



Inventory and Monitoring Division Protocol Review Guidance

Natural Resource Report NPS/NRSS/IMD/NRR—2018/1644



**ON THIS PAGE**

Forest monitoring crewmembers from Northeast Temperate Network (NETN) measure understory cover.
Photo courtesy of NPS

ON THE COVER

Water-quality monitoring at Acadia National Park.
Photo courtesy of NPS

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All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

This report received formal peer review by subject-matter experts who were not directly involved in the development of the guidance, and whose background and expertise put them on par technically and scientifically with the authors of the information.

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Executive Summary

This document provides guidelines for protocol reviews designed to ensure accountability, scientific integrity, and compliance with existing policy and guidance. In particular, this document standardizes the process for regular operational reviews, encouraging networks to maintain the connection between protocol documents and field practices, providing a formal and defensible approach to reviewing and revising protocols and vital signs, and ensuring that national and division peer review requirements are met during protocol reviews. This standardization contributes to the scientific integrity of monitoring protocols and networks.

Protocol reviews are divided into operational reviews and three types of scientific reviews (targeted, full, and multi-protocol/network). Each type of review has a different purpose, trigger, time frame, and outcomes. An operational review evaluates effectiveness and challenges of protocol implementation as prescribed in existing documentation. Targeted and full scientific reviews ensure that a protocol or group of related protocols clearly meets the stated objectives and reflects the highest scientific standards, given resource and other limitations. A multi-protocol review is considered a special case of a scientific review and is a high-level review of the network's science and vital signs.

This document provides detailed guidance on review procedures to provide networks with a formal and approved approach and a clearly defined path to follow. Guidance for each type of review is based on a "panel" format, which may not be the preferred approach in all cases. Networks may choose to implement other approaches for operational and scientific reviews of vital signs monitoring protocols, provided they are developed in collaboration with the regional program manager and the following minimum requirements are met:

- An operational review of every implemented protocol must be conducted annually.
- Operational reviews must produce the required outcomes described in the Operational Review Overview.
- Scientific reviews must be conducted when a network desires or is directed to consider substantive revisions to a protocol.
- A multi-protocol review must be conducted when a network desires or is directed to consider changes to the vital signs monitoring plan.
- Protocol reviews and multi-protocol reviews must produce the required outcomes described in the Scientific Review Overview.

The regional program manager will determine whether the network's approach will meet the review's intent, as specified in this guidance.

Definitions

Clarification: A change to a protocol that adds details or resolves a potential inconsistency. Most commonly used when a field situation arises that was not anticipated when drafting a standard operating procedure (SOP). Clarifications may also be needed when statements in different parts of a protocol conflict. Clarifications do not require review beyond the network (but should be relayed to other networks known to be implementing the protocol).

Deviation: A situation where data were collected in a manner substantially different from the methods documented within the SOPs that were current at the time of data collection. Examples of deviations include the crew not following established procedures, such as incorrectly evaluating tree canopy class or habitat characteristics, or not following quality control procedures. Examples that would not be considered deviations include the individual collecting the data (if all crew members are trained) as well as minor variations in quality assurance procedures, such as a data recorder not repeating all values back to the data collector. Note that deviations must be flagged and tracked during the network quality assurance (QA) process, and the project principal investigator must decide on an appropriate action (e.g., change the designated data quality, mark the data as unusable, correct the data, or modify procedures to reduce the chance of a future deviation). Documentation of deviations is needed for completeness so future data users know of issues and how they were corrected.

Difference: When multiple networks are implementing a protocol (via a shared protocol or a protocol and one or more protocol implementation plans), a procedure or design component that is altered in one or more networks.

External Reviewer: Someone from outside the network (or group of networks) implementing a protocol who has never been involved in the protocol's development or implementation. The peer review manager needs to evaluate the appropriate mix of reviewers. In some cases all reviewers may be from within the National Park Service's Inventory and Monitoring Division (NPS I&M), and in other cases non-NPS reviewers may be needed.

Major or substantive change: A proposed alteration to a protocol that has the potential to affect the data or data analyses, such that data collected after the change cannot easily be rectified with earlier data. Examples of substantive changes include changed monitoring objectives, changed data collection methods (e.g., quadrat to line-intercept), changes to what is measured (e.g., percent cover rather than cover classes), and most changes to the sampling design such as changing panels or adding and dropping sites (except for index site designs). Changing labs can be a substantive change if it changes Minimum Detection Limits (MDLs) and procedures. Changed QA processes and equipment changes to equipment that has different (better or worse) QA standards would also be substantive. Examples of changes that are not substantive would be removing sites from a program that does not have a statistical design, changes in GPS equipment (unless the GPS accuracy is important to the protocol), clarifications of SOP procedures, database changes, increased QA checks, equipment changes that meet existing quality standards (e.g., a different brand of DBH [diameter at

breast height] tape, and a new sonde model or manufacturer if sensor specifications remain the same).

New Analysis: An existing analysis or method is a statistical approach described in the approved protocol with, at a minimum, a model statement and a few paragraphs describing the approach and how the protocol sampling design is accounted for in the analysis. Many protocols have placeholders listing potential approaches that do not meet the minimum for an existing analysis. A statistical method is a new analysis when it replaces a placeholder or differs from an existing analysis. The new analysis method is intended for routine annual or trend reporting. For example, a mixed-effects model when linear regression or analysis of variance (ANOVA) was previously used. Changes to functional form or covariates are not new analyses. For example, using a second-order curve for a linear regression, changing the variance-covariance matrix or error distribution of a mixed-effects model, or adding weather covariates to an existing method would not be a new analysis (although such changes should never be implemented without the involvement of someone well-versed in the method). Note that new analyses are only subject to the protocol review process if they are intended to replace or update analyses described in the protocol for routine reports. Other analyses would fall under the existing peer-review requirements for publications. Note also that a new analysis described in a peer-reviewed journal methods paper can be incorporated into a protocol with minimal documentation.

Protocol: A set of documents governing how a monitoring program is implemented. These documents include a narrative, standard operating procedures, quality assurance plan, and supplementary materials (e.g., equipment instructions, maps of site access, and training presentations).

Review: An evaluation of part or all of a protocol or broader program, particularly one focused on assessing and improving a protocol's operational effectiveness or scientific foundation. Reviews are often scheduled to discuss proposed revisions to a protocol, but it is also possible for a review to identify needed revisions, and reviews may determine that revisions are not needed.

- **Operational Review:** A regular (annual) meeting to discuss matters related to protocol implementation and effectiveness. This type of review often results in minor revisions to protocols, such as clarifications of field methods. These revisions are not just to document deviations in the previous year, but include lessons learned and tweaks that should be made going forward. Operational reviews may also result in a recommendation for a scientific review.
- **Scientific Review:** An occasional meeting to ensure that a written protocol or group of protocols clearly meets the stated objectives and reflects the highest scientific standards for monitoring, given resource and other limitations (i.e., “best available sound science”). A scientific review is designed to review or propose substantive changes to a protocol or group of protocols (e.g., changes to sample design or methodological approach). A scientific review may also take the form of a big-picture network review of some or all protocols and activities, including overall constraints on the program and whether the network is monitoring the most appropriate vital signs in the most effective way possible.

- **Revision:** Any change to an existing protocol. Revisions may be minor and focused on enhancing operations, such as clarifications to procedures or edits to reflect current equipment used in the field. Revisions may also be substantive and focused on the underlying science, such as changes to the statistical sampling design.

Introduction

National Park Service (NPS) Inventory and Monitoring (I&M) networks have put substantial effort into producing rigorous, scientifically sound, and peer-reviewed monitoring protocols. Over time, networks may find that the original protocol is unclear in some areas or that improved, safer, or more cost-effective methods are available. Alternatively, monitoring staff may want a general review of a protocol to ensure that it is still scientifically sound and supports the other activities of the network. These reasons and others will lead I&M staff to review a protocol or even the entirety of a network's science operations.

This document provides guidelines for protocol reviews designed to ensure accountability, scientific integrity, and compliance with existing policy and guidance. In particular, this document standardizes the process for regular operational reviews, encouraging networks to maintain the connection between protocol documents and field practices, providing a formal and defensible approach to reviewing and revising protocols and vital signs, and ensuring that national and division peer review requirements are met during protocol reviews. This standardization contributes to the scientific integrity of monitoring protocols and networks. Adoption of this guidance increases the level of excellence of our program, contributes to the integrity of our program and the long-term value of our information, helps ensure that our data are relevant for management, prompts us to cooperate among networks and explore new partnership opportunities with parks and other entities, and increases the visibility of the NPS Inventory and Monitoring Division.

The guidance in this document intersects with a variety of National Park Service and Inventory & Monitoring Division guidance and policy documents (Figure 1). The mandate, goals, and overall roles and responsibilities of the Inventory & Monitoring Division are described in NPS 75. Our responsibilities for ensuring appropriate peer review are described in DO 11B and the Natural Resource Stewardship and Science Review Policies. The Inventory & Monitoring Division has developed additional policy and guidance where needed to clarify and further describe how the division operates. These include data management guidelines and standards, guidance for developing monitoring protocols, divisional peer review and authorship guidelines, and guidance covering network operations.

Protocol reviews are divided into operational reviews and three types of scientific reviews (targeted, full, and multi-protocol). Each type of review has a different purpose, trigger, time frame, and set of outcomes (Table 1). An operational review evaluates effectiveness and challenges of protocol implementation as prescribed in existing documentation. Targeted and full scientific reviews ensure that a protocol or group of related protocols clearly meets the stated objectives and reflects the highest scientific standards, given resource and other limitations. A multi-protocol review is considered a special case of a scientific review and is a high-level review of the network's science and vital signs.

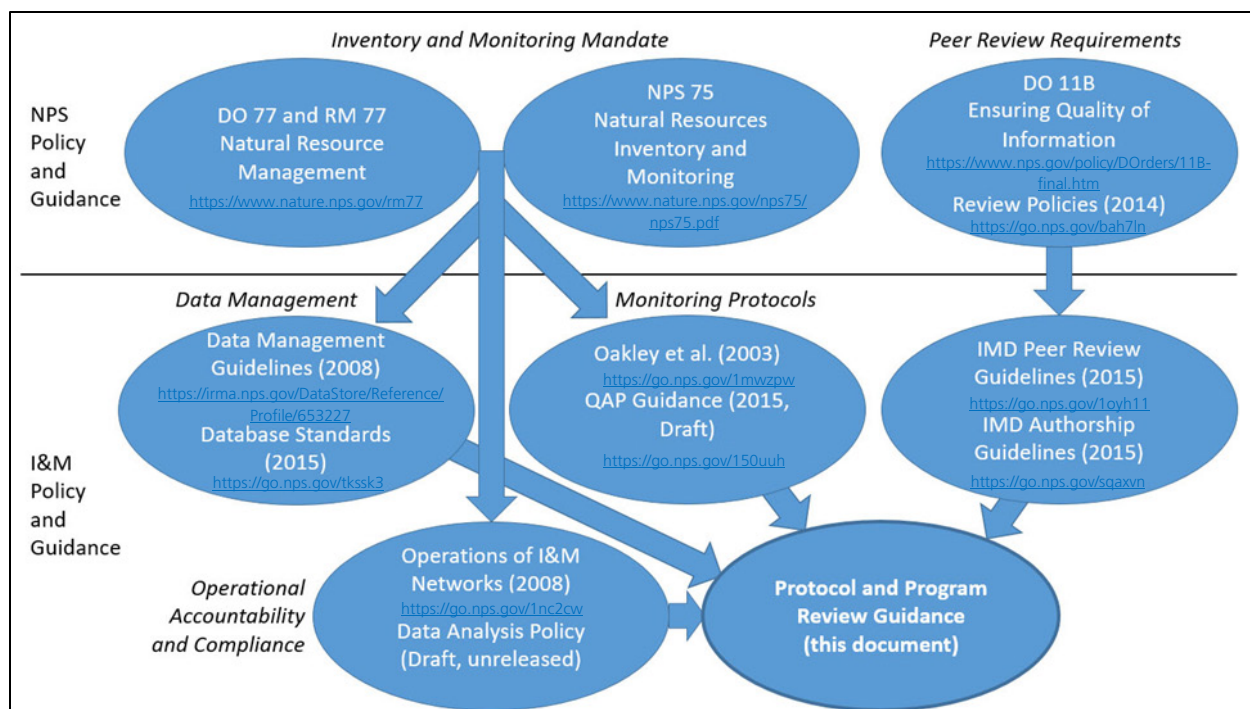


Figure 1. Protocol and program review guidance in the context of other National Park Service and Inventory and Monitoring Division guidance and policy.

This document provides detailed guidance on review procedures to provide networks with a formal and approved approach and a clearly defined path to follow. Guidance for each type of review is based on a “panel” format, which may not be the preferred approach in all cases. Networks may choose to implement other approaches for operational and scientific reviews of vital signs monitoring protocols, provided they are developed in collaboration with the regional program manager and the following minimum requirements are met:

- An operational review of every implemented protocol must be conducted annually.
- Operational reviews must produce the required outcomes described in the Operational Review Overview.
- Scientific reviews must be conducted when a network desires or is directed to consider substantive revisions to a protocol.
- A multi-protocol review must be conducted when a network desires to or is directed to consider changes to the Vital Signs Monitoring Plan.
- Protocol reviews and multi-protocol reviews must produce the required outcomes described in the Scientific Review Overview.

The regional program manager will determine whether the network’s approach will meet the review’s intent, as specified in this document.

Table 1. Types of reviews covered by this guidance and basic characteristics of each. NPM = Network Program Manager, RPM = Regional Program Manager.

Type of Review	Purpose	Triggers	Timing	Outcomes	Managed By	Approved By
Operational	Review protocol implementation and effectiveness	Completion of a field season.	Annual; required time ranges from a few hours to a few days	Documented suggestions for improving protocol. Documented decisions about suggestions. Documented deviations from protocol. Updated protocol documents (primarily SOPs). Plan for addressing safety concerns.	Protocol lead	NPM ¹
Scientific: Targeted Protocol	Discuss one or a few SOPs or limited design changes	Findings from operational review, multi-protocol review, or data analyses. Concerns from network staff or RPM. Availability of new approach or tool. Budget concerns.	As needed; required time ranges from a few days to several weeks	Synopsis of rationale for the review. Validation of current approach or approval to modify protocol. Documentation of the effects of changes on data and plan for updating data management and analysis. Revised protocol documents.	NPM or protocol lead	RPM
Scientific: Full Protocol	Conduct in-depth review of protocol	Findings from operational review, multi-protocol review, or data analyses. Concerns from network staff or RPM. Availability of new approach or tool. Budget concerns.	As needed; required time ranges from a few days to several weeks	Synopsis of rationale for the review. Validation of current approach or approval to modify protocol. Documentation of the effects of changes on data and plan for updating data management and analysis. Revised protocol documents.	NPM or protocol lead	RPM
Scientific: Multi-Protocol	Big-picture review of network Vital Signs and integration between them	Network staff or RPM believe a review is warranted.	As needed; required time ranges from one to several weeks	Synopsis of rationale for the review. Validation of current approach or approval to modify Vital Signs or other aspects of network operations.	NPM	RPM and IMD Chief

¹RPM if there is a change to the protocol narrative or Quality Assurance Plan.

Operational Review Overview

Purpose

To obtain feedback on protocol implementation, ensure that the written protocol remains in sync with annual monitoring activities, document changes in procedures and equipment, and capture lessons learned as changes to be made going forward. This review also provides monitoring staff with an opportunity to discuss the state of the science of the protocol, and recommend when a science review may be needed.

Scope

Operational reviews primarily cover standard operating procedures (SOPs) and operational documents.

Required Outcomes

1. Documentation of suggestions for improving the protocol and decisions regarding the suggestions. Note that some suggestions may trigger a scientific review.
2. Documentation of deviations between the protocol and the field implementation that could potentially affect data quality or utility. For these deviations, document whether the deviation needs to be addressed with changes or clarifications to procedures. Update the database with affected data appropriately flagged and documented.
3. Updated and approved protocol documents or an approved plan (tasks and timeline) for revising the protocol if procedures, methods, or equipment are changed or clarified. Approved plans may include a pilot study, data analysis, and scientific review.
4. Identification and verification that safety risks associated with protocol implementation are appropriately mitigated. For any newly identified or incompletely mitigated risks, approve a plan (tasks and timeline) for mitigating the risks and updating the network safety documents.

Timing

Operational reviews occur after each field season, or annually for continuous monitoring.

Participants

Network staff and cooperators, contractors or others involved with data collection, management, and analysis; plus additional experts if appropriate (e.g., water resources division [WRD] or regional hydrologist for water-quality [WQ] protocol reviews). If seasonal staff are no longer employed at time of review, their feedback should be solicited as part of their end-of-season process. If the protocol has one or more protocol implementation plans (PIPs) based on it, network staff are strongly encouraged to invite networks with PIPs to participate in the review.

Content

Discuss protocol implementation, including:

1. State of the science. Discuss whether changing needs, new conditions, or emerging information (from the network or external sources) suggest the need for a scientific review.
2. Known situations where SOPs were not followed, and whether these situations affected data quality or utility. Note that if a safety risk is identified in the field, the field crew must not visit sites or implement methods that risk their safety. In this situation, the crew should document their decision in the monitoring database, and it will be recorded as a deviation from the protocol. The operational review must consider the situation and determine if protocol changes to protect safety are needed, as well as whether the proposed changes require a scientific review.
3. Places where SOPs need clarification and how the unclear situation(s) were handled in the field. Consider other networks that may be implementing the protocol and identify changes that would need to be communicated to them.
4. Situations where new SOPs may be needed (including new equipment, new methods, and new data management practices). New SOPs will need scientific review if they affect the monitoring approach or quality of the data. For example, an SOP for a new GPS will not likely need scientific review, but a switch to monitoring shore bird nests via drones instead of helicopter would need a science review.
5. Potential changes to streamline or improve procedures (including new equipment).
 - a. The only situation where a change to procedures or equipment does not require a scientific review is where a change is required due to unforeseen events (e.g., sudden discontinuation of a key piece of equipment by the manufacturer).
 - b. For changes to methods and planned changes to equipment, a side-by-side comparison of the old and new methods or equipment should be conducted, with results to be scientifically reviewed prior to implementing changes.
6. Proposed improvements to reporting and analysis SOPs.
 - a. Note that new analysis approaches and example products will require a scientific review if the intent is to replace or update the current reporting and analysis procedures for routine products.
 - b. Discussion of sample site issues.
 - c. For non-statistical designs, sample site issues may include changes to sites, new sites, and discontinued sites.
 - d. For statistical designs, sample site issues may include discussion of exclusion criteria and whether the criteria need to be clarified, whether existing sites should be excluded based on the criteria, and whether previously excluded sites should be included. More substantive changes would require a targeted review or a scientific review.
7. Data management review.

- a. Ensure there are clear linkages between the SOPs, field data sheets, and database(s).
 - b. Determine if there are any concerns throughout the data life cycle (i.e., planning and preparation through data collection to review, reporting and archiving).
 - c. Ensure that data quality standards are clearly defined.
 - d. Document that the protocol database meets, at least, the mandatory database requirements as outlined in the Inventory and Monitoring Division (IMD) Database Standards, including handling of protected records.
 - e. Identify potential changes to data management procedures that maintain or enhance quality assurance and quality control (QA/QC).
8. Safety Review.
- a. Discuss any incidents or near misses, and actions taken or needed.
 - b. Solicit suggestions for making procedures safer, including equipment improvement and training needs.
 - c. Discuss any implications for sampling design and methods, e.g. whether additional situations for excluding sites for safety reasons are needed.
 - d. Is the sampling schedule reasonable, too strenuous, or too ambitious (e.g., doesn't leave for sufficient buffer time for schedule interruptions and setbacks).

Documentation

1. Protocol review meeting minutes in sufficient detail so a reader can understand the issues discussed and decisions made.
2. Documentation of side-by-side data collection when unplanned or unforeseen equipment changes might affect data quality or comparability (e.g., resulting from the discontinuation of water-quality sonde or sensor). This should include a correlation analysis demonstrating the relationship between data collected with old and new equipment or methods. Note that in many situations, results from the evaluation may require a scientific review to determine whether differences in equipment are acceptable. Scientific review is required for all situations where the correlation between side-by-side data is below 0.9 or shows signs of non-linearity.
3. Identification of factors encountered in the use of new equipment that might affect data quality or comparability, particularly when use of new equipment is driven by unplanned or unforeseen circumstances or when "old" equipment is unavailable for conducting side-by-side comparisons.
4. Documentation of known deviations from protocol methods (in a document of annual deviations, as well as in database).
5. For any newly identified or incompletely mitigated safety risks, provide a plan (tasks and timeline) for mitigating the risks and updating the network safety documents where appropriate.

6. Revised protocol documents (not all of the following documents are applicable in all situations). Tracked-change documents are recommended because they facilitate review by highlighting changes. The network program manager or regional program manager may choose to require tracked-change documents.
 - a. Revised narrative (rare; generally to synchronize methods descriptions with changes to SOPs).
 - b. Revised SOPs or new SOPs.
 - c. Revised QA/QC documentation (e.g., quality assurance plan [QAP]).
 - d. Updated supplementary materials.

Final Steps

1. The operational review is managed by the protocol lead. The network program manager reviews the minutes and associated documentation, e.g. side-by-side documentation, deviations documentation, and revised protocol documents (typically SOPs and QAP; supplementary materials do not need review).
2. The network program manager contacts the regional program manager to request a scientific review if needed, but operational reviews will generally not result in a need for scientific or external review.
3. Networks with PIPs based on another protocol are ultimately responsible for contacting the protocol lead(s) who administer the original protocol annually for the results of the operational review. However, the protocol lead is strongly encouraged to inform networks with PIPs of the operational review, solicit feedback about PIP implementations, and distribute the results of the operational review.
4. Changes to SOPs that stem from an operational review are reviewed and approved by the network program manager. The regional program manager must review and approve changes to the narrative or QAP.
5. Review documents must be stored in a readily discoverable location on the network's server.
6. The network program manager is responsible for updating the protocol's NPS Data Store record, using versioning capabilities.
7. The network program manager is responsible for updating information about the protocol in the I&M protocol tracking database (<https://irma.nps.gov/ProtocolTracking/>).

Guidance for Implementing an Operational Review

The following is one approach that will meet the requirements for an operational review. Networks may work with their regional program manager to develop a different approach that still meets the purpose, content, documentation, and level of internal review needed for a protocol operational review.

Staff Training and Protocol Implementation

In order to be most effective, preparing for the operational review begins during field staff training and continues as data are collected. Inform all field staff at the start of the season (and remind them mid-season) that:

- It is essential to collect data according to the protocol. The long-term usability of the data set is founded on the assumption that data are collected in the same way by every person and during every sampling event. Ideally, any changes to the protocol over time should happen between sampling seasons and with a thorough investigation of the potential effects of the changes.
- No protocol can cover 100% of the situations that arise in the field. When an unusual situation is encountered that does not appear to be covered by the protocol, discuss with the crew leader and protocol lead (if possible). Document the situation and decision that was made. Flag any data that were collected using ambiguous procedures. The protocol lead and data manager should be informed of data collection ambiguities as soon as practicable.
- Collecting data safely is a priority. Network safety documents must describe situations that are considered safe or unsafe, and there must be open discussion among the field crew regarding general and specific safety issues. If collecting data according to the protocol ever produces an unsafe condition, stop and do not collect data in an unsafe manner. Discuss the situation with the crew leader and protocol lead (if possible). Collect any data that can be collected safely. It is ok to attempt slight modifications if they are likely to enable safe and accurate data collection. Fully document the safety situation and all decisions made. Flag any data that were not collected according to the protocol, and inform the protocol lead and data manager as soon as practicable.
- Review quality assurance (QA) data as soon as practical after collection. This review must include looking for areas of potential bias that may suggest areas where data may not be collected according to protocol. Document any potential areas where QA data indicate bias, implement corrective measures, and identify the affected data for flagging.
- Anyone who becomes aware of data that have not been collected according to protocol must document the situation and identify the affected data for flagging. Notify the protocol lead and data manager as soon as practicable.
- Suggestions for improving the protocol are welcome. Ideas for improving the science, field efficiency, databases, data management, accuracy, and safety should be documented for discussion during the protocol operational review meeting. This can be done during the field season or as part of the field crew close-out process.

Appropriate documentation can take a variety of forms, and will likely vary by protocol and network. The protocol lead may want to provide all field crew members with the “End of Field Season” questions. At a minimum:

- Take advantage of comment spaces and flags on data entry sheets and in databases to document any data collected according to ambiguous or modified procedures.
- All staff should keep a record of questions, concerns, and suggestions in a field notebook or computer file. They should provide enough detail to allow someone else to understand the issue as well as any notes made in the database. Staff should forward any accumulated information to the protocol lead at regular intervals.

End of Field Season

At the end of the field season (or the specified end of annual data collection for protocols collecting data throughout the year), the protocol lead ensures that all staff have the opportunity to provide feedback about protocol implementation. Staff may include interns, seasonal employees, park staff, network staff (bio techs, protocol lead, data manager), cooperators, and contractors. The network may also want to contact networks that are using the protocol via a protocol implementation plan (PIP) as well as other agencies that may be implementing the protocol. The protocol lead asks everyone to respond to the following questions, particularly if they did not provide any comments during the field season:

- Did you encounter any ambiguous situations where you felt that the protocol was unclear? Please describe the situation and any data that may have been affected.
- Are you aware of any situations where you or someone else deviated from the protocol? Please describe the situation and any data that may have been affected.
- Do you have any suggestions for improving the protocol? Suggestions can cover any aspect of the protocol, including the underlying science, field equipment, methods, logistics, and safety.

Review Preparation

The protocol lead compiles and organizes the information needed for the review. Typically issues to be discussed fall into one of the following categories:

- **Protocol deviations**—Situations where the protocol was not followed as written.
- **Protocol clarifications**—Situations where the protocol is ambiguous and could be clarified.
- **Equipment changes**—Situations where equipment is outdated and needs to be replaced, and the replacement may have different capabilities and functions.
- **Methods improvements**—Situations where field or analytical methods could be streamlined or improved.
- **Data management improvements**—Situations where data management procedures could be streamlined or improved.

- **Safety improvements**—Situations where safety and related procedures could be streamlined or improved.
- **Logistics, communications, and field support**—Suggestions for optimizing logistics and operations, managing workload, and ensuring that contingencies (weather, terrain, etc.) are accounted for in field planning.

Many of the items to be covered during an operational review will be minor clarifications or improvements to the protocol that are unlikely to affect the data. For example, it is very common during an operational review to notice that crew members are regularly making similar comments, and that efficiency would be improved by adding summary codes or fields to the field form or database. For these and other minor changes, the protocol lead may want to prepare a tracked-changes version of the protocol and a “punch-list” of items addressed by the changes. These can be reviewed by operational review participants ahead of the formal meeting, and only discussed if a participant has a question or concern about the change.

Other items will be more substantive and require group discussion. These may include known deviations from the protocol, a desire to transition to a new type of equipment or method, safety concerns, and QA data indicating potential bias in data collection. Participants may also want to discuss the state of the science of the protocol, and whether changing needs or conditions as well as emerging information suggest the need for a scientific review. The protocol lead should prepare a meeting agenda and any background documents and information needed for participants to understand the discussion topics. This might include draft standard operating procedures (SOPs), side-by-side data collected using different methods, or QA results.

Review Meeting

The actual operational review meeting may take a variety of formats. It can range from a half-hour conference call for a protocol that has been implemented for several years by network staff to a two-day meeting for a protocol that is early in its implementation and involves a wide variety of external staff. The protocol lead should recommend the appropriate meeting duration based on the complexity of the issues that need to be discussed. For protocols implemented by a variety of external staff (parks, cooperators, and other agencies), it may make sense to have short conference calls for multiple years to cover key issues of concern, and then have a one to two day meeting every three to five years to dig deeper into operational aspects of the protocol, ensure that all participants are implementing the protocol consistently, and discuss potential new approaches that the group may want to consider.

Regardless of the length of the meeting, make sure to:

- Designate someone other than the protocol lead to take meeting minutes that document all decisions.
- Ensure that participants are comfortable with how minor changes to the protocol were addressed.

- Discuss any substantive issues that came up during the field season and during preparation for the operational review.
- Discuss any known protocol deviations and ambiguities and how they might be minimized or prevented in the future. This includes discussion of any deviations from QA or quality control (QC) procedures.
- Determine how to handle any data affected by protocol deviations and ambiguities. Actions may range from unflagging data that were found to have been collected according to protocol, to flagging data as lower quality or even unusable.
- Discuss any biases or substantial sampling variability detected when comparing QA/QC replicate data to original field data, and whether there are protocol modifications that would reduce or eliminate the biases.
- Discuss any potential changes to equipment, field methods, databases, data management, and analytical approaches. Determine the feasibility and appropriateness of collecting side-by-side data when new equipment and methods are proposed, and evaluate any such data that may be available.
- Discuss whether potential changes should be developed separately from the protocol or pursued as a pilot project. If so, set a specific timeline (two field seasons or less) for determining whether developmental or pilot methods should be incorporated into the protocol.
- Document whether any changes to equipment, field methods, or analytical procedures will require a scientific review.
- Discuss whether changing needs, new conditions, or emerging information (from the network or external sources) suggest the need for a scientific review.
- Discuss the timeline for updating documents and databases, and ensure that tasks can be completed prior to the next field season.

Review Follow-up

After the protocol operational review, the protocol lead:

1. Finalizes meeting minutes, ensuring they accurately reflect decisions made during the meeting.
2. Updates protocol documents using tracked changes to facilitate review by the network program manager (SOPs) or regional program manager (narrative and quality assurance plan [QAP]).
3. Works with the network data manager to ensure that data are appropriately flagged to reflect protocol deviations, ambiguities, and quality.
4. Works with the network data manager to document protocol deviations and changes in the monitoring database as well as in the metadata or other formal document.
5. Prepares revised protocol documents or new documents (e.g., a new equipment SOP) as required based on the outcome of the review, and provides documents to the network

program manager. In situations where additional work is needed before documents can be revised, a list of tasks and a timeline for completion is prepared.

6. Prepare a list of tasks and timeline for addressing any newly identified or incompletely mitigated safety risks and updating network safety documents.
7. Works with the network program manager to initiate a scientific review of any protocol components in need of external review.
8. Provides results of operational review to any network with a PIP based on the protocol.

Final Steps

1. The network program manager reviews changes to SOPs and approves or returns them for further revision. The network program manager may choose to send documents out for external review, although this should be rare for an operational review.
2. The network program manager reviews changes to the narrative and/or QAP and either asks for further revision or forwards the documents to the regional program manager for review.
3. The regional program manager reviews changes to the narrative and/or QAP and approves or returns them for further revision. The regional program manager may choose to send documents out for external review, although this should be rare for an operational review.
4. The protocol lead creates or updates the protocol-specific summary of deviations and substantive changes to the protocol over time, and ensures that the summary is linked from the database metadata.
5. The network program manager and protocol lead ensure that revised documents are published to the NPS Integrated Resource Management Applications portal (IRMA), the I&M protocol tracking database (<https://irma.nps.gov/ProtocolTracking/>) is updated, and networks that have PIPs based on the protocol are notified of the availability of final documents.
6. The protocol lead and network data manager work to update databases and field forms to reflect any changes agreed upon during the review.
7. The protocol lead ensures that all supplemental materials (including training guides and “cheat sheets”) are updated as needed.
8. The protocol lead ensures that review-related documents are organized and stored in a readily discoverable location on the network’s server.

Scientific Review Overview

Purpose

To ensure that a written protocol or group of protocols clearly meets the stated objectives and reflects the highest scientific standards for monitoring, given resource and other limitations (i.e., “best available sound science”). A science review may also take the form of a big-picture network review, including overall constraints on the program and whether the network is monitoring its Vital Signs in the most effective way possible. A scientific review is designed to review or propose substantive changes to a protocol or group of protocols (e.g., changes to sample design or methodological approach). The review determines if the changes will have a substantive effect on the data or data analysis, and if so, how to accommodate the changes. The scientific review may also evaluate new analytical approaches and whether findings are being reported in a way that is meaningful to park managers. The review will propose or assess one or more of the following:

1. Sampling design changes. Examples of these changes include additions or reductions in number of sites monitored, changes to frequency of sampling, and altered response design (how and what is measured at each site).
2. Methodological changes, including adding or removing methods or metrics, as well as revising methods in a way that may not be compatible with old methods. Revised methods need to account for the cost of changing to a new approach when that affects the continuity of the data set.
3. Changes to monitoring objectives alter the intent of the monitoring and warrant scientific review. Altered monitoring objectives affect the protocol’s sampling design, data collection methods, analytical approaches, and quality assurance steps.
4. Check on relevance, to ensure that monitoring objectives are appropriate, achievable, and use methods that produce the appropriate data at the appropriate standards to support sound science-based management of park resources.
5. Assess potential alignment and compatibility with related vital signs and park management needs, and effects of changes on other network monitoring activities.
6. Opportunity to collaborate or align with networks or other monitoring programs that have similar protocols.
7. Evaluate whether the network is monitoring the most appropriate vital signs in the most effective way possible.

Scope

Scientific reviews fall into three different categories, which vary in complexity, time commitment, and scope. Reviews may use a variety of formats, ranging from limited reviews of documents by individuals not associated with the protocol to a formal workshop with a variety of participants from different disciplines.

1. A targeted (or tactical) protocol review typically focuses on one or a few standard operating procedures (SOPs) or limited design changes.

2. A full (or strategic) protocol review is an in-depth review of a protocol that may be shared across networks.
3. A multi-protocol review assesses several or all network protocols and activities, typically focusing on big-picture questions about appropriateness of vital signs and integration between them.

Required Outcomes

1. Brief synopsis of rationale for the scientific review. Concisely describe the issue or concern that the scientific review is investigating. This could range from a general desire to ensure the scientific validity of a protocol to a specific issue that needs to be addressed.
2. For targeted and full protocol reviews, validation of current protocol objectives, design, methods, and standards (as appropriate for the type of scientific review), or recommendation to modify the protocol based on the findings of the scientific review. For example, a targeted review may only require validation or modification of some specific methods. In some situations, additional expert guidance regarding proposed changes may be needed before a decision can be approved. In this case the outcome will be an approved plan outlining the steps and timeline for making a decision.
3. If a recommendation is made to modify a protocol:
 - a. Documentation of any effects on data quality, data usability, or data quality standards, including whether (and how) data collected prior to protocol changes will be compatible with data collected after the changes.
 - b. Plan (tasks and timeline) for updating data management processes, revising the protocol database, flagging affected data, updating analysis methods, and updating reporting (as appropriate) to accommodate the changes.
 - c. Revised protocol documents suitable for peer review, or a plan (tasks and timeline) to accomplish the revisions.
4. For full protocol and multi-protocol reviews, an additional outcome is validation of current operations, or approval to modify the protocol(s) to improve information dissemination (what is being produced, in what formats, and how is it being made available) and support intended scientific and decision-support needs. If modifications are approved, an approved plan (tasks and timeline) for accomplishing the modifications is needed.
5. For multi-protocol reviews, an additional outcome is validation of the current suite of vital signs, or recommendation to modify the vital signs monitoring plan to improve the ability of the network to provide sound science to support park management. If monitoring plan changes are approved, a schedule of tasks and timelines for accomplishing the changes must be approved.

Timing

Reviews occur when:

1. An operational review identifies proposed substantive changes or issues that need to be evaluated prior to implementation.
2. Network staff or the regional program manager believe that a review of a protocol's science (including the design or fundamental approach) is warranted. Concerns about the credibility, relevance, or utility of data resulting from the protocol will trigger a scientific review.

Examples include:

- a. Quality assurance and quality control (QA/QC) data indicate high rates of suspect data.
 - b. Findings from research reports indicate changes to methods may be beneficial.
 - c. Underlying assumptions governing protocol sampling design have changed.
 - d. Changes to intended or anticipated uses of data warrant a change in data quality standards or methods.
 - e. Findings from analyses indicate that data may not have sufficient power to be as useful or relevant as planned.
3. Network staff or the regional program manager believe that a big-picture review of the network is warranted. Typically, this would be triggered by concerns about vital signs priorities, changes or potential changes in budget or staffing that substantially affect the network's ability to implement the high priority vital signs, or the desire to investigate potential broad-scale changes that might help the network be more successful.
 4. Changes in budget require the network to review alternatives and potential scientific effects of reduced resources available for implementing one or more protocols.

The exact timing of a scientific review will vary, but once the need for a scientific review is identified it should be conducted as soon as is feasible. Note that in the case of safety concerns, potentially unsafe practices identified during the field season or the operational review must be halted and documented as a protocol deviation.

Participants

Participants and their primary area of contribution may include some or all of the following, depending on the scope of the review:

1. Network staff and others involved with data collection, management, and analysis (protocol knowledge and scientific expertise).
2. Network program manager (science and technical oversight).
3. Network data manager (data management and QA/QC oversight).
4. Regional program manager (peer review manager and science oversight).
5. Relevant park staff (management needs, compliance, and subject matter expertise).
6. NPS Inventory and Monitoring Division (IMD) Deputy Chief for Science (science oversight).

7. Protocol lead(s) from network(s) with a protocol implementation plan (PIP) based on the protocol (optional; protocol knowledge and scientific expertise).
8. An effort should be made to coordinate with networks that have similar protocols and may also be considering scientific reviews.
9. Subject matter experts:
 - a. Taxonomic or topical experts (may be NPS).
 - b. Statistical expert (may be NPS).
 - c. Data management expert (may be NPS).

Content

The scientific review will address one or more of the following:

1. Evaluate a protocol against current science standards:
 - a. **Adequacy for meeting objectives**—Are the objectives relevant to park management? Does the monitoring design have sufficient power to meet these objectives? Are the estimates generated from data analyses precise enough to be informative for management? Are resource managers receiving timely and relevant information?
 - b. **Analysis**—Are well-defined and suitable status and trend analysis procedures present as an SOP or accessory document (including peer-reviewed journal articles)? The review will look closely at the analytical approach and ensure that it is appropriate for meeting the objectives, and is scientifically valid for the design.
 - c. **Methods**—Are the current methods sufficient and necessary for meeting the objectives? Are quality control methods appropriate, and does the protocol consider ways to adapt to unavoidable changes (e.g., changed equipment or observers)? Are there improved analytical methods available that would require modified or additional data collection? If so, are the improved methods incompatible with existing data, and are the effects of any loss of compatibility worth the benefits of the new approach? Are ancillary data (e.g., data not required by the protocol but collected because it is part of lab or instrument reports) appropriately documented and stored with the core monitoring data?
 - d. **Data Reliability**—Issues related to data management standards and processes may be raised during the course of a scientific review. For instance, QA/QC procedures are called into question based on an inordinate amount of flagged, missing, or questionable data. Or, there may be concerns that the database and data export tools do not appropriately meet the analytical needs of the network. Ideally, data management issues would be identified and resolved prior to a scientific review. However, if substantive data management concerns are raised during the course of a

scientific review, the network will work with the IMD central office to request a more in-depth review or audit (e.g., 360o review).

- e. **Reporting**—Are data and results being reported in a format that is scientifically accurate, useful and meaningful to park managers?
2. Propose or evaluate potential protocol changes to improve the ability to deliver sound science to parks or accommodate new programmatic constraints:
- a. Are proposed changes to monitoring objectives scientifically sound and will they meet the needs of park managers? Do changes to the objectives require any associated changes in sampling design, methods, analysis, reporting, or quality assurance and quality control?
 - b. Will proposed revisions to the study or sampling design still allow monitoring objectives to be met with an appropriate level of precision?
 - c. Will proposed revisions to the study or sampling design be compatible with existing data, and if not will the net benefits of the changes outweigh the loss of compatibility?
 - d. Will changes to methods or equipment still meet all data quality objectives?
 - e. Will changes to methods or equipment be compatible with existing data?
 - i. Side-by-side data comparison, when possible, sufficient to show either that the methods produce the same results (within expected instrument or observational error) or that there is a clear relationship between old and new data that will allow the old data to be used together in analyses.
 - ii. If old data are not compatible or usable with the new data, are the benefits of the new methods or equipment worth the loss of the old data, or a reduction in the ability to conduct trend analyses?
 - f. If proposing entirely new methods, are they compatible with the objectives and scientifically sound?
 - g. If proposing to remove methods, will the removal affect the ability to meet the monitoring objectives?
 - h. Have park staff been given the opportunity to comment on changes to objectives and methods, and potential effects on delivering timely and relevant information?
 - i. Are new or revised analysis approaches scientifically sound and do they meet the needs of park managers?
3. Support integration across vital signs or across monitoring networks and programs:

- a. Is there potential for the information collected with the protocol to be used for interpreting other vital signs within the network? If so, what issues prevent integration across vital signs (e.g., design, timing, spatial scale, lack of co-location) and can the issues be surmounted with minimal effect on the ongoing monitoring?
 - b. If information collected for this protocol is currently being integrated with other vital signs, will any proposed protocol changes affect this integration positively or negatively?
 - c. Are there opportunities for integrating the information collected with the protocol with data collected by other networks or programs regionally or nationally? If so, how compatible are the data sets, and what changes would be needed to make the data sets more compatible? Do the benefits of increased compatibility with external programs outweigh the costs of the changes to data continuity?
4. Ensure that the network is monitoring the most appropriate vital signs in the most effective way possible:
 - a. Are the high priority Vital Signs relevant and are the protocols providing timely information to park managers?
 - b. Are protocols appropriately integrated and are there any opportunities to collaborate to enhance the value of the data?
 - c. Can the network continue to operate given current and expected budget and staffing constraints?

Documentation

Documentation will include some or all of the following, *as appropriate*:

1. Review meeting minutes, including documentation of all substantive comments from reviewers.
2. Documentation of any analyses conducted to support the review. This includes documentation of side-by-side data collection to explore the consequences of planned or potential changes in equipment that might affect data quality or comparability (e.g. evaluating potential utility of new water-quality sondes or sensors). Side-by-side data analyses will generally be a correlation analysis demonstrating relationship between data collected with old and new equipment or methods.
3. Documentation to support any proposed protocol changes, including data comparisons for old and new methods (this may be a formal NRR if desired).
4. Revised protocol documents updated to meet all current standards. Tracked-change documents are recommended because they facilitate review by highlighting changes. The network program manager or regional program manager may choose to require tracked-change documents.

- a. Revised narrative.
 - b. Revised or new SOPs.
 - c. Revised or new QA/QC documentation (e.g., quality assurance plan [QAP]).
 - d. Updated or new supplementary materials.
5. Informal summary of changes and reasons for the changes, to help inform other networks and programs with similar protocols.
6. Vital signs monitoring plan addendum documenting changes to the network's approach (e.g., revised vital signs prioritization or altered staffing plans).

Final Steps

1. Regional program manager reviews the minutes, documentation, and revised protocol documents (e.g., narrative, SOPs and QAP; supplementary materials do not need review).
2. Regional program manager requests additional external review if appropriate and deemed necessary (external reviewer participation in the scientific review may meet peer review requirements).
3. Changes to protocol SOPs require approval from the network program manager.
4. Changes to the protocol narrative or QAP requires approval from the regional program manager. The narrative and quality assurance plan are published as NPS Natural Resource Reports, and if these have changed the revised versions need to be submitted to Natural Resource Publications Management Office (<https://www.nps.gov/im/report-procedures.htm>) for a new report number.
5. Changes to the vital signs monitoring plan require approval from the network board of directors and the national IMD chief.
6. Review documents must be stored in a readily discoverable location on the network's server.
7. The network program manager is responsible for updating information about the protocol in the I&M protocol tracking database (<https://irma.nps.gov/ProtocolTracking/>).

Guidance for Determining the Type of Scientific Review

The following are approaches that meet the requirements for the three types of scientific reviews. Networks may work with their regional program manager to select the relevant subset of activities from this guidance or develop a different approach that stills meet the purpose, content, documentation, and level of internal and external review needed for the various types of scientific review.

The process outlined below for protocol and multi-protocol reviews can take a substantial amount of time to work through to an approved long-term decision. There are many situations where networks may desire to make immediate changes to protocol implementation, prior to formal approval. Network staff must discuss these situations with their regional program manager, who has the authority to approve short-term exemptions while networks pursue long-term approval of desired changes.

Identify Scientific Review Goals and Constraints

Scientific reviews broadly focus on whether a protocol or group of protocols meets the stated objectives and produces the “best available sound science.” The first step toward a successful scientific review is a clear statement of your goals for the review. Upon completion of the review, what do you want to have accomplished? For example, are you focusing on a portion of a protocol, such as the sampling design or a proposal to change a field method? Or are you interested in a broad evaluation of the science underlying a protocol, including methods, data reliability, data analysis, and reporting? While many protocols could benefit from a complete review of all aspects, time and resources are often limited, and networks should focus the scientific review on the high priority issues.

Consider the following review topics as you develop your goals. Most reviews will identify a subset of these topics as the focus of the review, and some may identify topics not listed here.

- **Protocol relevance**—A review focusing on protocol relevance will typically explore whether the approach being used to address the vital sign is the most appropriate and whether it furthers park resource management needs. It may also consider how data collected will support timely, science-based management of park resources.
- **Monitoring objectives**—Reviews exploring potential changes to monitoring objectives will usually aim to ensure that the protocol methods are optimized to meet the objectives, and that the objectives are relevant to park management.
- **Sampling design**—Most reviews investigating sampling design focus on evaluating whether the sample size is appropriate. These reviews will often investigate the effect of adding or removing sites, or altering the temporal schedule to accommodate a change in available resources. Some reviews will consider more fundamental changes, such as switching between a never-revisit design and a fixed-panel design.
- **Response design**—The response design encompasses how and what is measured at each sampling site. Reviews that explore the response design are typically interested in

determining whether the approach to sampling a site (e.g., plot configuration) yields data that are representative of the site, and whether the general methods chosen are appropriate for meeting the protocol objectives. This review can also consider additional data that might be collected at the same site visit; either simple measures newly determined to be important, or things that technological advances now make trivial to add.

- **Methods**—Reviews that focus on the protocol methods will normally explore whether one or more field methods should be added, modified, or removed, as well as the best way to implement changes to ensure continuity of the monitoring data.
- **Data reliability**—Reviews that include data reliability will ensure that issues related to data management standards or processes are addressed. They may focus on whether there are clearly defined data quality standards and appropriate quality assurance (QA) and quality control (QC) procedures in place to ensure that the data set is reliable, with known accuracy and precision.
- **Analyses**—Reviews that explore analyses typically look at whether the current analyses are appropriate (e.g., are the assumptions met? Is the desired ability to detect change achieved?), and whether new or alternative analyses would be more suitable for meeting the protocol objectives. This type of review may also explore how results of analyses are translated or interpreted for park managers. These reviews may consider whether modifications to the methods are needed to support a new analytical approach. This review may also address whether the database articulates appropriately with the analytical needs of the network.
- **Collaboration**—Reviews that include collaboration look for opportunities to collaborate or align with other networks or monitoring programs with similar protocols. These reviews typically explore whether modifications needed to increase consistency across similar protocols are feasible, scientifically sound, and can be done in a way that retains continuity with existing data. Collaboration is often considered as part of a multi-network review of similar protocols.
- **Integration**—Reviews that look at integration generally explore whether a given protocol is appropriately integrated with other protocols. The goal, when possible, is to allow the data sets to build off of each other and provide a more unified picture of resource status and trends for scientists and managers. Integration is often considered as part of a multi-protocol review.
- **Vital Signs relevance**—A review that includes vital signs relevance will take a big-picture view of a network monitoring program and the rationales for choosing the different vital signs. It will ask whether the network is monitoring the correct set of indicators. This review will look at whether any vital signs should be dropped or added, and will consider the state of the science as well as the data collected for different vital signs. For example, do new methods allow for inexpensive monitoring of a vital sign that was previously tabled due to lack of resources? Are any existing vital signs duplicative? Vital signs relevance is often considered as part of a multi-protocol review.

Identify the constraints and opportunities affecting your protocol implementation:

- **Funding**—What amount of money will the network spend on the protocol this year? Can the network afford to maintain this level of spending into the future, or is it necessary to operate the protocol more cheaply? Are there areas where costs can be reduced without affecting the protocol (e.g., a less expensive analytical lab)? Are appropriate funds currently allocated to data management, analysis, and reporting?
- **Staffing**—What staff, cooperators, and contractors are required to implement the protocol? What skill sets are required? Is it feasible for the network to get the right people with the appropriate skills? Does the network need to reduce the number of people involved with this protocol? Is the staffing robust to changes and vacancies?
- **Park support**—What level of support is needed from the network parks, including staff, logistics, and equipment? Are agreements in place to ensure long-term participation in the monitoring, and are there alternatives if one or more parks are unable to continue supporting monitoring? Are there opportunities to increase park participation?
- **Time**—What is the time commitment of the people involved with implementing the protocol? Can the network maintain or increase the time commitment, or does the network need to reduce the amount of time people spend implementing this protocol? Do the people implementing the protocol have enough time, at the right time, to get through the required work each year, including data analysis and reporting?
- **Technology**—What technological tools and equipment are required to implement the protocol? Is the network considering changes to the technology used, and are new tools safe, effective, and allowed by the NPS? Will any new tools being considered provide data with similar or better properties (e.g., precision or accuracy) than existing tools?

Determine Appropriate Type of Scientific Review

Once you have defined the goals and constraints of your review, it should be simple to identify the appropriate type of review for your needs. A targeted protocol review typically addresses one or two goals, in a rapid manner designed to minimize interference with ongoing network operations. A full protocol review is more time consuming, and takes a holistic and in-depth look at the protocol, while a multi-protocol review looks at the larger program and how the protocols interrelate to provide scientists and managers with scientifically sound information.

1. Targeted protocol review:
 - a. Changes are needed because of science findings, availability of a new method, safety, or budget.
 - b. Typically focuses on one or a few standard operating procedures (SOPs) or limited design changes.
 - c. A rapid review that ensures scientific standards found within the protocol are being met.
2. Full protocol review:

- a. A network or group of networks is interested in evaluating the state of the science and assessing whether the protocol (or group of similar protocols) can be improved.
 - b. Data analyses that indicate multiple problems with the protocol, such as poor power across multiple metrics or parks, would likely trigger a full protocol review.
 - c. Typically, an in-depth review of a protocol that may be shared across networks.
3. Multi-protocol review:
- a. Considers multiple protocols or the whole program.
 - b. Typically focuses on the big-picture, including overall constraints on the program and whether the network is monitoring the most appropriate vital signs in the most effective way possible.

Targeted Protocol Review Guidance

Follow the guidelines in this section if you are conducting a targeted protocol review. This process will ensure that an appropriate level of scientific review is obtained for proposed protocol changes. Note that since targeted protocol review meetings will typically result in changes to protocol documents, the inclusion of external reviewer(s) that have been approved by the regional program manager will constitute the required review of the protocol modifications and substantially speed the approval process.

The majority of targeted protocol reviews will involve one or two of the potential goals listed in “Identify Scientific Review Goals and Constraints.” The network may wish to reduce the sampling frequency in order to make the protocol cheaper to implement, or the network may want to change field procedures (e.g., reduce the number of parameters used in water-quality analyses, or start using a drone with a camera instead of helicopter overflights to census coastal birds). Although the specifics will vary, each targeted review will require similar stages and will address similar questions. Each network conducting a targeted review is responsible for ensuring that any specific or unique questions related to their particular goals and constraints are fully addressed during this process.

Preparation

The preparation for a review is crucial. The review meeting cannot be conducted efficiently without relevant information and analyses. Preparation will typically involve:

Identify the information needed—Based on the goals for the review, what will participants need to know to evaluate the proposed changes to the protocol? For example, a review focused on sampling design will need information about the current and potential designs, resource constraints relevant to the design (e.g., maximum sampling effort the network is capable of), targets for detectable levels of change for the protocol objectives, and the ability of different design options to meet the identified level of change targets.

Compile relevant data—In most cases, the network should have at least some data that can be used to assess the proposed protocol changes. This may be existing network monitoring data, data from a pilot study, or data from another network or monitoring program. For example, a review focused on sampling design will likely use existing data to estimate the detectable level of change of different design options. A meeting looking at a new method will likely use existing monitoring data plus side-by-side or otherwise comparable data from a pilot test with the new method.

Analyze data—Use appropriate procedures to analyze the available data that are relevant to the goals of the review meeting. For example, run the analyses to determine detectable level of change for different sampling design scenarios. For a review looking at a new method, determine the relationship between data collected using the current and potential field method, as well as the sampling variability and bias of both methods.

Identify pros and cons—Use the analysis results and other available information to identify the pros and cons of the different options being considered. Consider financial, logistic, analytic, personnel (number, expertise), compatibility with other networks or regional programs, and safety pros and cons. For example, a review exploring sample design changes would consider the ability of the different options to meet the target detectable level of change for the protocol, as well as the sample population and representativeness of the data collected under different designs, appropriateness of strata or management units in the design, and the feasibility of implementing the different designs. A review looking at a new sampling method would likely compare the sampling variability and bias of each method, and the potential for data continuity if the methods are changed (e.g., are the data from the two methods highly correlated), as well as the costs and other constraints for implementing each method.

Consider repercussions—Don't forget to consider additional repercussions related to the changes being considered. For example, if the review is focused on a design change, will the new design be capable of delivering useful information to managers in a timely manner? Will the new design be based on the same population, or can the old or new design be adjusted to use the same population, so that existing data retains value? For a review looking at new methods, will there be additional training requirements? What about data management, analysis, and reporting?

Targeted Protocol Review Meeting

Once the preparatory work is done, it is time to plan and hold a targeted review meeting.

1. Identify participants:

- a. **Core participants**—The protocol lead, network data manager, and network program manager are key participants at a targeted review meeting.
- b. **Reviewer(s)**—At least one appropriate external (to the network) reviewer must be included in the review. This individual is chosen by the network program manager and protocol lead and cleared with the regional program manager, since this individual's review feedback will constitute the external review of revised protocol documents that is required by NPS policy. The reviewer(s) will have expertise appropriate to the topics being covered by the review. For example, a quantitative ecologist with sampling design expertise is needed for reviews looking at sampling design changes, a taxonomic or topical expert would be needed for a review looking at using a new method, and a data management expert is needed for data reliability reviews.
- c. **Other participants**—Additional participants that will likely have valuable feedback to add to the protocol review include anyone who collects, manages, analyzes, or reports the data for the protocol. Park staff who use the information generated by the protocol must be provided with a briefing on the review and invited to participate. If a different network has a protocol implementation plan based on the protocol, it's a good practice to invite the partner network to send a representative to the meeting. Also consider inviting other networks with broadly similar protocols or review topics,

and consider either combined reviews with other networks or reciprocal participation between protocol leads where appropriate.

2. **Plan timing, logistics, and funding as needed**—Is funding needed to obtain analytical and statistical support? Or to provide your cooperator additional funding for data analyses and meeting attendance? For in-person meetings, consider travel costs and travel ceiling for participants (including cooperators, reviewers, and park staff). Is there a particular schedule required (e.g., if you are trying to achieve approval of changes before the next field season), and will key parties be able to meet that schedule? The meeting can be in-person or via telephone or webinar, as appropriate depending on the administrative (e.g., travel ceiling), financial, and logistic (e.g., availability of personnel) constraints.
3. **Assign homework**—Provide meeting participants with the relevant data, analyses, and other information developed above (“Preparation”) and ask them to review the information prior to the meeting. Participants should provide questions or comments to the protocol lead prior to the meeting.
4. **Organize feedback**—The protocol lead should organize any questions and comments received from the participants prior to the meeting, and be ready with initial responses.
5. **Conduct meeting**—During the meeting, specifically discuss:
 - a. The proposed changes and any comments or concerns from participants.
 - b. The justification for the proposed changes, and if the changes have been implemented, when were they implemented?
 - c. Will the changes affect the network’s ability to meet the protocol objectives? If the change is a change in objectives, will the changes affect the network’s ability to provide relevant information about the vital sign to managers?
 - d. Will the changes affect the network’s ability to detect management-relevant status and trends?
 - e. Will the changes affect data management processes, data analyses, reporting, or science communication?
 - f. The pros and cons of the different alternatives, including data continuity as well as time, staffing, and budget effects.

Document the discussion in the meeting notes, and document all decisions made by the group, including the rationale for the decision.

Meeting Documentation

The following documentation is needed to support the review meeting decisions and prepare the protocol changes for approval:

Meeting notes or minutes—After the meeting, finalize the meeting notes and include documentation of all substantive comments and the protocol lead’s response to each comment. Ensure that the notes include a brief synopsis of the rationale for the review, as well as a summary of

substantive decisions and any effects on data quality, data usability, or data quality standards. Circulate the meeting notes to the participants for their review.

Tasks and timeline—Document tasks and timeline (if needed) for revising protocol documents, including any needed data collection or research prior to finalizing changes. Document the tasks and timeline for updating data management processes, revising the protocol database, flagging affected data, updating analysis methods, and updating reporting (as appropriate) to accommodate any protocol changes.

Revised protocol documents—These include the narrative, standard operating procedures, and quality assurance plan. Provide the documents in both “clean” and “tracked-changes” format, unless otherwise directed by the regional program manager. The tracked-changes format facilitates a rapid review of differences, while the clean version is typically easier to read and more suitable for further external review (if needed).

Supporting documentation—Discuss with your regional program manager if any additional supporting documentation is needed. This may include data analyses and information from the “Preparation” stage of the review.

Approval Process

The regional program manager is responsible for ensuring that all protocols are scientifically sound and meet NPS and I&M standards. By including the regional program manager in the selection of review participants, the approval process can be streamlined.

1. **Obtain park feedback**—Ensure that park staff are given the opportunity to comment on changes to the protocol, especially if they did not participate in the review. Providing the meeting notes to park staff for review will likely meet this need.
2. **Submit documents**—Provide the meeting notes, revised protocol documents, and any requested supporting documentation to the regional program manager.
3. **Regional Program Manager review**—The regional program manager will review the documents, and determine if additional external review is needed. This will likely only be required for changes that have a high effect on the protocol and where there was disagreement among protocol review participants regarding the best course of action.
4. **Approval**—If additional review is obtained, or if the regional program manager has additional comments or questions, the network will address additional review comments. When the regional program manager is satisfied with the protocol changes, they will provide formal approval via e-mail or memo.

Final Steps

Once the regional program manager approves the revised protocol, the changes can be implemented by the network. However, the network will also need to complete these additional steps to finalize the changes:

1. **Technical editing**—All revised documents should be sent to a technical editor to ensure that the changes match the format and style guidelines for protocols.

2. **Publication**—The narrative and quality assurance plan are published as NPS Natural Resource Reports (NRR), and if these have changed the revised versions need to be submitted to the Natural Resource Publications Management Office (<https://www.nps.gov/im/report-procedures.htm>) for a new report number.
3. **Post to NPS Integrated Resource Management Applications portal (IRMA)**—Update the record for the protocol on IRMA with the approved version of the protocol documents.
4. **Archiving**—The network program manager ensures that review-related documents are organized and stored in a readily discoverable location on the network's server.
5. **Protocol tracking database**—The network program manager is responsible for updating information about the protocol in the protocol tracking database.

Full Protocol Review Guidance

Follow the guidelines in this section if you are conducting a full protocol review. Note that since full protocol review meetings will almost always result in changes to protocol documents, the inclusion of external reviewers that have been approved by the regional program manager will constitute the required review of the protocol modifications and substantially speed the approval process.

A full protocol review will involve most of the goals listed in “Identify Scientific Review Goals and Constraints,” although some will be addressed more thoroughly than others depending on the needs of the network and the reason for the review. Protocol relevance, monitoring objectives, sampling design, response design, methods, data reliability, and analyses are the core topics of a full review. A full protocol review is most commonly triggered by data analyses that indicate multiple potential areas of concern about the protocol’s ability to meet its objectives. For example, data reviews may flag high variability in multiple metrics, or a power simulation indicates that the sample size is inadequate for several parks. Other reasons for a full review could include questions from network or park staff about the value of the monitoring objectives for meeting park management needs, or the arrival of game-changing technological or analytical tools that would substantially alter protocol implementation.

Although the specifics will vary, each full review will require similar stages and will address similar questions. Each network conducting a full review is responsible for ensuring that any specific or unique questions related to their particular goals and constraints are fully addressed during this process. The process described below is also suitable for groups of networks that are implementing the same protocol or a set of very similar protocols. However, multi-network reviews will require close coordination to ensure that all participants’ needs are met, and careful attention to differences between protocols that might affect the outcome of the review.

Preparation

The preparation for a review is crucial. The review meeting cannot be conducted efficiently without relevant information and analyses. Make sure to allocate enough time for completing the preparatory steps carefully and thoroughly. This will potentially take several weeks of staff time. The review meeting will not be a success if participants do not have what they need.

Initial planning meeting—The protocol lead, network program manager, and regional program manager should discuss which aspects of the protocol require more intensive review, and which aspects can have less emphasis during the protocol review.

Identify and compile the information needed—What will participants need to know to evaluate the protocol? What do they need to know or have available prior to the meeting?

1. **Protocol relevance**—Review the rationale for monitoring in the narrative. Is it still appropriate? Do new data indicate that any of the assumptions or information used in the rationale have changed? Is there new research that suggests a different approach to monitoring this vital sign? For example, advances in the conceptual understanding of the system may suggest changing one or more metrics. If not already present in the narrative,

work with the park(s) to document how the data collected will support timely, science-based management of park resources.

2. **Monitoring objectives**—Review the monitoring objectives. Are they “SMART” (Specific, Measurable, Achievable, Relevant, and Timely)? Does each monitoring objective have associated statistical objectives documenting the desired level of variability or ability to detect change (where appropriate; some objectives are not statistical)? If there are substantial methodological or sampling design changes being considered, the objectives will need a close look to ensure that they are appropriate for the revised approach. Document any concerns with the current objectives and draft revised objectives if needed.
3. **Sampling design**—The sampling design will be an important focus of reviews where there are concerns about sample size or target population, or where a proposed change in methods affects the number of plots that can be sampled or their location. Document any concerns about the current design and potential alternatives, and identify the data needed to evaluate the alternatives (typically this will be a set of simulations exploring different design-related trade-offs). Questions about sample design often center on determining an appropriate sample size and revisit frequency.
4. **Response design**—The response design encompasses how and what is measured at each sampling site. This component may be a focus of the review when there are concerns about data variability and power, since altering the sampling strategy at a site (e.g., changing plot size or the number of subsamples) is one way to deal with these issues. This is also a good time to think about whether any metrics should be added or removed from the sampling design. Describe any concerns about the current response design and any options under consideration. Determine whether data are available that will allow you to evaluate the current design and potential changes to the response design for their ability to meet the statistical objectives of the protocol.
5. **Methods**—Methods are typically a large component of a full protocol review. If sampling variability is unacceptably high, the methods will need to be reviewed for ways to reduce it. If new methods are being explored, the full effects of the new methods on the data collection process (from field logistics through data management and analysis) need to be considered. If the new method replaces an old method, then comparability between new and old methods will be an important area for the review to address. If you are considering dropping some methods, then you will need to consider whether the protocol objectives can be met without them. Compile information about any proposed methodological changes, including new or revised procedures, and data collected with the new or revised methods. If replacing an older method, compile any data that can be used to assess data comparability.
6. **Data reliability**—Data reliability is the foundation of empirical science, and the review should evaluate whether data follow the established data management lifecycle for the protocol. As you prepare for the review identify potential weak linkages in data management processes to bring to the attention of reviewers. Following are some questions to consider. Are the data quality standards clearly defined, and are the quality assurance and quality control (QA/QC) procedures compliant with current requirements and sufficient to produce a

data set that is reliable, with known accuracy and precision? Are all QA/QC procedures as defined in the protocol and quality assurance documents (e.g., quality assurance plan) being implemented? Are there clear linkages between the SOPs, field data sheets, and database files? Are database design standards adequate to achieve long-term storage and retrieval needs of the network? Do data export tools meet the analytical needs of the network? Does the protocol include collection of appropriate duplicate data to quantify sampling error and inter-observer variability? If not, what surrogate data are used to assess data accuracy and precision? If you are considering new or changed methods, how will you ensure data reliability and quantify accuracy and precision? In addition to identifying potential issues be prepared to also provide options for improving data management processes and subsequent data reliability.

7. **Analyses**—Some reviews will focus on data analyses as the central component, but all full protocol reviews should consider this topic area. For a review that focuses on data analyses, typically there is a concern that the current approach is inadequate and there is an interest in exploring alternatives. In this case, document the assumptions and concerns with the current analytical approach and contrast with the known alternatives. Don't forget to consider whether an alternative analytical approach will require collection of new or different data or changes to data management processes. For reviews where analysis is an ancillary concern, document whether any of the proposed changes to the protocol will have an effect on the analytical approach, and whether any additional changes may be needed to correct or minimize that effect. This portion of the review may also explore how data are translated for managers. For example, it could review or develop ecological thresholds for use in reporting.
8. **Collaboration**—This topic area is optional for a full protocol review, but is a common component of a multi-network review. Typically, collaboration discussions focus on whether modifications needed to increase consistency across similar protocols are feasible, scientifically sound, and can be done in a way that retains continuity with existing data. In this case, document the similarities and differences between the different network implementations to identify areas for discussion. Collaboration topics may also include economies of scale, such as sharing resources or staff to more efficiently implement monitoring.
9. **Integration**—This topic area is optional for a full protocol review. Considering integration is important when data collected with the protocol are used for understanding the data from other network protocols. In this case, it is important to consider how any changes to the protocol may affect the analysis and interpretation of data collected by the related protocol(s). If these effects are expected, document how they will be addressed or minimized.

Summarize and analyze data—Produce data summaries and conduct appropriate analyses where needed to further the goals of the protocol review. Summaries and analyses will need to be tailored to the specific goals of the review, but will likely include:

1. **Data variability**—If not available from the most recent annual data review, produce summaries or analyses that document whether data are within acceptable levels of variability when compared using repeated measurements, different observers, or reference to a known

standard. If there are no data available to understand sampling variability, the feasibility of obtaining these data should be a topic during the review. Documentation of data variability will be incorporated into a revised QAP, when appropriate.

2. **Ability to meet statistical objectives**—All protocols with status- or trend-related objectives should have explicit statistical objectives. Simulations or other appropriate statistical methods will be needed to document that the current sampling design is sufficient to meet the statistical objectives of the protocol. The simulations do not need to be exhaustive, but they should use a representative portion of the data (e.g., several metrics that cover the range of data spatial and temporal variability). When there are specific questions related to sampling design (e.g., proposed changes in revisit interval or number of sites) or the current design has too little or too much power, a range of scenarios encompassing the current and potential design options should be developed and tested for a representative portion of the data. If changes to the response design are being considered, appropriate scenarios with the new and old design must be developed and tested.
3. **Data comparability**—If a change of methods is being considered, ideally at least a year of side-by-side data using the old and new methods will be available. If so, calculate the correlation between data from the old and new method and inspect a plot of the data. Determine whether there is a clear relationship between the old and new methods. A high correlation and 1:1 relationship indicates that the methods are interchangeable, while a high correlation with a different relationship indicates that old data may be statistically adjusted and used in the future.

Identify pros and cons—For each topic area being covered during the review where a decision between multiple options is needed, use the compiled information and analysis results to identify the pros and cons of the different options being considered. Consider financial, logistic, analytic, personnel (number, expertise), compatibility with other networks or regional programs, and safety pros and cons. For example, if sample design changes are being considered, document the ability of the different options to meet the target detectable level of change for the protocol, as well as the sample population and representativeness of the data collected under different designs, appropriateness of strata or management units in the design, and the feasibility of implementing the different designs. If a decision is needed between multiple sampling methods, compare the sampling variability and bias of each method, and the potential for data continuity if the methods are changed, as well as the costs and other constraints for implementing each method.

Consider repercussions—Don't forget to consider additional repercussions related to any changes being considered. For example, if the review will be considering a sampling design or methodological change, will the new approach be capable of delivering useful information to managers in a timely manner? Will the new design be based on the same population, or can the old or new design be adjusted to use the same population, so that existing data retains value? For a review looking at new methods, will there be additional training requirements? What about data management, analysis, and reporting? Will any changes being considered affect data needs of related protocols?

Full Protocol Review Meeting

Once the preparatory work is done, it is time to plan and hold a full protocol review meeting.

1. **Identify participants**
 - a. **Core participants**—The protocol lead, network data manager, network program manager, and regional program manager are key participants at a full protocol review meeting. Other core participants include staff and cooperators that are substantially involved with collecting, managing, analyzing, interpreting, and reporting the data.
 - b. **Reviewers**—At least two appropriate external (to the network) reviewers must be included in the review in order to streamline approval of any changes to protocol documents. These individuals are recommended by the network program manager and protocol lead and confirmed by the regional program manager, since these individuals' review feedback will constitute the external review required by NPS policy. The expertise of the reviewers will need to cover the breadth of topics that the protocol review will address. This will generally include one or more topical experts with substantial knowledge of the vital sign and methods being reviewed, as well as a statistical expert who can address sampling design and analysis questions.
 - c. **Other participants**—Additional participants that will likely have valuable feedback to add to the protocol review include anyone who collects, manages, analyzes, or reports the data for the protocol. Depending on how closely involved these individuals are with the protocol, the participation of some people may be limited to interviews or a written opportunity to provide input. Park staff who use the information generated by the protocol must be provided with a briefing on the review and invited to participate. If a different network has a protocol implementation plan based on the protocol, it's a good practice to invite the partner network to send a representative to the meeting. Also consider inviting other networks with broadly similar protocols or review topics, and consider either combined reviews with other networks or reciprocal participation between protocol leads where appropriate.
2. **Plan timing, logistics, and funding as needed**—Is funding needed to obtain analytical and statistical support? Or to provide your cooperator additional funding for data analyses and meeting attendance? For in-person meetings, consider travel costs and travel ceiling for participants (including cooperators, reviewers, and park staff). Is there a critical timing and particular schedule required (e.g., if you trying to achieve approval on changes before the next field season), and will key parties be able to meet that schedule? A full protocol review meeting should ideally be conducted as an in-person meeting lasting from one to three days. If financial and travel constraints make this impossible, a well-organized series of virtual meetings may meet the needs of the review.
3. **Orientation webinar**—An orientation webinar that provides background and guidance to review participants is highly recommended. The webinar should contain an overview of the protocol, including objectives, design, methods, analyses, and noteworthy results. The webinar should also introduce the major topics that will be covered during the review, and

the options that are being considered to resolve known issues or address constraints that are hampering implementation.

4. **Assign homework**—Provide meeting participants with the relevant data, analyses, and other information developed above (“Preparation”) and ask them to review the information prior to the meeting. Because of the breadth of the review topics, participants will likely need to focus on the areas where they have the most expertise or experience, and the protocol lead should suggest particular areas of focus. Participants should provide questions or comments to the protocol lead prior to the meeting.
5. **Organize feedback**—The protocol lead should organize any questions and comments received from the participants prior to the meeting, and be ready with initial responses.
6. **Conduct meeting**—During the meeting, cover the topic areas below. For each topic, consider any proposed changes as well as comments or concerns from participants. Changes need to be clearly justified, and the effects of the changes need to be clearly documented. Be sure to consider potential effects on network operations, the ability to meet monitoring objectives, the ability to detect management-relevant changes, as well as effects of changes on data management processes, analysis, and reporting. Document the discussion in the meeting notes, and document all decisions made by the group, including the rationale for the decision.
 - a. **Protocol relevance**—Do participants agree that the protocol rationale is still valid and that the protocol will support timely, science-based management of park resources? Is there any research or data suggesting that a different approach would be better for monitoring this vital sign? Are any changes needed to enhance the relevance of this protocol?
 - b. **Monitoring objectives**—Do participants agree that the objectives (or proposed revisions to them) are “SMART,” and that associated statistical objectives are clear and relevant?
 - c. **Sampling and response designs**—Do participants agree that the sampling and response designs (or proposed changes to them) will be sufficient to meet the objectives of the protocol? Will analyses based on the data be timely and have sufficient power?
 - d. **Methods**—Do participants agree that the methods (or proposed changes to them) are scientifically sound and appropriate for the protocol? Is sampling variability at an acceptable level for allowing the detection of management-relevant status and trends? If a new method affects the ability to use existing data, are the benefits of the change worth the cost in data continuity and have the effects been minimized to the greatest extent possible? Have the data management implications of any changes in methods been considered?
 - e. **Data reliability**—Do the participants agree that the data follow the established workflow? Are there any methods that could benefit from improved quality assurance or control in order to document or reduce variability? Are there opportunities to

improve data management processes including tools to meet analytical needs? If substantial data management concerns are voiced during the meeting that cannot be resolved, document the need for a data management evaluation by the I&M central office.

- f. **Analyses**—Do participants agree that the analyses (or proposed changes to them) are appropriate for meeting the protocol objectives and represent the best available sound science for interpreting the data set? Are there alternative analyses that would be more powerful or more appropriate? Would alternative approaches require substantial changes to the methods or sampling design, and would the changes be feasible given the network's constraints?
- g. **Other topics**—If included in this review, include science communication, collaboration, integration, and any other topics that are relevant to the protocol.
- h. **Big picture**—Overall, considering the discussions during the review meeting, will the protocol (with planned revisions) provide meaningful data to support park management? Can the revised protocol be implemented with the resources that are available? If not, are there viable alternatives? If there are any lingering concerns about the viability and relevance of the protocol, a multi-protocol review may be needed to look at the protocol in the context of the overall network operations and make decisions about which protocols are essential to continue and which may need to be suspended.

Meeting Documentation

The following documentation is needed to support the review meeting decisions and prepare any protocol changes for approval:

Meeting notes or minutes—After the meeting, finalize the meeting notes and include documentation of all substantive comments received from participants and the protocol lead's response to each comment. Ensure that the notes include a brief synopsis of the rationale for the review, as well as a summary of substantive decisions and any effects on data quality, data usability, or data quality standards. Circulate the meeting notes to the participants for their review.

Tasks and timeline—Document tasks and timeline (if needed) for revising protocol documents, including any needed data collection or research prior to finalizing changes. Document the tasks and timeline for updating data management processes, revising the protocol database, flagging affected data, updating analysis methods, and updating reporting (as appropriate) to accommodate any protocol changes. If applicable, document tasks and timeline for changes to information dissemination and support for science and decision-support needs.

Revised protocol documents—These include the narrative, standard operating procedures, and quality assurance plan. Provide the documents in both “clean” and “tracked-changes” format, unless otherwise directed by the regional program manager. The tracked-changes format facilitates a rapid review of differences, while the clean version is typically easier to read and more suitable for further external review (if needed).

Supporting documentation—Discuss with your regional program manager if any additional supporting documentation is needed. This may include data analyses and information from the “Preparation” stage of the review.

Approval Process

The regional program manager is responsible for ensuring that all protocols are scientifically sound and meet NPS and I&M standards. By including the regional program manager in the selection of review participants and as a core participant in the review, the approval process can be streamlined.

1. **Obtain park feedback**—Ensure that park staff are given the opportunity to comment on changes to the protocol, especially if they did not participate in the review. Providing the meeting notes to park staff for review will likely meet this need.
2. **Submit documents**—Provide the meeting notes, revised protocol documents, and any requested supporting documentation to the regional program manager.
3. **Regional Program Manager review**—The regional program manager will review the documents, and determine if additional external review is needed. This will likely only be required for changes that have a high effect on the protocol and where there was disagreement among protocol review participants regarding the best course of action.
4. **Approval**—If additional review is obtained, or if the regional program manager has additional comments or questions, the network will address additional review comments. When the regional program manager is satisfied with the protocol changes, they will provide formal approval via e-mail or memo.

Final Steps

Once the regional program manager approves the protocol, the changes can be implemented by the network. However, the network will also need to complete these additional steps to finalize the changes:

1. **Technical editing**—All revised documents should be sent to a technical editor to ensure that the changes match the format and style guidelines for protocols.
2. **Publication**—The narrative and quality assurance plan are published as NPS Natural Resource Reports, and if these have changed the revised versions need to be submitted to the Natural Resource Publications Management Office (<https://www.nps.gov/im/report-procedures.htm>) for a new report number.
3. **Post to the NPS Data Store**—Update the record for the protocol on the Data Store with the approved version of the protocol documents.
4. **Archiving**—The network program manager ensures that review-related documents are organized and stored in a readily discoverable location on the network’s server.
5. **Protocol tracking database**—The network program manager is responsible for updating information about the protocol in the I&M protocol tracking database (<https://irma.nps.gov/protocoltracking/>).

Multi-Protocol Review Guidance

Follow the guidelines in this section if you are conducting a multi-protocol review. Note that since the multi-protocol review may result in changes to the network vital signs monitoring plan, the inclusion of external reviewers that have been approved by the regional program manager and national I&M chief will constitute the required review of the revised plan and substantially speed the approval process.

A multi-protocol review typically addresses whether the network can effectively address its high priority vital signs given the constraints of budget, staff, time, park support, and technology. The review may look at collaboration (opportunities to build partnerships with other programs), integration (looking at whether protocols appropriately leverage each other to build a unified picture of resource status), and relevance (are the appropriate vital signs being monitored?). The trigger for a multi-protocol review is typically the desire by network staff, the regional program manager, or park staff to look beyond individual protocols to assess the long-term health of the network. This is particularly important in periods of budgets that do not keep up with inflation, since erosion of buying power inevitably leads to the need to make smart decisions about how to restructure a program to continue providing as much information as possible to park managers.

Although the specifics will vary, each multi-protocol review will require similar stages and will address similar questions. Each network conducting a multi-protocol review is responsible for ensuring that any specific or unique questions related to their particular goals and constraints are fully addressed during this process. The multi-protocol review needs to be handled sensitively, since some staff may feel threatened by a process in which protocols that they have spent years developing and implementing may be deemed low priority. The emphasis must be on working collaboratively and equitably to chart the future of the network.

Preparation

The preparation for a multi-protocol review is crucial. The review meeting cannot be conducted efficiently without relevant information. Make sure to allocate enough time for completing the preparatory steps carefully and thoroughly. This will likely take multiple weeks of staff time. The multi-protocol review meeting will not be a success if participants do not have what they need.

Initial planning meeting—The protocol leads, network program manager, and regional program manager should discuss which aspects of this guidance require more consideration, and which aspects were recently reviewed or otherwise can have much less emphasis in the multi-protocol review. The national I&M division chief and deputy chief for science should be informed of the plans for the multi-protocol review and periodically updated during the review process.

Identify and compile the information needed—What will participants need to know to evaluate the network's science program? What do they need to know or have available prior to the meeting?

1. **Vital Signs relevance**—Network staff and park resource managers should review the list of network high priority vital signs (or the subset targeted for the review), the protocols that

address them, and the monitoring objectives of the protocols. For each high priority vital sign, does the associated protocol provide the information that is needed by park management in a timely manner? If not, what is needed? Does the list of high priority vital signs (plus any additional monitoring conducted by the park) address important monitoring priorities of each park? Are there any vital signs that are less important or overlapping with other vital signs? Are there any areas of long-term management concern that are not covered by the current monitoring efforts? Have technological or methodological advances made it feasible to monitor a vital sign that could not previously be monitored effectively? Network staff should seek the opinions of outside experts as needed to evaluate the presence of technological and methodological advances.

- a. **Changes to the vital signs list and prioritization need to be approached cautiously**—Networks are in the business of long-term monitoring and should not chase the latest management needs, but they should also be capable of adjusting if the initial list of vital signs appears incomplete or overly ambitious.
 - b. **It may help to establish explicit criteria and rating levels for reviewing vital signs**—Suggested criteria: (1) Value for management; (2) Uniqueness of data (i.e., are similar data sets available); (3) Ability to document effects of stressors (e.g., climate change, land use change); (4) Feasibility (monitoring methods exist or can be adapted); and (5) Cost effectiveness (bang for the buck, ability to get good data cheaply). An example of rating levels for “Value for park management” would be: (1) Integral; (2) Very helpful; and (3) Limited value.
2. **Implementation**—Evaluate the network’s implementation of vital signs monitoring and ability to meet non-monitoring needs (e.g., administrative responsibilities and providing park technical support). Are data being managed effectively and certified promptly? Are monitoring results being provided to park managers in an appropriate format and a timely manner? Is the network operating within budget and meeting its administrative requirements (including contracting, HR, and budget)?
 3. **Integration**—Network staff should assess whether Vital Signs are integrated to the maximum extent possible. Integration typically implies colocation of multiple protocols in time and space so that their data can support each other. Are there areas where related Vital Signs could be better integrated? What changes would be needed to improve integration? If data from one Vital Sign are needed to better understand another (e.g., water quality effects on fish species), are the right data being collected, and are they being effectively used in data analyses? Are there data that are not currently being collected or acquired (e.g., lidar data) that would benefit one or more protocols?
 4. **Collaboration**—Network staff should assess collaboration opportunities with parks, other networks, and other programs. Is anyone else implementing similar protocols for any network vital signs? If so, are there any benefits to ensuring consistency with the other protocol(s)? Are any changes needed to ensure consistency across protocols, and are those modifications feasible, scientifically sound, and would it be possible to retain continuity with existing data?

5. **Budget constraints**—Network staff should develop a budget that reflects the cost, by expense category, of protocol and non-protocol network functions. Non-protocol functions include technical support to parks, national I&M activities, program management, and overhead (e.g., annual leave, training, office rent, general equipment). Can all high priority network protocols and functions be accomplished if there is a 10% reduction in the network's budget? What would the network have to eliminate to accommodate a 10% cut?
 - a. **Assuming budget is a constraint, identify options for reduced protocol implementation and estimate the cost savings from the different options**—Consider the full suite of options, including cancelling one or more protocols, reducing return intervals to permanent plots, reducing the number of samples per year, and collecting less data at each plot (including fewer lab analytes). If protocol changes (other than cancellation) are deemed worth pursuing by participants in the multi-protocol review, follow-up targeted protocol reviews will be needed for the protocols where modifications are proposed.
 - b. **Recommended budget format**—Develop a spreadsheet where the columns reflect each protocol or function. The rows of the spreadsheet reflect major expenditure line items, such as personnel (separate lines for permanent, term, and seasonal), contracts and agreements, equipment (don't forget equipment replacement needs), and so on. The categories from the network's five-year budget can be used for the rows.
6. **Staffing constraints**—The network should assess whether it currently has the right organization to meet its mission. Do the current staff, cooperators, and contractors have the skills to meet the anticipated needs of the network over the next five to 10 years? If not, what skills or positions are needed, and can the needs be met within the network's budget? Will the network be able to meet the needs of data management, analysis, and reporting for the long term? Is there sufficient flexibility in the organization to be robust in the event someone leaves or retires? Do network staff, cooperators, and contractors have enough time, at the right time, to meet the requirements of their jobs?
7. **Park support**—The network staff should identify areas where the parks could provide support to facilitate monitoring. Consider field support (equipment, supplies, housing, and staff) as well as other options (e.g., science communication, data management, and data analysis).

Summarize information—Summarize the feedback from network and park staff as needed.

Individual feedback on vital signs relevance will need to be presented concisely, and the approach used to come up with final scores for the vital signs will need to be clearly presented. For example, some networks may choose to produce weighted scores of individual rating criteria, while others will prefer to use the criteria as a guide to establishing final weights. Whatever approach is used should be clearly stated, and consistent within the network.

Identify needed decisions and options—Based on the information from network and park staff, identify decisions that are needed during the review meeting, the options being considered for each decision, and the pros and cons of the different options. Decisions would include things like whether

or not to add or drop a vital sign, or whether to pursue modifying a protocol to take advantage of a potential collaboration. For the options being considered, the pros and cons need to consider cost, logistics, analyses, personnel implications, and any other potential benefits or negative effects of the proposed changes.

Multi-Protocol Review Meeting

Once the preparatory work is done, it is time to plan and hold the multi-protocol review meeting.

1. **Identify participants**
 - a. **Core participants**—The network program manager, regional program manager, protocol leads, and network data manager are key participants at a multi-protocol review meeting. The national I&M division chief and deputy chief for science must be invited to the meeting, but are not required attendees.
 - b. **Reviewers**—At least two appropriate external (to the network) reviewers must be included in the review in order to streamline approval of any changes to the vital signs monitoring plan. These individuals are recommended by the network program manager and regional program manager and confirmed by the national I&M division chief, since these individuals' review feedback will constitute the external review required by NPS policy. The expertise of the reviewers will need to include appropriate experience with designing and managing long-term monitoring programs. Depending on the focus of the review, it may be appropriate to include one or more topical experts with substantial knowledge of one or more of the decisions that will need to be made.
 - c. **Other participants**—Park staff who use the information generated by the network will likely have valuable feedback. Parks must be provided with a briefing on the review and invited to participate.
2. **Plan timing, logistics, and funding as needed**—For in-person meetings, consider travel costs and travel ceiling for participants (including cooperators, reviewers, and park staff). Is there a critical timing and particular schedule required (e.g., if you trying to achieve approval on changes before the next field season), and will key parties be able to meet that schedule? A multi-protocol review meeting should ideally be conducted as an in-person meeting. If financial and travel constraints make this impossible, a well-organized virtual meeting or meetings may meet the needs of the review.
3. **Orientation webinar**—An orientation webinar that provides background and guidance to review participants is highly recommended. The webinar should contain an overview of the network, including vital signs, protocols, additional network functions (e.g., park technical support), staffing, and budget. The webinar should also introduce the major topics that will be covered during the review, and the options that are being considered to resolve known issues or address constraints that are hampering the network.
4. **Assign homework**—Provide meeting participants with the relevant information developed above ("Preparation") and ask them to review the information prior to the meeting. Participants should provide questions or comments to the protocol lead prior to the meeting.

5. **Organize feedback**—The network program manager should organize any questions and comments received from the participants prior to the meeting, and be ready with initial responses.
6. **Conduct meeting**—During the meeting, cover the topic areas described previously in the Preparation section. For each topic, consider any proposed changes as well as comments or concerns from participants. Changes need to be clearly justified, and the effects of the changes need to be clearly documented. Document the discussion in the meeting notes, and document all decisions made by the group, including the rationale for the decision.

Meeting Documentation

The following documentation is needed to support the multi-protocol review meeting decisions and prepare any monitoring plan changes for approval:

Agenda and meeting goals—Short description documenting the reason for holding the meeting, the meeting goals, and the meeting agenda.

Meeting notes or minutes—After the meeting, finalize the meeting notes and include documentation of all substantive comments received from participants and the network program manager's response to each comment. Include a summary of planned changes to the vital signs monitoring plan and potential changes to protocols that need to be addressed through protocol reviews. If applicable, document changes to information dissemination and support for science and decision-support needs. Circulate the meeting notes to the participants for their review.

Tasks and timeline—Document the tasks and timeline needed to implement the changes discussed by the meeting participants.

Monitoring plan addendum—Prepare a memo describing any changes to the network vital signs monitoring plan. This includes anything decided during the multi-protocol review that differs from information in the monitoring plan. It may include an updated conceptual model highlighting a new vital sign, a revised vital signs prioritization table, updated objectives, or a new preferred staffing structure.

Supporting documentation—Discuss with your regional program manager and the national I&M Division chief if any additional supporting documentation is needed.

Approval Process

The regional program manager is responsible for general oversight of the network, and the national IMD chief is responsible for approving network vital signs monitoring plans. By including the regional program manager and national IMD chief in the selection of review participants and including the regional program manager as a core participant in the review, the approval process can be streamlined.

1. **Obtain park feedback**—Ensure that park staff are given the opportunity to comment on changes to the monitoring plan, especially if they did not participate in the review. The

network program manager will need to host a meeting or phone call with affected or interested park staff.

2. **Obtain technical committee and board approval**—Changes to vital signs and vital signs prioritization must be formally approved by the network board of directors.
3. **Submit documents**—Provide the meeting notes, monitoring plan addendum memo, and any requested supporting documentation to the regional program manager.
4. **Regional program manager and national IMD chief review**—The regional program manager and national IMD chief will review the documents, and determine if additional external review is needed. This will likely only be required for changes that have a large effect on the network and where there was disagreement among protocol review participants regarding the best course of action.
5. **Approval**—If additional review is obtained, or if the regional program manager or I&M Division chief have additional comments or questions, the network will address additional review comments. When the regional program manager and national IMD chief are satisfied with the monitoring plan changes, they will provide formal approval via a memo.

Final Steps

After the regional program manager and national IMD chief approve the monitoring plan addendum, the changes can be implemented by the network. This may involve conducting one or more targeted protocol reviews to identify the best way to implement recommendations from the multi-protocol review. The network will also need to post the monitoring plan addendum and approval memo to the Data Store, in the same record as the network's vital signs monitoring plan. The network must also ensure that full documentation of the meeting is archived with the network's operational records.

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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National Park Service
U.S. Department of the Interior



Natural Resource Stewardship and Science

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