



Quality Assurance Plan for Water Quality Monitoring in the Pacific Island Network

Natural Resource Report NPS/PACN/NRR—2023/2576



ON THE COVER

An anchialine pool at Pu'uhonua o Hōnaunau National Historical Park.
Photograph courtesy of Amanda McCutcheon.

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Natural Resource Report NPS/PACN/NRR—2023/2576

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Abstract

In accordance with guidelines set forth by the National Park Service Inventory and Monitoring Division, a quality-assurance plan has been created for use by the Pacific Island Network in the implementation of water quality monitoring protocols, including the marine water quality protocol (Raikow et al. 2023) and future water quality protocols that will address streams and standing waters. This quality-assurance plan documents the standards, policies, and procedures used by the Pacific Island Network for activities specifically related to the collection, processing, storage, analysis, and publication of monitoring data. The policies and procedures documented in this quality assurance plan complement quality assurance efforts for other components of the overall protocol workflow, including initial creation of the protocol as described in the protocol narrative and quality assurance plans for other monitoring activities conducted by the Pacific Island Network.

List of Terms¹

Accepted Data: Data that have undergone all quality assurance and quality control procedures as defined in a published protocol and associated standard operating procedures (SOPs). Used in cases where a Quality Assurance Plan has not been developed and approved.

Accreditation: A formal recognition that an individual or organization (e.g., laboratory) is competent to carry out specific tasks or specific types of tests, and/or meets predetermined qualifications or standards. For labs, this is typically done on an analyte basis for a limited/specific period of time.

Accuracy: A measure of the degree of conformance of the values generated by a specific method or procedure with the true value. The concept of accuracy includes both bias (systematic error) and precision (random error). EPA recommends that this term not be used and that precision and bias be used instead to convey the information usually associated with accuracy. See Precision and Bias.

Bias: Systematic error that is manifested as a consistent positive or negative deviation from the known or true value. It differs from random error which shows no such deviation.

Calibration: Determination, by measurement or comparison with a standard, of the correct value of each measure on a meter or other device, or the correct value for each setting of a control knob. The levels of the calibration standards should bracket the range of planned measurements.

Certified Data: Certified data are those data that a) have been through all QA/QC procedures as outlined in the QAP, b) meet expected quality standards, or are appropriately identified and annotated at the record level in cases where they do not meet those standards, c) have documented procedures for data collection, processing, and transformation in appropriate metadata formats, and d) are suitable for use.

Comparability: The degree to which different methods, data sets, and/or decisions agree or can be represented as similar; a data quality indicator.

Data Quality Objectives (DQOs): Qualitative and quantitative statements that clarify the objectives of observations, define the appropriate type of data, and specify the levels of uncertainty that are acceptable to managers when using data. DQOs provide the statistical framework for planning data collection and management, and are used as the basis for establishing the quality and quantity of data needed to support decisions. Includes qualitative Data Quality Values (DQVs) and informs development of Measurement Standards (or Measurement

¹ Definitions are based on a combination of USGS (1995) and EPA (1997).

Quality Objectives; MQOs), performance standards, accreditation standards, and policy standards.

Data Quality Values (DQVs): Desired qualitative characteristics of data and datasets related to intrinsic data quality (reasonability, accuracy, objectivity, credibility), contextual data quality (relevance, timeliness, completeness, comparability), representational data quality (interpretability, understandability, consistency), and data accessibility (security, discoverability, utility).

Data Validation: Quality control tools or processes designed to evaluate legitimacy of data as they proceed through the data management lifecycle. Typically, data that do not pass validation procedures are either corrected using prescribed methods or flagged/graded to inform data users as to their appropriate use.

Data Verification: Quality assurance tools or processes where data are checked for accuracy and inconsistencies as they migrate through the data management lifecycle. Data Verification helps to ensure that data are complete, properly formatted so that they can be processed, and accurately translated when transferred from one source to another.

Data Flagging/Data Qualification: A code or annotation that signals that data do not meet specified data quality standards.

Minimum Detection Limit (MDL): The minimum concentration of an analyte that, in a given matrix and with a specific method, has a 99% probability of being identified, qualitatively or quantitatively measured, and reported to be greater than zero.

Minimum Quantification Limit (MQL): The concentration of analyte in a specific matrix for which the probability of producing analytical values above the method detection limit is 99%.

Precision: The degree of similarity among independent measurements of the same quantity, without reference to the known or true value.

Provisional Data: Provisional data are those data that have undergone incomplete QA/QC procedures as defined in the QAP and are not suitable for general use. Provisional data may be used in some cases, however, depending on the amount of QA/QC completed, and the intended use.

Quality Assurance (QA): The set of activities designed to ensure that data, products, or services meet defined standards of quality with a stated level of confidence. Quality Assurance focuses on ensuring that data are collected and managed to the highest practicable quality, at or above stated data quality standards.

Quality Assurance Plan (QAP): Documentation of Quality Assurance and Quality Control procedures for a protocol, program (e.g., water quality monitoring), and national database application (i.e., Data Store).

Quality Control (QC): Operational techniques and activities that are used to ensure that data or products meet designated requirements for quality. Quality Control procedures focus on testing data for quality and can include both an evaluation of whether data quality meet data quality objectives and/or procedures to correct data.

Raw Data: Data in their state of original collection, either in the form of paper or electronic field forms, electronic sensor files, or digital media (photo, video, or audio). These data generally have been collected following some QA procedures, but have not undergone any QC procedures.

Sensitivity: The ability of a method or instrument to discriminate between minimally different levels of a variable of interest by producing a noticeably different measurement response.

Standards, Measurement (also Measurement Quality Objectives): Data quality requirements specifying the level of precision, bias, sensitivity, resolution, etc., that data must meet to be accepted for use in analysis.

Standards, Performance: Data quality requirements specifying the detection ability, sensitivity, variability, etc., of equipment, sensors, or observers to reliably measure characteristics within target populations.

Standards, Accreditation: Data quality requirements related to individuals or organizations involved with data collection, analysis, or processing to ensure desired data credibility and defensibility. Examples include professional accreditation/certificates, required training, chain-of-custody requirements and others.

Standards, Policy: Data quality requirements related to ensuring appropriate management, use, dissemination, qualification, and documentation of data.

Introduction

The National Park Service (NPS) Inventory and Monitoring Division (IMD) was established by an act of Congress in 1999 to provide more than 270 national park system units a core suite of baseline minimum scientific information (inventories) and to identify and implement long-term monitoring of high-priority measurements of resource condition in those units (Fancy et al. 2009). The purpose of natural resource monitoring in parks is to develop scientifically sound information on the current status and long-term trends in the composition, structure, and function of park ecosystems, in order to inform natural resource management decisions.

The purpose of this Quality Assurance Plan (QAP) is to document the standards, policies, and procedures used by the Pacific Island Network (PACN) water quality monitoring protocols (e.g., Raikow et al. 2023). This QAP applies to data collection, processing, storage, analysis, and publication, methods for environmental data transformation, and generation of quality control data. Considerations made to maintain quality during the initial design of the protocol are described in the narrative document. Procedures to maintain quality during preparations for field work and other stages of the protocol workflow are described in standard operating procedures (SOPs), which are made public on the Integrated Resource Management Applications Portal (IRMA). The policies and procedures documented or referenced in this quality-assurance plan complement the quality-assurance plans for other monitoring activities conducted by PACN. This QAP serves as a guide for all PACN personnel who are involved in protocol activities and as a resource for identifying memoranda, publications, and other literature that describe associated techniques and requirements in more detail.

Protocol Overview

The PACN water quality monitoring protocol is focused on physical and chemical parameters of the water column in anchialine pools, streams, lakes, wetlands, groundwater, and near shore marine areas in Ala Kahakai National Historic Trail, Pu‘uhonua o Hōnaunau National Historical Park, Kaloko-Honokōhau National Historical Park, Pu‘ukoholā Heiau National Historic Site, Kalaupapa National Historical Park, Haleakala National Park, National Park of American Samoa, War in the Pacific National Historical Park, and American Memorial Park. Depth, nitrogen, phosphorus, chlorophyll, oxygen, pH, temperature, conductivity (salinity), and turbidity are monitored under the water quality pool protocol. Environmental water quality monitoring data will be used to inform management decisions relating to water-body support of endemic fauna and general habitat degradation.

Protocol Activities and Modules

Two management questions influenced the selection of water quality as a vital sign to be monitored by PACN: 1) What is the current state of resources? 2) What temporal trends are occurring in resources? These questions were used to develop monitoring objectives focused on animal communities:

- 1) Assess physical and chemical attributes of the water column in waterbodies of PACN parks, including the current status and spatial patterns.
- 2) Detect long-term trends in water-quality attributes of water bodies in PACN parks.

This QAP describes quality measures related to environmental data collected or derived from field work, and quality control data collected for the Pacific Island Network Water Quality Monitoring Protocol. Thus, from within the overall workflow of the protocol, relevant components, or “modules,” include the following:

- 1) Site Reconnaissance, Establishment, and Maintenance: Data associated with sampling locations, including descriptions, locational data, navigation, and surveying data.
- 2) Sensor Data Collection: Data collected by sensors, probes, and sondes, and post-processing of sensor data.
- 3) Laboratory Sample Data: Sample collection and preparation information, shipping and chain of custody information, and resultant data and QA/QC information provided upon delivery from the lab.
- 4) Quality Control Data: Data collected to evaluate environmental data quality.

Activities across modules are given a number and described in Table 1. Numbering in tables within subsequent sections refer to these activities, but not all activities are relevant to all sections.

Table 1. Protocol data-generating activity matrix for water quality monitoring in the Pacific Island Inventory and Monitoring Network (e.g., Raikow et al. 2023).

Activity Type	#	Activity	Sampling Design
Site reconnaissance, establishment, and maintenance	1	Obtain supporting data	The compilation of data not collected during field activities (e.g., pool location, hydrologic regime).
	2	Define sampling frame	The sampling frame is the population of all possible sites, from which sites actually sampled are chosen.
	3	Choose sampling regime	The creation of a sampling regime that aligns with monitoring objectives, is consistent with the literature when relevant, and innovates when necessary.
Sensor data	4	Measure depth	Multiparameter sonde probe
	5	Measure chlorophyll and related algal parameters	Multiparameter sonde probe
	6	Measure pH	Multiparameter sonde probe
	7	Measure temperature	Multiparameter sonde probe
	8	Measure specific conductance (salinity)	Multiparameter sonde probe
	9	Measure turbidity	Multiparameter sonde probe
	10	Measure dissolved oxygen	Multiparameter sonde probe
Laboratory sample data	11	Measure total dissolved nitrogen (TDN)	Water sample

Table 1 (continued). Protocol data-generating activity matrix for water quality monitoring in the Pacific Island Inventory and Monitoring Network (e.g., Raikow et al. 2023).

Activity Type	#	Activity	Sampling Design
Laboratory sample data (continued)	12	Measure total dissolved phosphorus (TDP)	Water sample
	13	Measure nitrates	Water sample
Quality control	14	Matrix-spike degradation study	Matrix water spiked at parks with known quantities of nutrients, stored for set durations, then analyzed.
	15	Blank study	Deionized water run through steps in the sampling process.

Sampling Design

A summary of the water quality protocol sampling regime is provided in Table 2.

Table 2. Activity-level sample design matrix for water quality monitoring in the Pacific Island Inventory and Monitoring Network (e.g., Raikow et al. 2023).

Activity Type	#	Activity	Sampling Design	Revisit Design
Site reconnaissance, establishment, and maintenance	3	Choose sampling regime	Targeted by ecosystem type: marine areas site dispersion optimized for spatial analysis of selected landscape features, streams sampled above confluences, anchialine pool populations stratified by local group, other ecosystems are small enough not to need complex sampling designs.	Twice a year; quarterly for anchialine pools.
Sensor data	4	Measure depth	Mean of replicate readings taken over a ten-minute period.	Twice a year; quarterly for anchialine pools.
	5	Measure chlorophyll and related algal parameters	Mean of replicate readings taken over a ten-minute period.	Twice a year; quarterly for anchialine pools.
	6	Measure pH	Mean of replicate readings taken over a ten-minute period.	Twice a year; quarterly for anchialine pools.
	7	Measure temperature	Mean of replicate readings taken over a ten-minute period.	Twice a year; quarterly for anchialine pools.
	8	Measure specific conductance (salinity)	Mean of replicate readings taken over a ten-minute period.	Twice a year; quarterly for anchialine pools.
	9	Measure turbidity	Mean of replicate readings taken over a ten-minute period.	Twice a year; quarterly for anchialine pools.
Laboratory sample data	10	Measure dissolved oxygen	Mean of replicate readings taken over a ten-minute period.	Twice a year; quarterly for anchialine pools.
	11	Measure total dissolved nitrogen (TDN)	Three replicate independent grab samples per sample station.	Twice a year; quarterly for anchialine pools.
	12	Measure total dissolved phosphorus (TDP)	Three replicate independent grab samples per sample station.	Twice a year; quarterly for anchialine pools.
	13	Measure nitrates	Three replicate independent grab samples per sample station.	Twice a year; quarterly for anchialine pools.

Data Quality Objectives

Data quality values and standards for implementation are provided in Table 3.

Table 3. Data Quality Values (DQVs) for Pacific Island Inventory and Monitoring Network water quality protocols (e.g., Raikow et al. 2023).

Types of Data Quality	Data Quality Value	Definition	Protocol Considerations
Intrinsic data quality	Accuracy	Measurements reflect the true value of the parameter being observed. This applies to measures (length, width, position) or classes (species, types, or categories). Includes components of precision and bias.	Consistency of instrumentation and sampling methods used by technicians in the field are most important for this protocol.
	Representativeness	Measurements represent conditions at the time of sampling. Combined with accuracy, leads to repeatable data collection.	An ecosystem-based approach tailors the goal of achieving representativeness to the fundamental ecology of each ecosystem type.
Contextual data quality	Comparability	The degree to which data can be compared among sample locations, data sources, or periods of time.	Sampling procedures are industry standard and the same for all sites and ecosystems.
	Timeliness/currency	How recent the data need to be to be considered valid for their intended use. Data represent conditions and/or are available and in a format for use at the appropriate time in the decision-making process.	Sites are sampled within days of each other to ensure a synoptic survey and prevent the opportunity for ecological change to occur between the first and last site sampled.
	Completeness	All data/measures required to evaluate accuracy representativeness are present; incomplete data sets (either at a location, across sampling locations, or over time) lose utility or relevance. Data records contain values as planned across the period of record.	All major parameters are measured with sondes. Relevant nutrient species are measured.
Representational data quality	Consistent representation	Use of standard definitions when describing data quality or resource quality based on data.	Only standard parameters and units are used.
Data accessibility	Security	Access to data, products, and systems limited to appropriate audiences.	Protected information has been identified and protected data SOPs established.

Measurement Quality Objectives

Measurement Quality Objectives for field tasks are summarized in Tables 4 and 5.

Table 4. Measurement Quality Objectives for water quality monitoring in the Pacific Island Inventory and Monitoring Network (e.g., Raikow et al. 2023).

Activity Type	#	Activity	Quality Indicator	Quality Objectives
Sensor data	4	Measure depth	Precision, bias	10% precision, ± 1 mm bias
	5	Measure chlorophyll and related algal parameters	Precision, bias	30% precision, 10% bias
	6	Measure pH	Precision, bias	10% precision, ± 0.3 units bias
	7	Measure temperature	Precision, bias	10% precision, ± 1.0 °C bias
	8	Measure specific conductance (salinity)	Precision, bias	10% precision, ± 30 μ S bias
	9	Measure turbidity	Precision, bias	10% precision, 10% bias
	10	Measure dissolved oxygen	Precision, bias	10% precision, ± 0.5 mg/L
Laboratory sample data	11	Measure total dissolved nitrogen	MDL ¹ , precision, bias	See Table 5 in this report.
	12	Measure total dissolved phosphorus	MDL ¹ , precision, bias	See Table 5 in this report.
	13	Measure nitrates	MDL ¹ , precision, bias	See Table 5 in this report.

¹Method detection limit

Table 5. Example laboratory method performance requirements and analysis methods to be used for nutrient chemistry analysis of water quality in Pacific Island Network parks.

Analyte	Units	MDL Objective ¹	Precision Objective	Accuracy Objective	Potential Methods Conforming to NELAC Guidance
Nitrate + nitrite	mg N/L	0.001	± 0.01 or ±10%	± 0.01 or ±10%	- EPA Method 353.2 (1997) - Enzyme Catalyzed Reduction
Total dissolved nitrogen	mg N/L	0.0070	± 0.01 or ±10%	± 0.01 or ±10%	Standard Methods #4500-N C, 4500-NO3 F and EPA Method 353.2 (1997)
Total dissolved phosphorous	mg P/L	0.01	± 2 or ±10%	± 2 or ±10%	Standard Methods #4500-P.B.5, #4500 P.E, and EPA Method 365.1 (1997)

¹Method detection limit

Data Standards

Anchialine pools studied under the water quality protocol are home to several rare and protected species. These pools are also highly valued cultural resources. Products that have been identified upon submission by the Aquatic Ecologist as containing sensitive information will either be revised into a form that does not disclose the locations of sensitive resources or withheld from posting and distribution (Table 6). When requests for distribution of the unedited version of products are initiated by the NPS, by another federal agency, or by another partner organization (e.g., a research scientist at a university), the unedited product (e.g., the full data set that includes protected information) may only be shared after a Confidentiality Agreement is established between NPS and the other organization. All official Freedom of Information Act (FOIA) requests will be handled according to NPS policy. In these cases, the Aquatic Ecologist will work with the Data Manager and the park FOIA representative.

Table 6. Protected data standards for water quality monitoring at Pacific Island Network parks (e.g., Raikow et al. 2023).

Activity Type	#	Data	Rules for Dissemination
Site reconnaissance, establishment, and maintenance	2	Pool location	Precise locations, e.g., coordinates, are not to be published. Spatial analyses and general maps are permissible.

Quality Assurance Procedures

Quality assurance procedures for data-generating activities of the water quality monitoring protocol are summarized in Table 7.

Table 7. Summary of quality assurance procedures for data-generating activities of water quality monitoring in Pacific Island Network (PACN) parks (e.g., Raikow et al. 2023).

Activity Type	#s	Activity	QA Procedures	Description	Citation
Site reconnaissance, establishment, and maintenance	1	Obtain supporting data	Metadata compiled by PACN.	Metadata stored in database.	PACN Water Quality database.
	2	Define sampling frame	Clear definition of pool population from which individual sample sites are collected.	- Sampling frame defined prior to conducting any field observations. - Waterbodies in all parks have been located. - Waterbodies have been mapped in GIS with coordinates recorded. - Waterbody location data has been entered into a database.	PACN Water Quality database and PACN geodatabase.
	3	Choose sampling regime	Sample regime creates data that support the scientific objectives.	The sampling regime is based on a poor current state of knowledge concerning anchialine pool biogeochemistry.	Raikow et al. (2023)
Sensor data	4	Measure depth	Probe calibration	- Calibration within three days prior of starting each sampling effort. - Probe.	SOP #6 . YSI EXO Sonde Operation
	5	Measure chlorophyll	Probe calibration	- Calibration within three days prior of starting each sampling effort. - Probe calibration in distilled water.	SOP #6 . YSI EXO Sonde Operation
	6	Measure pH	Probe calibration	- Calibration within three days prior of starting each sampling effort. - Probe calibration with two standards.	SOP #6 . YSI EXO Sonde Operation

¹Total dissolved nitrogen

²Total dissolved phosphorus

Table 7 (continued). Summary of quality assurance procedures for data-generating activities of water quality monitoring in Pacific Island Network (PACN) parks (e.g., Raikow et al. 2023).

Activity Type	#s	Activity	QA Procedures	Description	Citation
Sensor data (continued)	7	Measure temperature	Probe calibration	- Calibration within three days prior of starting each sampling effort. - Probe calibration using NIST-calibrated temperature probe.	SOP #6. YSI EXO Sonde Operation
	8	Measure specific conductance	Probe calibration	- Calibration within three days prior of starting each sampling effort. - Probe calibration using two standards.	SOP #6. YSI EXO Sonde Operation
	9	Measure turbidity	Probe calibration	- Calibration within three days prior of starting each sampling effort. - Probe calibration using two standards.	SOP #6. YSI EXO Sonde Operation
	10	Measure dissolved oxygen	Probe calibration	- Calibration within three days prior of starting each sampling effort. - Probe calibration in water-saturated air.	SOP #6. YSI EXO Sonde Operation
Laboratory sample data	11, 12, 13	TDN ¹ , TDP ² , and nitrates	Equipment cleaning	- Bottles acid-washed. - Filter Tower acid-washed.	SOP #7. Collecting Freshwater Samples: General Procedures
	11, 12, 13	TDN ¹ , TDP ² , and nitrates	Sample storage	- Samples put on ice and in dark in field. - Samples frozen until analysis.	SOP #7. Collecting Freshwater Samples: General Procedures
	11, 12, 13	TDN ¹ , TDP ² , and nitrates	Filter use	New filter for every sample site.	SOP #7. Collecting Freshwater Samples: General Procedures
	11, 12, 13	TDN ¹ , TDP ² , and nitrates	Filter flush	Filter flushed with matrix water prior to filtering sample.	SOP #7. Collecting Freshwater Samples: General Procedures

¹Total dissolved nitrogen

²Total dissolved phosphorus

Table 7 (continued). Summary of quality assurance procedures for data-generating activities of water quality monitoring in Pacific Island Network (PACN) parks (e.g., Raikow et al. 2023).

Activity Type	#s	Activity	QA Procedures	Description	Citation
Laboratory sample data (continued)	11, 12, 13	TDN ¹ , TDP ² , and nitrates	Bottle rinse	Bottle rinsed three times with filtered matrix water prior to collecting sample.	SOP #7 . Collecting Freshwater Samples: General Procedures

¹Total dissolved nitrogen

²Total dissolved phosphorus

General or Shared QA Procedures

The following QA procedures are shared among activities or are consistently required as data migrate through the workflow.

Data Entry and Verification of All Activities: The primary goal of data verification is to determine where errors are being introduced into the data entry forms. To the greatest extent possible, data entry errors are minimized through the use of automated methods within the forms (e.g., range limits, pick lists, and calendars). Following data entry into databases, data are verified by checking the accuracy of computerized records against the original paper field data sheets. Data is verified by a data entry personnel who did not enter the data. Data entry personnel check 100% of the records to the original field forms. After the computerized data are verified to accurately reflect the original field data, the paper field data sheets are archived, and the electronic version is used for all subsequent data activities. Data are not publicly published during the entry and verification steps. Verification must proceed data certification (see “Quality Control” below for description of data certification).

Lab Processing Requirements: Laboratory must follow chain of custody requirements. Laboratory QA/QC checks, including blanks, spikes, and duplicate samples, must be provided with sample results. Other QA/QC information, including documentation of instrument calibration slopes, limits of detection, statement of instrument comparability, and standard reference material used, must be available upon request or posted at designated internet sites.

Roles and Responsibilities

The water quality protocol will be implemented by the PACN aquatic ecologist, a PACN biological technician serving as the field lead, and additional biological technicians or NPS staff when available. Roles and responsibilities are summarized in Table 8.

Table 8. Roles and responsibilities of those implementing water quality monitoring at Pacific Island Network parks (e.g., Raikow et al. 2023).

Name	Position	Role	Contact Information
Daniel George	Regional Program Manager	QAP approval, protocol approval, and ensuring that data meet quality objectives.	415-686-6910
Ryan Monello	Network Program Manager	Program coordination.	808-985-6183
David Raikow	Protocol Lead	- Ensure that safety training is completed, and that safety policies and procedures are communicated and followed by the field crew. - When present, is responsible for ensuring crew safety in the field. - Ensure protocol objectives are met on schedule and within budget. - Oversee project operations and protocol implementation. - Coordinate necessary changes to protocol. - Train or direct training of field crews. - Certify and report data. - Supervise lead field technician. - Acquire necessary park permits. - Facilitate communications between IMD staff and park staff.	808-985-6325
Anne Farahi	Lead Technician	- In the absence of the aquatic ecologist, ensure crew safety in the field. - Train field crews in field procedures. - Plan and execute field monitoring activities. - Complete a field trip report following a monitoring event. - Maintain field equipment and instrumentation and arrange for repair. - Oversee field data collection. - Enter data and verify data as needed. - Conduct data summaries and general analysis. - Assist PACN aquatic ecologist with report preparation. - Annually review protocol and field notes.	808-985-6181
Amanda McCutcheon	Technician	- Participate in protocol field monitoring activities. - Collect, record, enter, and verify data.	808-329-6881 x1219

Table 8 (continued). Roles and responsibilities of those implementing water quality monitoring at Pacific Island Network parks (e.g., Raikow et al. 2023).

Name	Position	Role	Contact Information
Kelly Kozar	Data Manager	• Oversee data management activities. • Facilitate check-in, review, and posting of data, metadata, reports, and other products to national databases and clearinghouses according to schedule. • Maintain and update database application. • Provide database training as needed.	808-985-6186
Mark Wasser	GIS Specialist	• Consult on spatial data collection, GPS use, and spatial analysis techniques. • Facilitate spatial data development and generate site maps. • Work with PACN aquatic ecologist to analyze spatial data and develop metadata for spatial data products. • Primary steward of GIS data and products.	808-985-6184

Training Requirements

Table 9 summarizes Division- or NPS-wide training requirements.

Table 9. Training and professional certification requirements for Inventory and Monitoring Division (IMD) scientific staff involved with the Pacific Island Network water quality monitoring (e.g., Raikow et al. 2023).

Specialized Training—Title or Description of Course	Personnel/Groups Requiring Training	Purpose	Training Provider	Recurrence Requirements	Location of Training Records/ Certificates ¹
DOI Scientific Integrity Training	All IMD scientific employees	Ensure understanding of roles and responsibilities	DOI/DOILearn	Once	DOILearn

¹If training records and/or certificates are on file elsewhere, document their location in this column. If training records and/or certificates do not exist or are not available, then this should be noted.

Quality Control Procedures

Quality Control procedures are designed to ensure that collected and generated data meet specified requirements and/or are appropriately annotated or corrected. The following procedures are shared among activities or are consistently required as data migrate through the workflow:

- **Identification of Protected Data:** Anchialine pool locations are protected data and will be withheld from posting and distribution.
- **Geospatial Data Verification:** All geospatial data for water quality sites will be evaluated using ArcGIS to ensure accuracy.
- **Identification of Suspect Data:** Data are inspected for suspect entries during verification. Data is checked for outliers. Units are checked.
- **Quality Control Studies:** Field procedures and lab procedures are checked for variation between sample locations and processing time.

Data Certification

Following the quality assurance step of data verification, data is certified by an expert who explores the data to identify observer error, instrument error, or data that do not conform to expected ranges but which are the result of unusual natural circumstances. Valid data that deviate from normal circumstances are recorded but flagged as outside the normal inference space.

Data certification confirms the following:

- Data have been through all QA/QC procedures as outlined above.
- Data meet specified quality standards and/or the data that do not meet those standards are appropriately identified and communicated at the record level.
- Procedures for data collection, processing, and transformation have been documented in appropriate metadata formats.
- Suspect data has been identified.
- Data are suitable for use.

In the absence of an approved QAP, data that have been through all QA/QC procedures as outlined in the approved protocol narrative and SOPs are deemed acceptable per IMD data certification guidelines. After review and approval of this QAP, data certification will occur no less frequently than one year after data verification is complete. The protocol lead, the PACN Aquatic Ecologist, is responsible for certifying that all processes described above have occurred in accordance with SOPs.

Data Annotations and Qualifications

Data that do not meet quality or use standards as described above will be annotated using codes explaining reasons for rejection (Table 10).

Table 10. Quality Control (QC) annotation codes to be recorded for data records that do not meet data quality standards for water quality monitoring at Pacific Island Network parks (e.g., Raikow et al. 2023).

Annotation Code	Description
Flagged	Data that do not meet quality control standards are flagged at the record level.
External event	Data that are the result of an external event (i.e. flooding of pool) that excludes them from the normal inference space will be flagged at the record level.

Project Quality Assessment

Routine Data Quality Evaluations

Periodic data audits and quality control inspections will be used to maintain and improve data quality procedures. Quality control studies of inter-observer variability should verify that staff is operating in conformance with the data quality procedures. Seasonal-close out evaluations provide an opportunity to improve procedures or equipment. These quality checks promote a cyclic process of continuous feedback and improvement of both the data and the quality planning process. Typically, the results of quality assessments will be documented and reported to the network program manager as an internal report as opposed to being published in a report series (Table 11). The monitoring protocol lead is responsible for ensuring that nonconformities in data management practices are corrected.

In addition to reporting trends, trend reports are an opportunity to critically evaluate whether methods and the sampling regime are fulfilling monitoring objectives. Substantive changes to the protocol may be made during trend evaluation, to the extent possible without sacrificing comparability with existing datasets.

Table 11. Routine data quality evaluation and informal reports to be produced as a part of implementing water quality monitoring at Pacific Island Network parks (e.g., Raikow et al. 2023).

Report	Purpose and Description	Frequency
Overall data quality assessment	Measure of the number of data points/ sampling events that do not meet data quality objectives as compared to overall effort.	Conducted cumulatively for the period of record and in logical subgroups (parks, field season, etc.) as data are certified.
Data quality objective review	Ensure that data quality objectives are appropriate to meet stated monitoring objectives.	During five-year protocol review.
Training/certification compliance	Ensure resources/time available to maintain certification requirements.	Annually prior to workplan development.

Communicating Data Quality

PACN will document data quality, data quality goals, and objectives. To meet this requirement, the QAP will be included or referenced when disseminating any data collected under this protocol, in addition to providing all data quality annotations with data.

Documentation

Records

NPS Director’s Order 11D: Records and Electronic Records Management (Jarvis 2012) and its appendix, NPS Records Schedule, describe NPS activities and standards in maintaining and providing access to records at all levels of the Service (Table 12). DO 11D states that all records of natural and cultural resources and their management are considered mission-critical records, that is, necessary for fulfillment of the NPS mission. The NPS Records Schedule, which provides guidelines on natural resource-related records, including the results of IMD programs, indicates that all natural resource records are considered “permanent” and need to be retained either in an appropriate park museum facility or at the National Archives.

Table 12. Required records to be maintained as a part of implementing water quality monitoring at Pacific Island Network parks (e.g., Raikow et al. 2023).

Record Type	Record
Sample collection documents and records	• Field datasheets • Photos • Safety readiness review documents • Permit application/acceptance memos
Data assessment documents and records	• Physical copies of sheets • Quality review reports
Other	• Manuscript submittal forms for published reports • Personnel training certifications/documentation

Metadata

Metadata for all published data products must be FGDC compliant. The abstract for all metadata must include the Pacific Island Network water quality monitoring project link in IRMA (<https://irma.nps.gov/DataStore/Reference/Profile/2166407>) to ensure that data can be traced to all methods used for data collection and processing as well as to the latest version of the protocol, this QAP, and all associated SOPs.

Information Dissemination

All data reports disseminated for general (public) use will be based on certified data. In general, data will be certified prior to internal use for supporting park-, regional-, or national-level resource management decisions. However, in some cases the use of provisional data (data that have not undergone complete QA/QC as defined in this QAP) may be warranted to base decisions on best-available science.

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- U.S. Geological Survey (USGS). 1995. Quality Assurance / Quality Control Manual: National Water Quality Laboratory. Open-File Report 95–443. U.S. Geological Survey, Denver, Colorado.

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.

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