



Quality Assurance Plan for Anchialine Pool Monitoring in the Pacific Island Network

Version 1.0

Natural Resource Report NPS/PACN/NRR—2018/1811



ON THE COVER

An anchialine pool at Halape, Hawai'i Volcanoes National Park
Photograph courtesy of Anne Farahi.

Quality Assurance Plan for Anchialine Pool Monitoring in the Pacific Island Network

Natural Resource Report NPS/PACN/NRR—2018/1811

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Abstract

In accordance with guidelines set forth by the National Park Service Inventory & Monitoring Division, a quality-assurance plan has been created for use by the Pacific Island Network in the implementation of anchialine pool monitoring protocol (Raikow et al. 2018). 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, quality-assurance plans for other monitoring activities conducted by Pacific Island Network, and supplement the National Inventory & Monitoring Division Quality Management Plan.

Version History

Version 1.0

To create a new version of this document, carefully follow the instructions in [SOP #30: Protocol Revision](#). Use the Revision History Log below to describe the revisions.

Revision History Log. Populate the revision history log by providing the previous version number, new version number, revision date, author of the change, location of changes, reasons for the changes made, and the name of the person who approved the revision.

Previous Version Number	New Version Number	Revision Date	Author	Location of Changes Made	Reasons for Change	Network Regional Reviewer Approval
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For minor changes, version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02). Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0).

List of Terms¹

Accepted Data: Data that have undergone all QA and QC procedures as defined in a published protocol and associated 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 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, 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 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 Quality Objectives; MQOs), Performance Standards, Accreditation Standards, and Policy Standards.

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

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 so as to inform appropriate use.

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 (inventory and overall I&M), 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.

Standard Operating Procedure (SOP): Detailed written instructions to achieve uniformity of the performance of a specific function.

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 Program 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) for activities specifically related to the collection, processing, storage, analysis, and publication of data collected under the PACN anchialine pool monitoring protocol (Raikow et al. 2018), 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 the PACN and supplement the quality management plan for the NPS Inventory & Monitoring Program. 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 primary objective of the PACN anchialine pool monitoring protocol (Raikow et al. 2018) is to quantify the annual abundance of select crustacean, mollusc, odonate, and fish species in order to determine if the population size of these species declines or increases over time within each pool. A secondary objective of this protocol is to annually measure abiotic and biotic characteristics of each pool where crustacean, mollusc, odonate, and fish species are monitored. The abiotic and biotic characteristics selected for monitoring include: riparian vegetation species and % cover; a pool map and photographic record; geomorphology characteristics represented by canopy closure, substrate particle sizes, water depth, and detritus depth; light exposure measurements; and a suite of water quality measurements as outlined in Jones et al. (2011).

Protocol Activities and Modules

This QAP describes quality measures related to environmental data collected or derived from field work, and quality control data collected for the PACN anchialine pool monitoring protocol (Raikow et al. 2018). The relevant components (modules) include:

Site Reconnaissance, Establishment, and Maintenance: Data associated with sampling locations including descriptions, locational data, navigation, surveying.

Field Observations: Environmental data collected on-site, including organism surveys, geomorphological measurements, and other observations.

Quality Control Data: Data collected to evaluate environmental data quality.

Data are collected or derived as a part of the PACN anchialine pool monitoring protocol (Raikow et al. 2018). 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 the PACN anchialine pool monitoring protocol (Raikow et al. 2018).

Protocol Module	Activity #	Activity	Description
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 light levels	Measurement of light levels at the water surface
Field Observations	5	Map pool	Mapping overall pool layout
	6	Survey shrimp with traps	A survey of shrimp abundance and diversity
	7	Survey shrimp visually	A survey of shrimp abundance and diversity
	8	Survey fish	A survey of fish abundance and diversity
	9	Survey odonates	A survey of adult odonate presence and diversity
	10	Survey vegetation	A survey of riparian vegetation diversity and coverage.
	11	Survey snails	A survey of benthic aquatic snail abundance and diversity
	12	Survey geomorphology	A survey of substrate particle size, substrate type, & depth
Quality Control Data	13	Repeating field observations	Evaluation of inter-observer variance

Sampling Design

A summary of the anchialine pool protocol sampling regime is provided in Table 2.

Table 2. Activity-level sample design matrix for the PACN anchialine pool monitoring protocol (Raikow et al. 2018).

Protocol Module	Activity #	Activity	Sampling Design	Revisit Design
Site Reconnaissance, Establishment, and Maintenance	3	Choose sampling regime	Targeted: Five fixed sites at KAHO and three fixed sites at PUHO, with seven additional sites where only odonates are surveyed	Fixed sites visited annually; all activities follow this revisit design
Sensor data	4	Measure light levels	Mean of five measurements taken along a transect spanning each pool	–
Field Observations	5	Map pool	Measure, draw, photograph.	–
	6	Survey shrimp with traps	Timed baited trap survey.	–
	7	Survey shrimp visually	Timed visual counts within quadrats.	–
	8	Survey fish	Timed trap survey	–
	9	Survey odonates	Visual timed observation.	–
	10	Survey vegetation	Visual survey of species and estimate of riparian bank coverage.	–
	11	Survey snails	Visual survey along transect.	–
	12	Survey geomorphology	Measure substrate particle size along transect, record type and measure depth.	–

Data Quality Objectives

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

Table 3. Data quality values (DQVs) for the PACN anchialine pool protocol (Raikow et al. 2018).

Data Quality Type	Data Quality Value	Definition	Protocol Considerations
Intrinsic Data Quality	Accuracy	Species identification is correct; measurements reflect the true value of the parameter being observed; this applies to measures (length, width, position) or classes (species, types, or categories) and includes components of precision and bias	Animal and plant identifications are made to species using established identification keys; most species are easily distinguishable and a photo identification guide is included in the SOPs
	Representativeness	Measurements represent conditions at the time of sampling for specific pools and populations within those pools	Monitoring of five fixed sites in KAHO, three fixed sites at PUHO, and seven additional fixed sites at KAHO where only odonates will be monitored
Contextual Data Quality	Comparability	The degree to which data can be compared among sample locations, data sources, or periods of time	Procedures are the same for all pools, and where geomorphology differs the methods are recorded to ensure differences can be evaluated
	Timeliness / Currency	How recent the data need to be to be considered valid for their intended use: Data represents conditions and/or is available and in a format for use at the appropriate time in the decision-making process	Sampling will occur annually between October 1st and December 31st (fourth calendar quarter) and within two hours before and four hours after high tide
	Completeness	All data and 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 taxa are surveyed in five KAHO and three PUHO pools. Monitoring encompasses biological, physical and chemical parameters
Representational Data Quality	Consistent Representation	Use of standard definitions when describing data quality or resource quality based on data	Only standard species names and parameter units are used
Data Accessibility	Security	Access to data, products, and systems limited to appropriate audiences	Protected information has been identified and SOPs established for how to handle it

Measurement Quality Objectives

Measurement Quality Objectives for field tasks are summarized in Table 4.

Table 4. Measurement Quality Objectives for the PACN anchialine pool monitoring protocol (Raikow et al. 2018).

Protocol Module	Activity #	Activity	Measure	Quality Objective
Sensor data	4	Measure light levels	PAR	≤ 5% variation in air traceable to NIST certified instrument
Field Observations	5	Map pool	Pool sketch	Distance between major features directly measured; width or other size dimensions of major features measured to the centimeter
	6	Survey shrimp with traps	Relative abundance	±5% difference between observers
			Species identification	100% accuracy
	7	Survey shrimp visually	Areal density	±5% difference between observers
			Species identification	100% accuracy
	8	Survey fish	Relative abundance	±5% difference between observers
			Species identification	100% accuracy
	9	Survey odonates	Presence/absence	±5% difference between observers
			Species identification	100% accuracy when specimen is close enough to identify
	10	Survey vegetation	% of bank occupied by species	±5% accuracy
			Species identification	100% accuracy
	11	Survey snails	Areal density	±5% difference between observers
			Species identification	100% accuracy
	12	Survey geomorphology	Particle size	±1mm
			Substrate depth	±5cm

Data Standards

Taxonomic Standards

Taxonomic data will be collected to published identification standards (Table 5). Taxonomic concepts are essential for data sharing, as the combination of taxonomic name and identification reference allow both parties to be sure they agree on the underlying circumscription of the taxon or community, even if they use a different name. Taxonomic standards are also required to ensure comparability. Identifications will specify both the taxon and the reference used for making the identification.

Table 5. Taxonomic references for the PACN anchialine pool monitoring protocol (Raikow et al. 2018).

Category	Activity #	Taxon	Standard to be Used	Reference
Collection of Field Observations	6,7	Shrimp	Field Subject Matter Expert	Field crew lead with documented identification proficiency
	8	Fish		
	9	Odonates		
	10	Vegetation		
	11	Snails		
Reporting of Field Observations	6,7	Shrimp	Scientific Publication	Yamamoto and Tagawa 2000
	8	Fish	Scientific Publication	Hoover 2006
	9	Odonates	Scientific Publication	Howarth and Mull 1992, Polhemus and Asquith 1996.
	10	Vegetation	Scientific Publication	Native vegetation: Wagner et al. 1999, Wagner et al. 2012. Non-native vegetation: ITIS
	11	Snails	Scientific Publication	Yamamoto and Tagawa 2000

Protected Data Standards and Procedures

Pools included in the anchialine pool protocol are home to several rare and protected species. 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, another federal agency, or a 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 the PACN anchialine pool monitoring protocol (Raikow et al. 2018).

Protocol Module	Activity #	Data	Rules for Dissemination
Site Reconnaissance, Establishment, and Maintenance	1	Pool location	Precise locations (e.g., UTM coordinates) of protected species are not to be published; spatial analyses and general maps are permissible
Field Observations	5 - 12	Species	Precise locations (e.g., UTM coordinates) of protected species are not to be published; spatial analyses and general maps are permissible

Quality Assurance Procedures

Quality Assurance procedures for data-generating activities of the PACN anchialine pool monitoring protocol (Raikow et al. 2018) are summarized in Table 7.

Table 7. Summary of quality assurance procedures for data-generating activities of the PACN anchialine pool monitoring protocol (Raikow et al. 2018).

Protocol Module	Activity #	Activity	QA Procedures	Description	Citation
Site Reconnaissance, Establishment, and Maintenance	1	Obtain supporting data	Metadata compiled by parks and PACN	Metadata stored in database	PACN anchialine pool 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 Anchialine pools in all parks have been located Anchialine pools have been mapped in GIS with coordinates recorded Anchialine pool location data has been entered into a database Anchialine pools have been numbered and permanent tags have been affixed to the ground in KAHN where pool identification is difficult	PACN anchialine pool database PACN water quality database PACN geodatabase
	3	Choose sampling regime	Sample regime creates data that supports the scientific objectives	The sampling regime is based on a poor current state of knowledge concerning physical, chemical, and biological factors influencing the distribution of target animal species	Raikow et al. 2018

Table 7 (continued). Summary of quality assurance procedures for data-generating activities of the PACN anchialine pool monitoring protocol (Raikow et al. 2018).

Protocol Module	Activity #	Activity	QA Procedures	Description	Citation
Sensor Data	4	Measure light levels	Data obtained from instrument is comparable to accepted standards and across time	Instrument calibrated bi-annually	SOP # 7: Light Measurement
Field Observations	5	Map pool	Data are comparable to PACN GIS data and is comparable across time	Distance and location measurements made quantitatively	SOP #12: Pool Mapping and Photographing
	6, 7	Survey shrimp	Data are comparable across time.	Species identified with a key	SOP #13: Baited Trap Shrimp Survey SOP #14: Visual Shrimp Survey
	8	Survey fish	Data are comparable across time.	Species identified a with key	SOP #15: Fish Survey
	9	Survey odonates	Data are comparable across time.	Species identified with a key	SOP # 16: Odonate Survey
	10	Survey riparian vegetation	Data are comparable to other vegetation data collected by PACN.	Species identified with a key Survey has a time limit	SOP #17: Riparian Vegetation Survey
	11	Survey snails	Data are comparable across time.	Species identified a with key	SOP #19: Snail Survey
	12	Survey substrate	Data are comparable across time.	Transect location is recorded and revisited each sampling trip	SOP #18: Geomorphology

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: 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 will check 100% of the records to the original field forms. 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). 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 is not publically published during the entry and verification steps. See “Quality Control” below for description of data certification.

Roles and Responsibilities

The PACN anchialine pool monitoring protocol (Raikow et al. 2018) 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 the PACN anchialine pool monitoring protocol (Raikow et al. 2018).

Name	Position	Role	Contact Info
Lisa Garrett	Regional Program Manager	QAP approval, protocol approval & ensuring that data meet quality objectives	208-310-4085
Ryan Monello	Network Program Manager	Program coordination	808-985-6183
David Raikow	Aquatic Ecologist (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 PACN safety procedures and operational leadership policies are followed 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 and KAHO-based technician - Acquire necessary park permits - Facilitate communications between I&M staff and park staff - Certify data and lead or collaborate on analysis and reporting of data	808-985-6325

Table 8 (continued). Roles and responsibilities of those implementing the PACN anchialine pool monitoring protocol (Raikow et al. 2018).

Name	Position	Role	Contact Info
Anne Farahi	Lead biological science technician	• In the absence of the aquatic ecologist ensure PACN safety procedures and operational leadership policies are followed in the field • Train field crews in species identifications and 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 • Oversee or carry out data entry or verification • Conduct data summaries and general analysis • Assist PACN aquatic ecologist with report preparation • Annually review protocol and field notes	808-985-6181
Amanda McCutcheon	Biological science technician	• Participate in protocol field monitoring activities • Oversee field data collection in absence of lead biological science technician • Collect, record, enter and/or verify data	808-329-6881 x1219
Kelly Kozar	Data Manager	• Oversee all database and data management activities • Facilitate check-in, review, and posting of data, metadata, reports, and other products to national databases and clearinghouses according to central office guidelines • Maintain and update database application • Provide database training as needed	808-985-6186

Table 8 (continued). Roles and responsibilities of those implementing the PACN anchialine pool monitoring protocol (Raikow et al. 2018).

Name	Position	Role	Contact Info
Mark Wasser	GIS Specialist	• Consult on spatial data collection, metadata documentation and GPS use and training • Facilitate spatial data development and generate site maps • Work with PACN aquatic ecologist on spatial presentation and descriptive spatial analyses • 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 IMD scientific staff involved with the PACN anchialine pool monitoring protocol (Raikow et al. 2018).

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 / DOI Learn	Once	DOI Learn
Animal Identification	Field workers	To identify animals	In-house	None	PACN

¹ If 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 (Table 10). 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 are withheld from posting and distribution.

Geospatial Data Verification: All geospatial data for anchialine pool locations will be evaluated using ArcGIS to ensure accuracy.

Identification of Suspect Data: Data are inspected for suspect entries during data validation and data certification. Data is checked for outliers. Species are checked against expected species lists, and unexpected species are re-checked. Units are checked.

Quality Control Studies: Activities that require qualitative assessment or counting by field staff are evaluated for inter-observer variability, including visual shrimp surveys, riparian plant surveys, and snail surveys. Inter-observer variability will be assessed during annual quality control studies conducted independently and prior to sampling trips, due to time restraints while conducting synoptic monitoring.

Table 10. Quality Control (QC) annotation codes to be recorded for data records that do not meet data quality standards for the PACN anchialine pool monitoring protocol (Raikow et al. 2018).

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

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 11). Data annotations should also be used to qualify data based on where they are in the certification process, and the level of protection required by the data.

Table 11. Quality control procedures to be conducted in the implementation of the PACN anchialine pool monitoring protocol (Raikow et al. 2018).

Activity	Activity #	Measure	QC Procedure	Description
Measure light levels	4	PAR	Outlier check	Inspection of data for records that are outside norms of adjacent data
Survey shrimp	6, 7	Species identification	Species found in expected species list; Protected data screening	Species not in expected lists are double checked; flags data that are protected and not to be distributed publicly
	6, 7	Areal density	Observer check; Outlier check	Analysis of data collected by an individual; inspection of data for records that are outside norms of adjacent data
Survey fish	8	Species identification	Species found in expected species list; Protected data screening	Species not in expected lists are double checked; flags data that are protected and not to be distributed publicly
Survey riparian vegetation	10	Species identification	Species found in expected species list	Species not in expected lists are double checked
	10	% of bank occupied by species	Summary stats check	Ensure percentages add up to 100%
Survey snails	11	Species identification	Species found in expected species list; Protected data screening	Species not in expected lists are double checked; flags data that are protected and not to be distributed publicly
	11	Areal density	Observer check; Outlier check	Analysis of data collected by an individual; inspection of data for records that are outside norms of adjacent data
Survey geomorphology	12	mm	Outlier check	Inspection of data for records that are outside norms of adjacent data

Data Certification

Following the quality assurance step of 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 or are the result of unusual circumstances. Valid data that deviates from normal circumstances is recorded but flagged as outside the normal inference space. As part of this process, a subset of randomly selected records (10%) should be reviewed after initial verification by the Aquatic Ecologist. If greater than 10% errors are found, the entire data set should be verified again.

Data certification confirms that:

- Data have been through all QA/QC procedures as outlined above.
- Data either meet specified quality standards and/or that 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 SOP #23: Data Quality Review and Certification.

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 12). 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 or 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.

Table 12. Routine data quality evaluation and informal reports to be produced as a part of implementing the PACN anchialine pool monitoring protocol (Raikow et al. 2018).

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

The Network will document data quality sufficient to notify end-users, program ecologists and other network staff about the QA/QC procedures used in the management of data quality as well as the 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 (DO) 11D: Records and Electronic Records Management (2012; https://www.nps.gov/policy/DOrders/DO_11D.pdf) 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 13). 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 Inventory and Monitoring 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 13. Required records to be maintained as a part of implementing the PACN anchialine pool monitoring protocol (Raikow et al. 2018).

Sample Collection Documents and Records	Data Assessment Documents and Records	Other
Data collection field notes	Data QA/QC Snapshots for published reports	Manuscript submittal forms for published reports
Photos	–	Personnel training certifications / documentation
Safety Readiness Review documents	–	–
Permit application / acceptance memos	–	–

Metadata

Metadata for all published data products must be FGDC compliant. The abstract for all metadata must include the following link (<https://irma.nps.gov/DataStore/Reference/Profile/2192753>) to ensure that data can be traced to all methods used for data collection, processing, the latest version of the protocol, this QAP, and all associated standard operating procedures.

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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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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