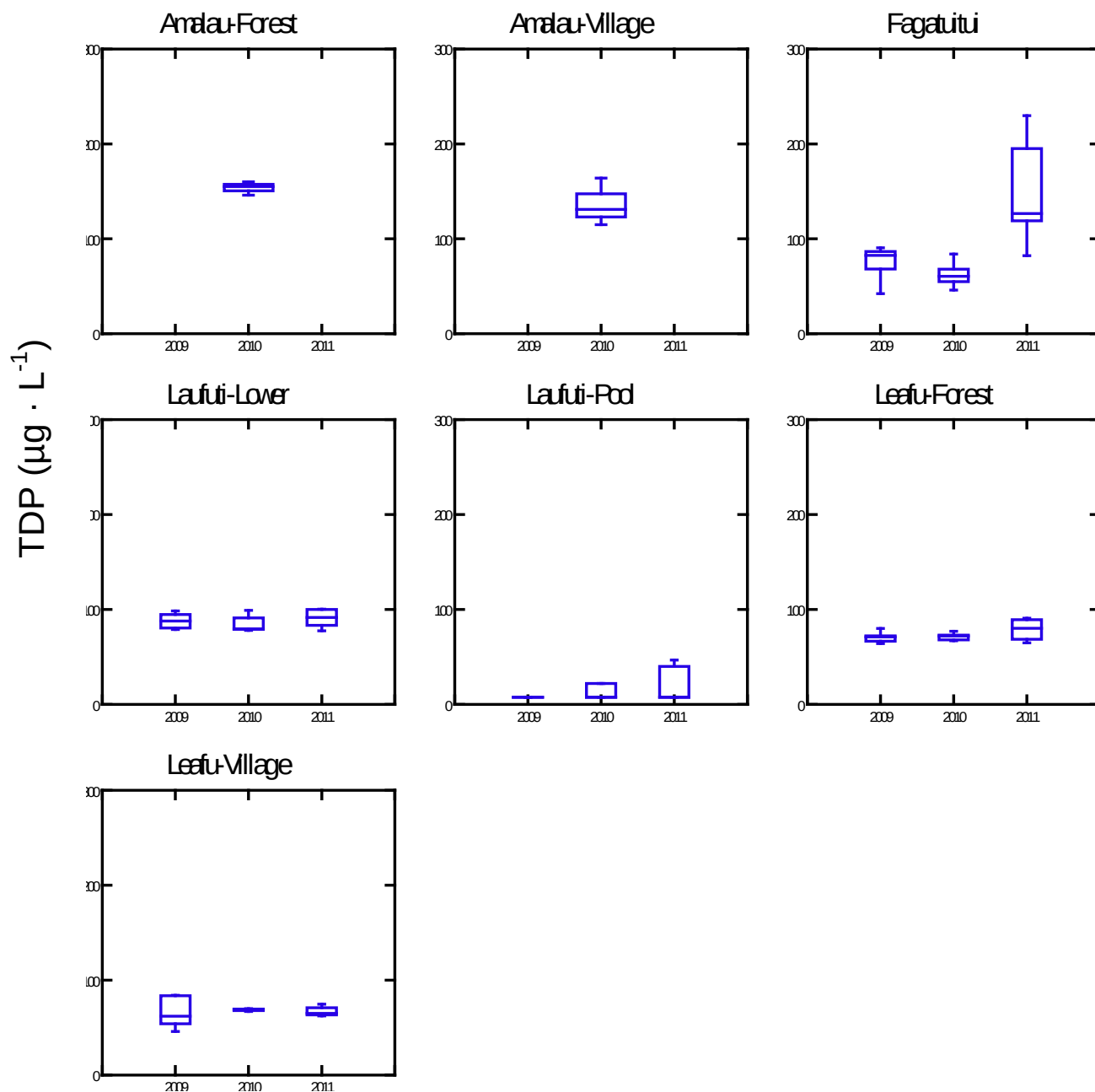


Figure 3. Box plots of total dissolved phosphorus in streams of National Park of American Samoa.

Total Dissolved Nitrogen

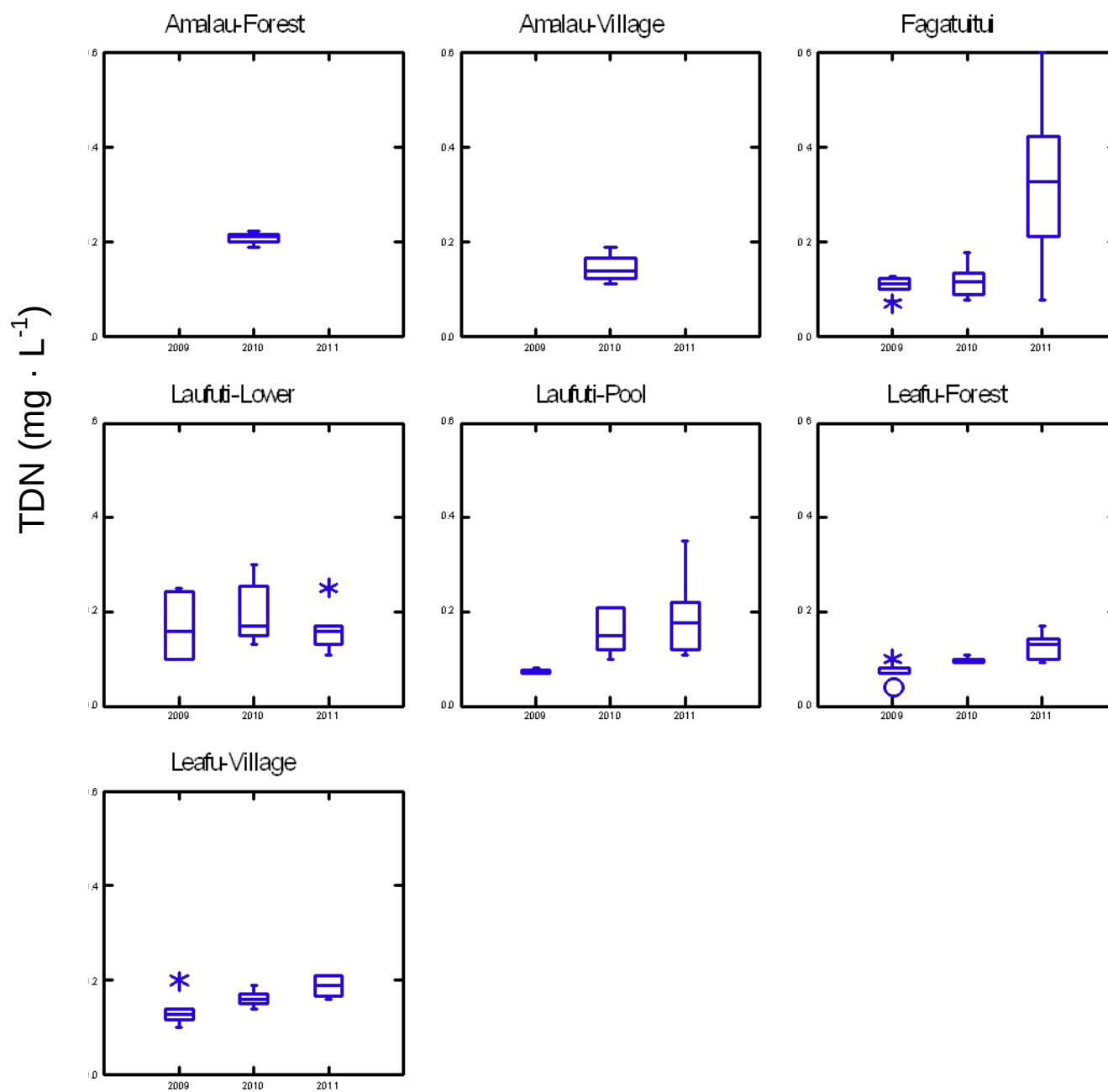


Figure 4. Box plots of total dissolved nitrogen in streams of National Park of American Samoa.

Nitrate + Nitrite

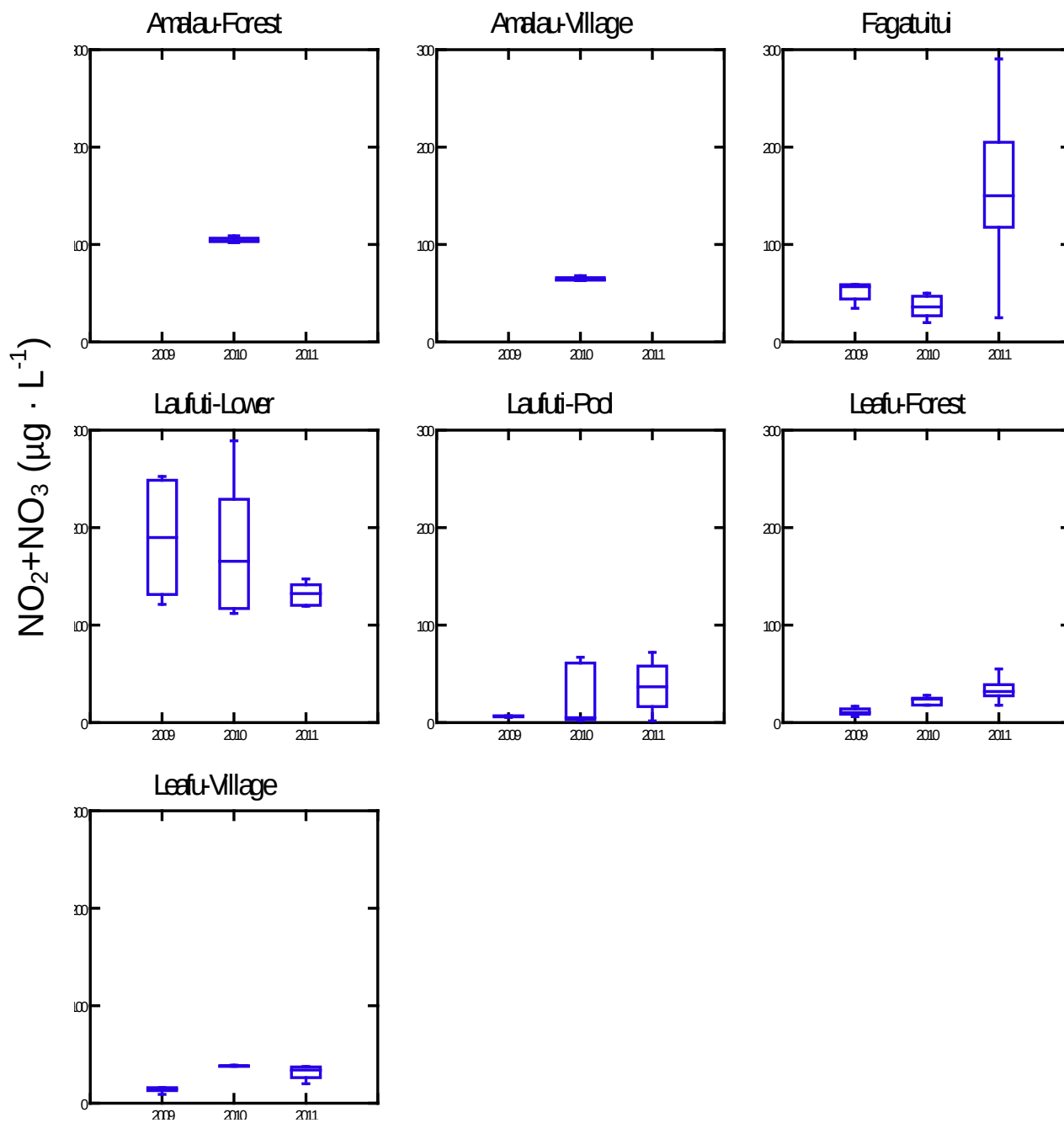


Figure 5. Box plots of Nitrate + Nitrite in streams of National Park of American Samoa.

Chlorophyll

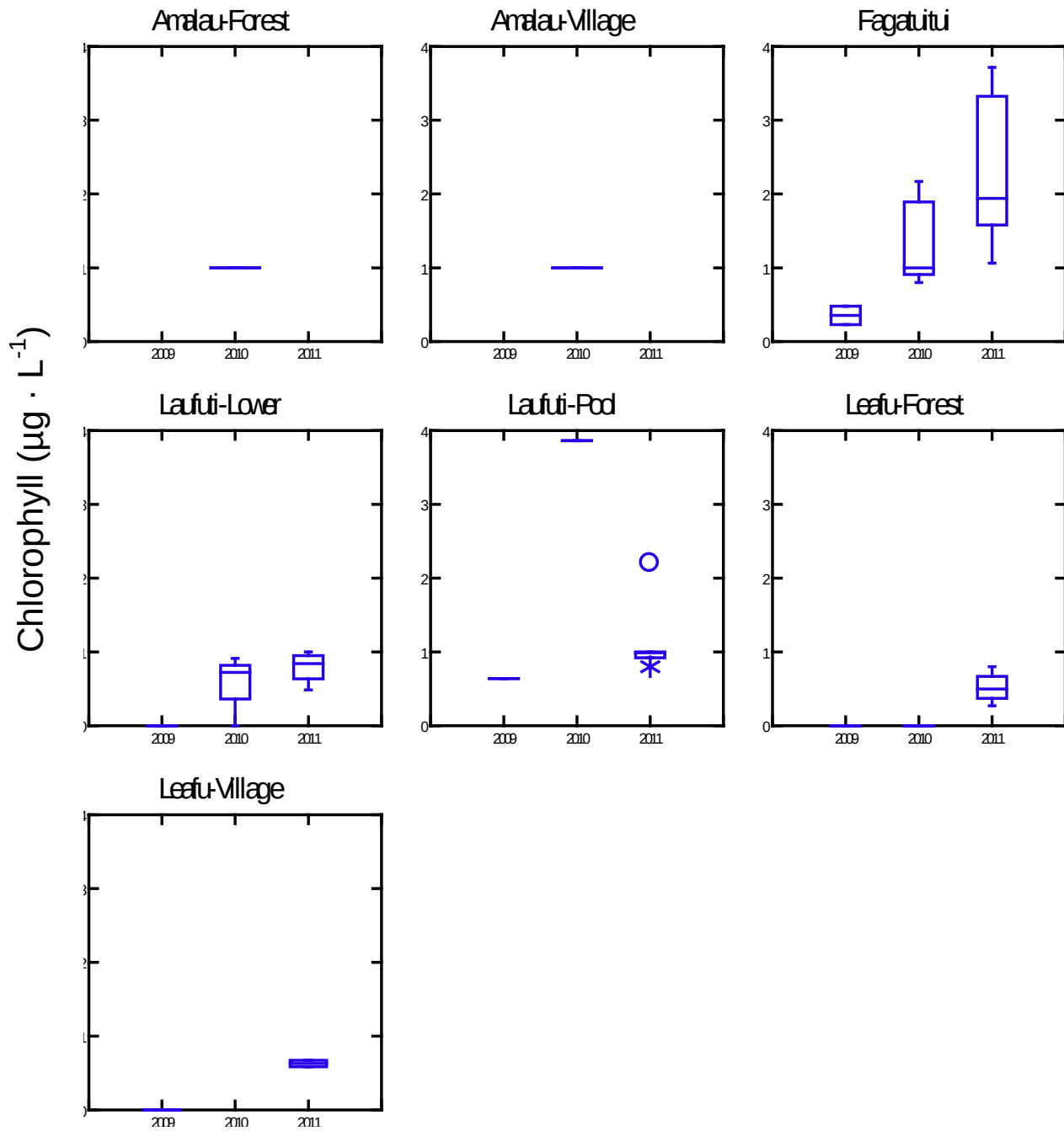


Figure 6. Box plots of chlorophyll in streams of National Park of American Samoa.

Oxygen Concentration

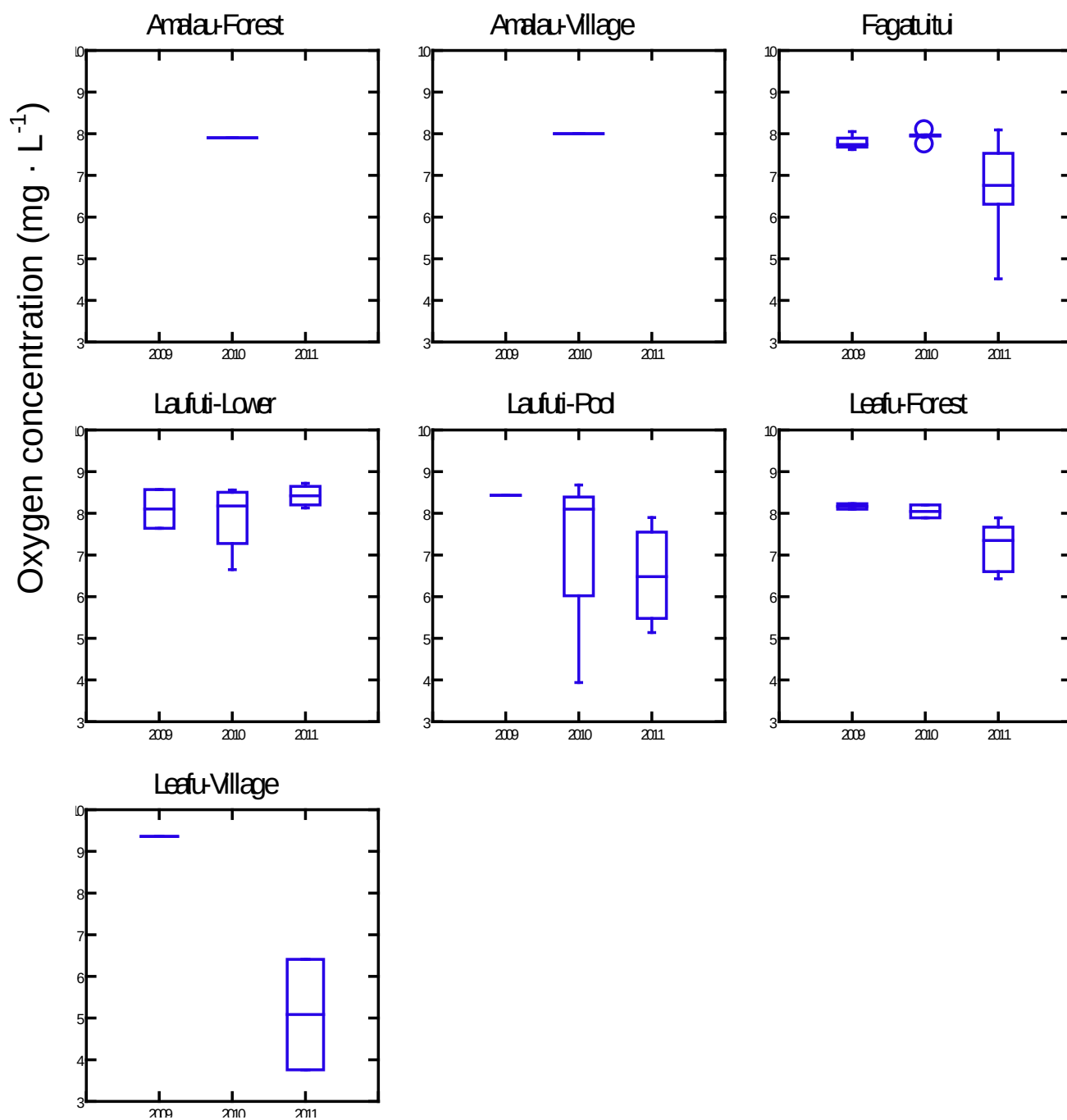


Figure 7. Box plots of oxygen concentration in streams of National Park of American Samoa.

Oxygen Saturation

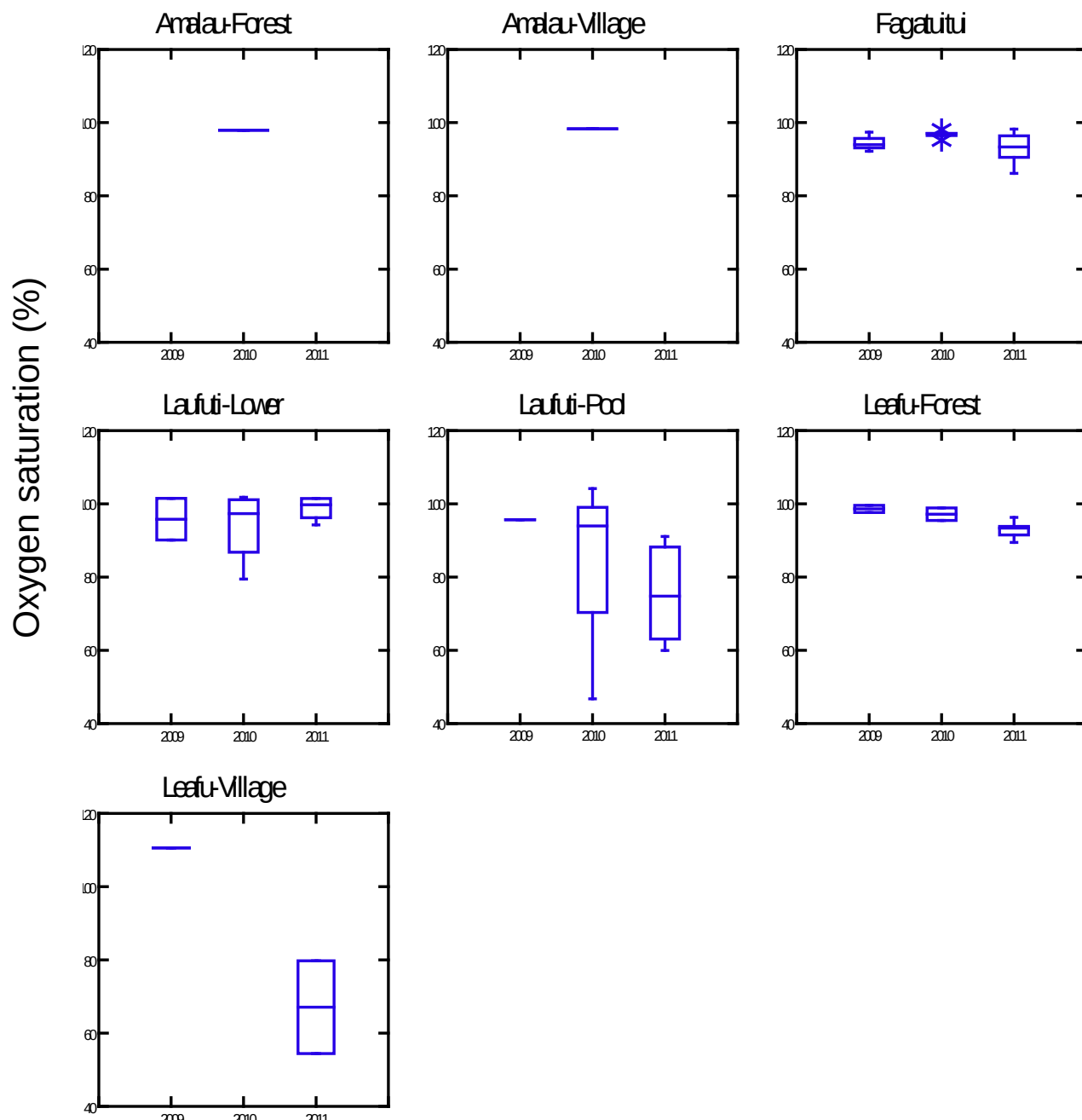


Figure 8. Box plots of oxygen saturation in streams of National Park of American Samoa.

pH

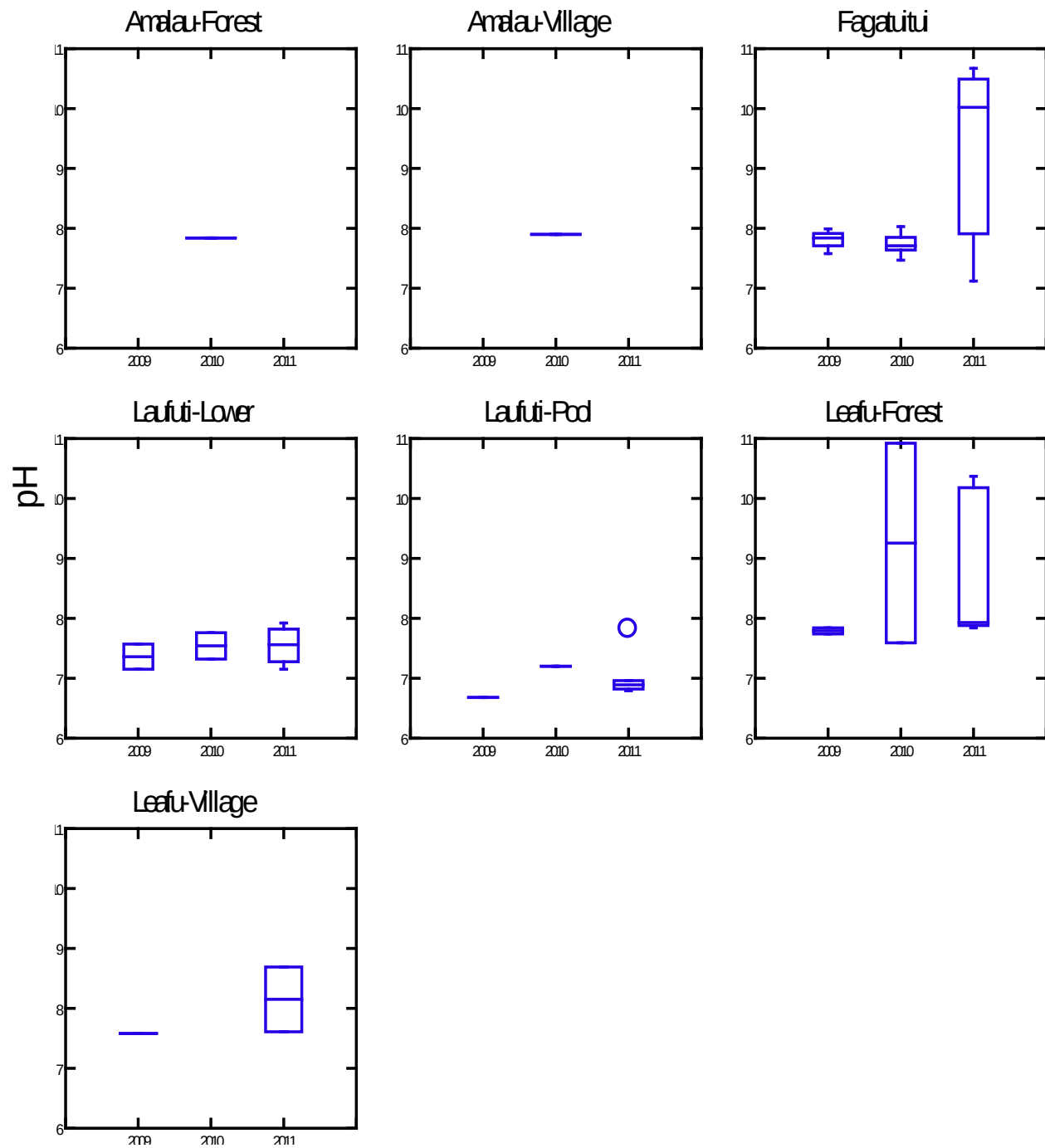


Figure 9. Box plots of pH in streams of National Park of American Samoa.

Salinity

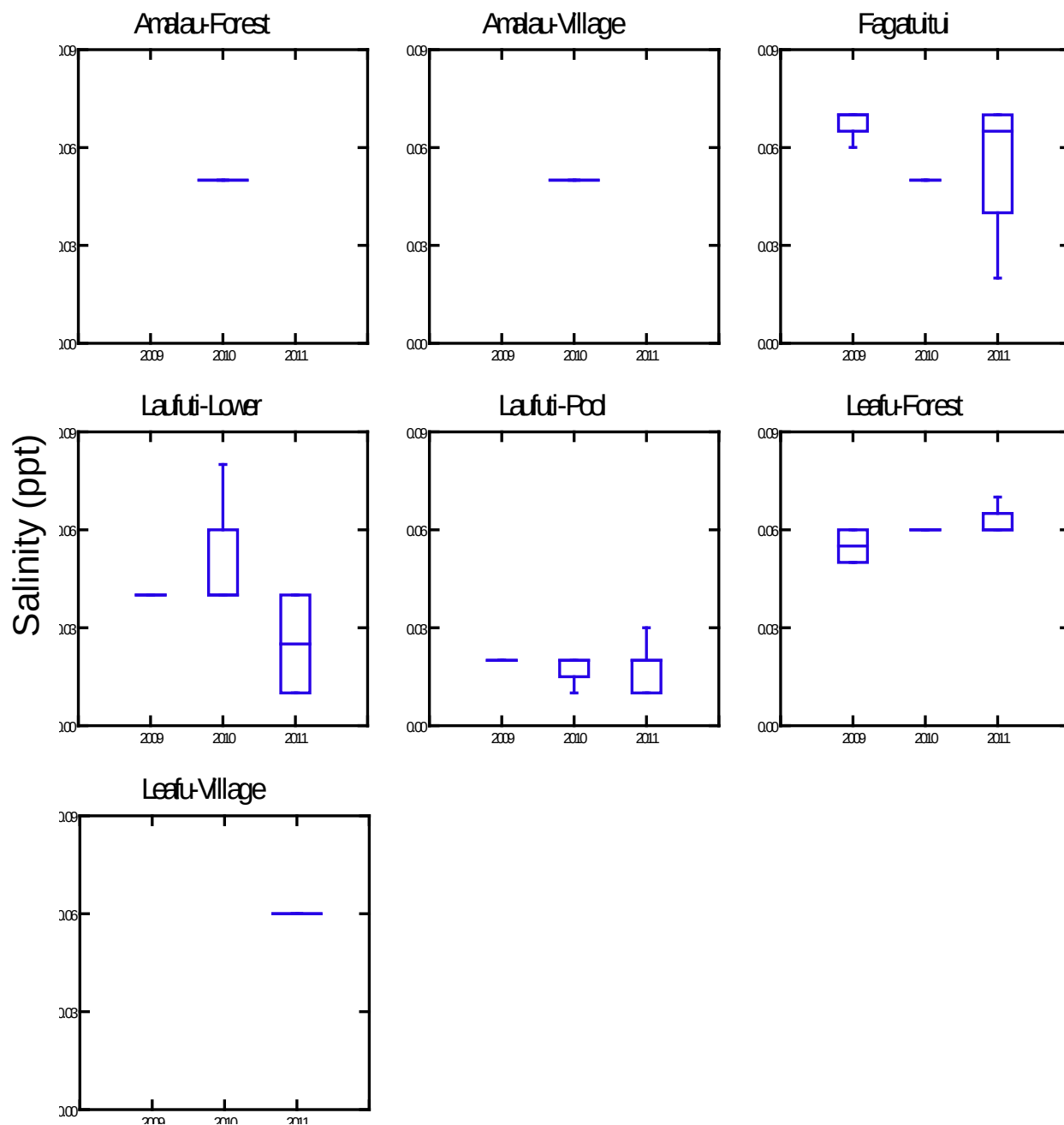


Figure 10. Box plots of salinity in streams of National Park of American Samoa.

Specific Conductance

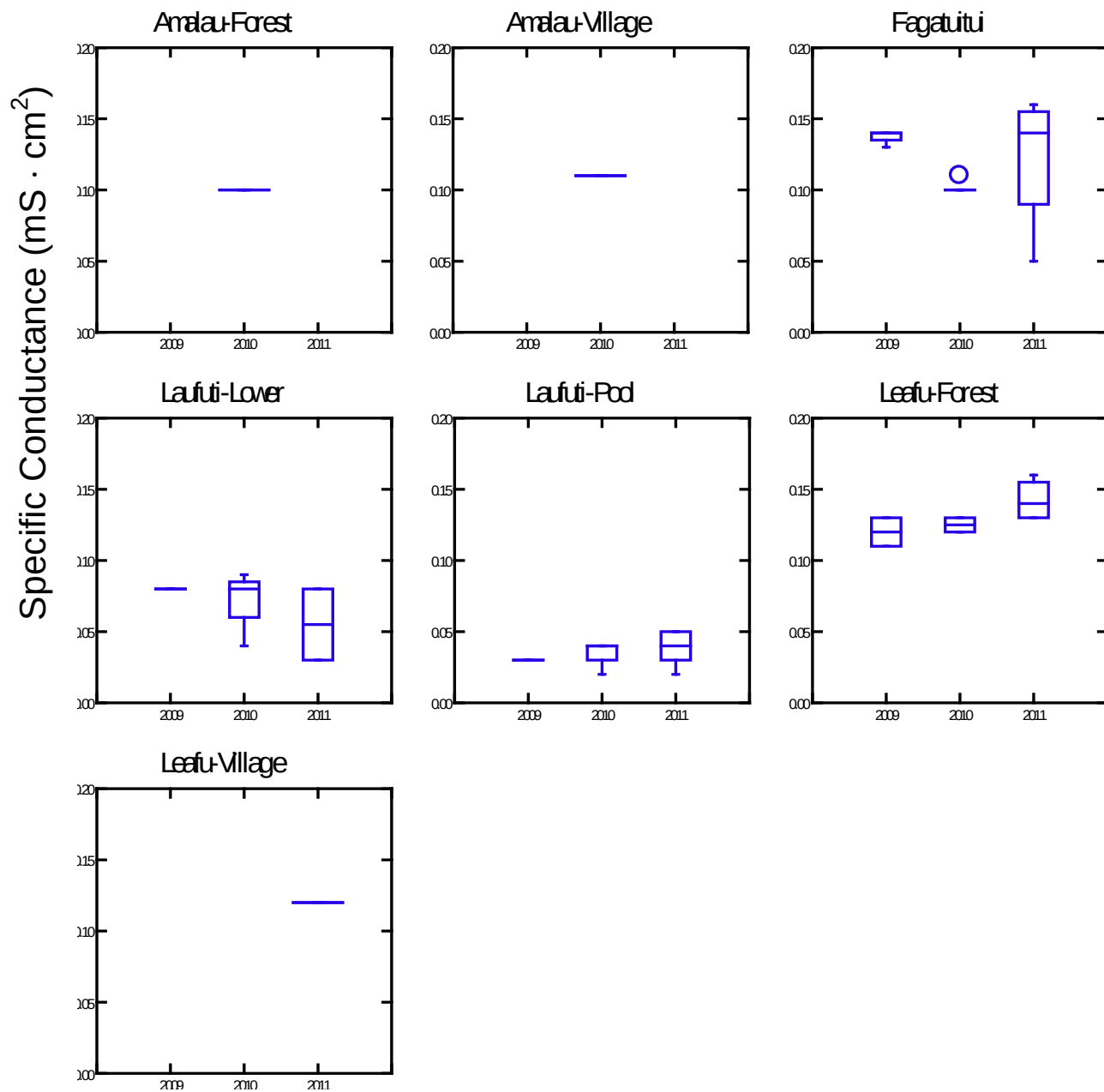


Figure 11. Box plots of specific conductance in streams of National Park of American Samoa.

Temperature

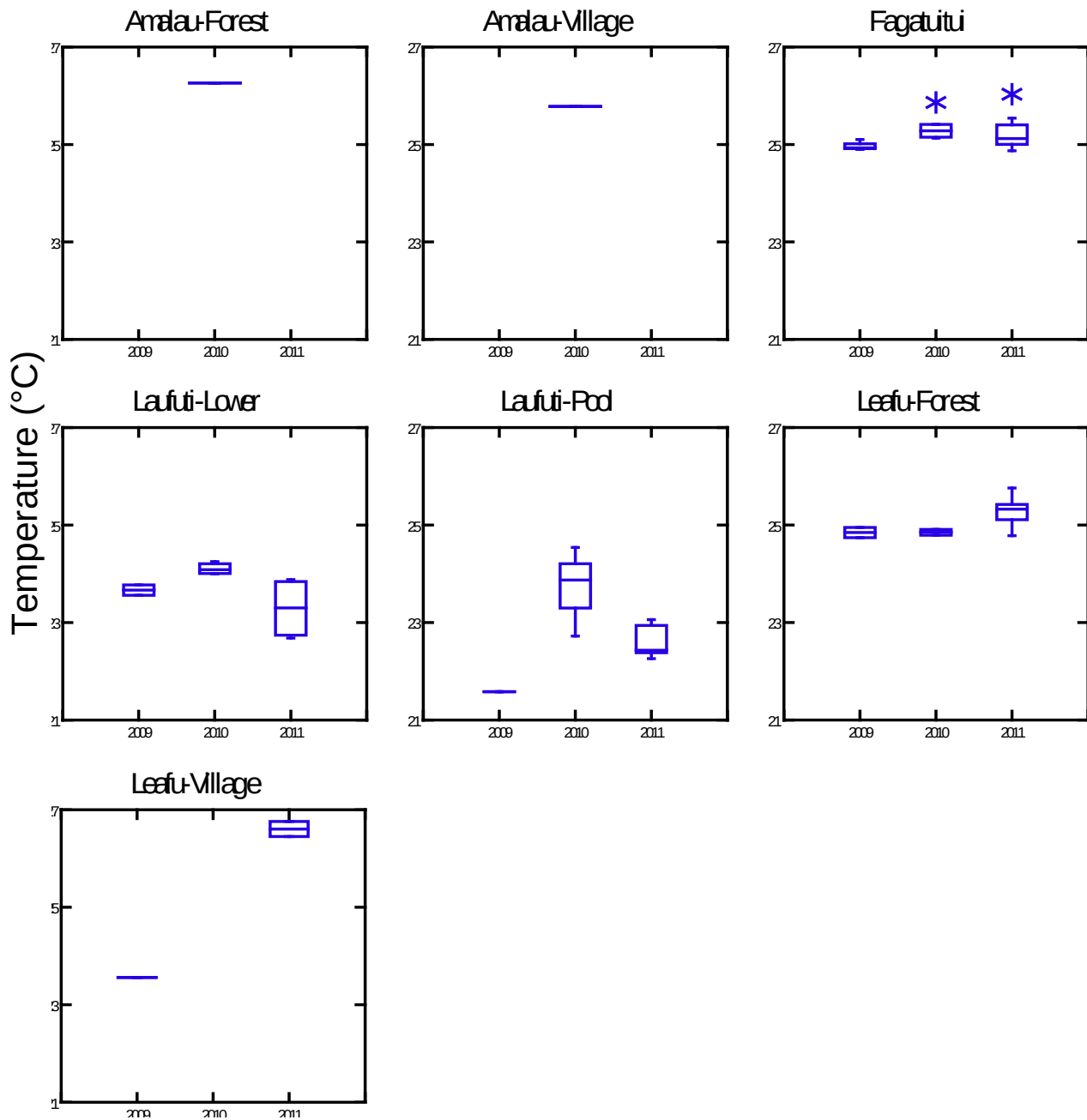


Figure 12. Box plots of temperature in streams of National Park of American Samoa.

Turbidity

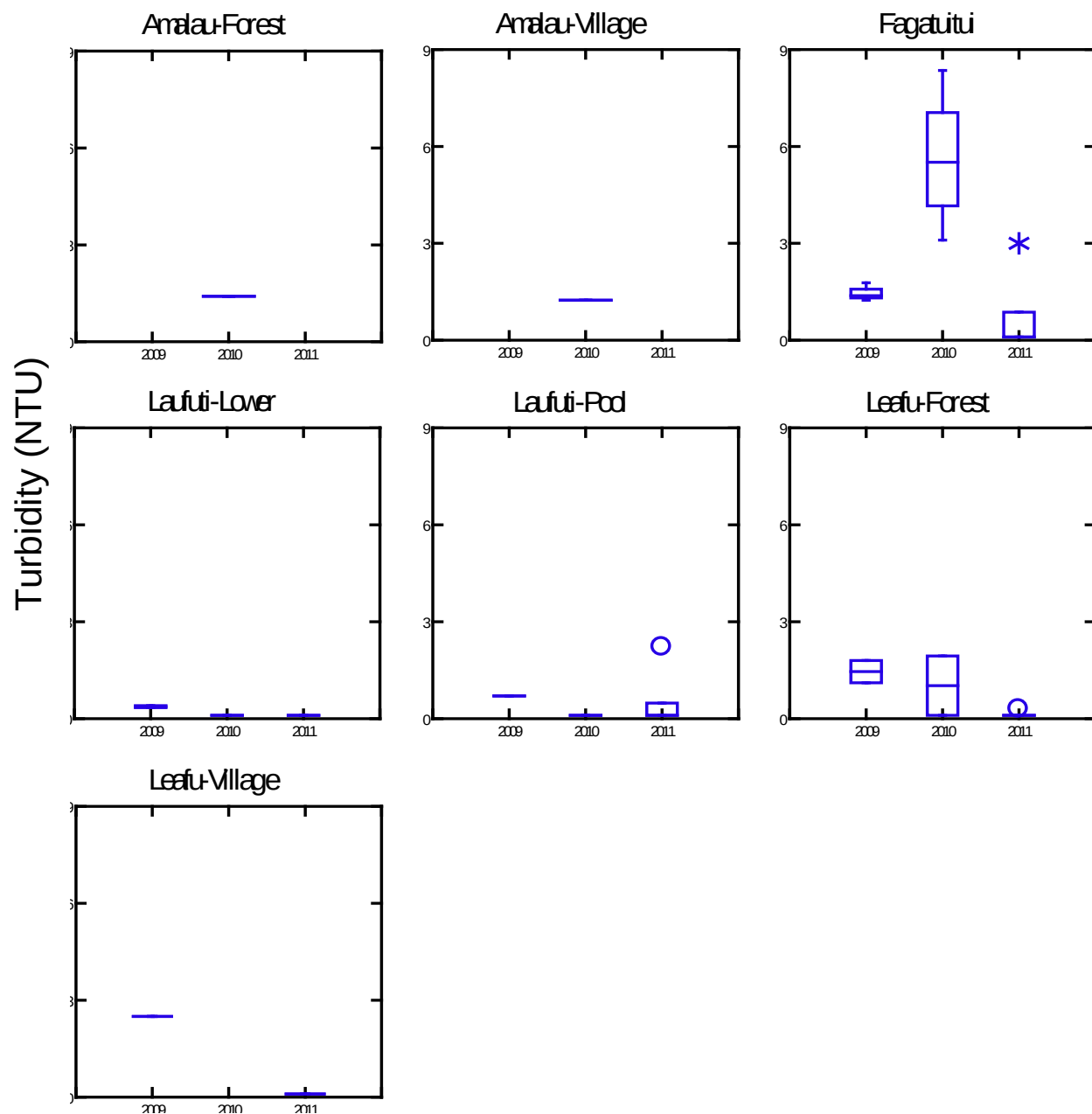


Figure 13. Box plots of turbidity in streams of National Park of American Samoa.

Discussion

Lower concentrations of dissolved nutrients observed in Laufuti pools as compared to flowing portions of Laufuti stream are consistent with hydrological conditions. Water in shallow non-flowing pools are in greater contact with biofilms on substrate surfaces, which consume dissolved nutrients. Differences between parameter values measured in Amalau Stream forest and village sites were subtle, and may not be statistically significant. The only water quality criterion defined by the state also measured in this program was turbidity, which slightly exceeded the published limit once in Fagatuitui Stream in 2010. Note, however, that streams are only sampled during low flow conditions due to safety concerns.

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The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 126/127909, February 2015

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