



Coastal Infrastructure Investment Analysis Framework

Background, Cultural Resources Objectives and Performance Metrics Updates, and Next Steps



Relocating the Cape Hatteras Lighthouse Principal Keeper's Quarters at Cape Hatteras National Seashore, March 23, 1999.

NPS

Coastal Infrastructure Investment Analysis Framework: Background, Cultural Resources Objectives and Performance Metrics Updates, and Next Steps

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Abstract

In 2022, three directorates of the National Park Service—Park Planning, Facilities and Lands; Cultural Resources, Partnerships, and Science; and Natural Resource Stewardship and Science—began collaborating to develop a decision analysis framework to guide major facility investments in coastal parks. The framework aims to consistently and transparently identify key tradeoffs among potential Investment Concepts (ICs) and thus inform the values-based discussions required to select a specific IC for implementation. The framework is intended as a tool for regional- and bureau-level investment review boards, though the structure and concepts have broader application. The directorates collaborated with the U.S. Geological Survey to develop the framework, referred to as the Coastal Infrastructure Investment Analysis Framework (CIIAF). This document summarizes revisions to the framework to improve the objectives and performance metrics used to assess the impacts of potential ICs on cultural resource values. The first chapter provides an overview of the context motivating development of the CIIAF and the ProACT decision analysis framework upon which it is based. The chapter summarizes, broadly, the development status of each of the CIIAF's elements but does not fully reproduce framework details available elsewhere (Eaton et al. 2024). The second chapter summarizes the updated objectives and performance metrics (version 3.0) used to characterize cultural resource values relevant to the analysis context. Chapter 2's appendices summarize guidance from the decision analysis literature on desirable characteristics of objectives and performance metrics. The third chapter recommends next steps in testing and revising the framework's objectives and performance metrics, noting that these elements require multiple rounds of refinement. Chapter 3 also highlights the elements still needing development.

List of Terms and Acronyms

B-IRB: Bureau Investment Review Board

CAHA: Cape Hatteras National Seashore

CHIS: Channel Islands National Park

CIIAF: Coastal Infrastructure Investment Analysis Framework

CONUS: Contiguous United States

CR: Cultural Resources

CRIS: Cultural Resources Inventory System

CRPS: Cultural Resources, Partnerships, and Science Directorate

DO: Director's Order

FIIS: Fire Island National Seashore

FORA: Fort Raleigh National Historic Site

GATE: Gateway National Recreation Area

HPPD: Historic Property Project Documentation

IC: Investment Concept

MCMS: Museum Collections Management System

NPS: National Park Service

NRSS: Natural Resource Stewardship and Science Directorate

PM: Performance Metric

PMIS: Project Management Information System

PPFL: Park Planning, Facilities and Lands Directorate

PrOACT: A decision analysis framework named for the five key elements of a decision—Problem, Objectives, Alternatives, Consequences, and Tradeoffs

R-IRB: Regional Investment Review Board

USGS: United States Geological Survey

WASO: Washington Support Office (NPS headquarters)

WRBR: Wright Brothers National Memorial

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Executive Summary

Many coastal assets of the National Park Service (NPS) are vulnerable to failure due to coastal hazards, and many of those vulnerabilities are projected to increase due to climate-driven changes in environmental conditions. To address this growing challenge, three directorates of the National Park Service—Park Planning, Facilities and Lands; Cultural Resources, Partnerships, and Science; and Natural Resource Stewardship and Science—collaborated with Decision Analysts from the U.S. Geological Survey to develop a consistent, transparent, and analytical process to inform major facility investment decisions at coastal parks (Eaton et al. 2024). The resulting framework, termed the Coastal Infrastructure Investment Analysis Framework (CIIAF), aims to identify key tradeoffs among potential Investment Concepts (ICs, the first phase of the capital investment process) and thus inform the values-based discussions required to select a specific IC for further development. The framework is intended as a tool for the regional- and bureau-level investment review boards.

The framework distinguishes five elements of a decision: problem, objectives, alternatives, consequences, and tradeoffs; and clarifies those elements that reflect the values of the decision makers (problem, objectives, tradeoff weights) from those reflecting technical or subject matter expertise (alternatives, consequences). This report presents revised cultural resource-focused (CR) objectives and performance metrics (version 3.0), summarizes the current development status of the CIIAF, and recommends next steps for pilot testing, completion of the remaining framework elements, and continued framework refinement.

Version 1.0 of the cultural resource objectives and performance metrics, from the original USGS collaboration, suffered from poor alignment with core concepts and terminology used in cultural resources management practices. While it addressed integrity, there was no consideration of condition (see Chapter 2). Version 2.0, developed by Cultural Resources, Partnerships, and Science Directorate (CRPS) subject matter experts, resolved that alignment but did not fully reflect and align with important aspects of the decision analysis framework underpinning the CIIAF.

Version 3.0's development was informed by first identifying shortcomings of version 2.0's objectives and performance metrics relative to characteristics desired in effective objectives and performance metrics. Those characteristics have been identified in the decision analysis literature and are summarized in Appendix 3. For example, one objective in version 2.0 focused on current knowledge regarding presence of CRs and the quality of that knowledge, but such knowledge is unaffected by the choice of IC to be implemented in *the future*. For effective decision analysis, each objective should be focused narrowly enough that achievement is influenced only by the choice of IC and not by factors outside the influence of that decision.

Version 3.0 has seven objectives; all derive from the core value of minimizing loss of a CR's integrity due to implementation of the IC. Six objectives focus on the IC's potential direct impact on integrity and condition for each of the three types of CR: Historic Properties, Museum Collections, and Ethnographic Resources. The seventh objective focuses on the source of understanding of the potential impact(s).

Version 3.0 has seven performance metrics, each associated with a specific objective and each aiming to provide a yardstick for distinguishing among important levels of achievement of that objective. Rephrased, each performance metric seeks to differentiate among relevant types of consequences of an IC. The version 3.0 metrics reflect the important distinction that while integrity cannot be improved, condition may be. Further, some metrics distinguish the case where an IC may potentially degrade integrity to the point where National Register significance no longer holds.

The report recommends specific information goals for testing the version 3.0 objectives and performance metrics while also outlining broader pilot-testing recommendations applicable to the full CIIAF. These goals are based on the desired characteristics of effective objectives and performance metrics. It is quite common for objectives and performance metrics to require multiple iterations of development to arrive at effective articulation of the underlying values (Bond et al. 2010). Such testing, and potentially refinement, is especially important in the context of a framework intended to be applied widely, consistently, and thus should be both expected and welcomed. Testing will also contribute to socializing the framework and encourage parks engaged in testing to contribute to the framework's development.

The report provides a roadmap for completing the framework through iterative pilot testing and continued refinement. It summarizes the current development status of each framework element and highlights recommended next steps. Pilot testing is presented as the immediate next phase of framework development and is encouraged across a range of parks and infrastructure decisions to ensure the framework elements under review are assessed under a broad variety of decision contexts. The report also outlines priorities for completing the remaining Tradeoffs component, updating the framework and supporting documentation, supporting broader implementation, and exploring future applications of the CIIAF. These recommendations supplement, but do not replace, the list of future tasks collaboratively developed by NPS and USGS (see page 7 of Eaton et al. 2024).

Potential extensions of the framework to address different types of investment decisions are mentioned, highlighting that many of the framework's objectives and performance metrics are equally appropriate for investment decisions addressing impacts of other hazards, including at interior parks. Similarly, the framework's structure and the seven categories of fundamental objectives (Operations: core functions, Operations: support workforce, Financial, Natural Resources, Cultural Resources, Visitor Experience, Resilience to Hazards) are broadly relevant to many other NPS decision contexts, even if the specific objectives and performance metrics would need to be modified. Developing such variants would leverage the substantial past investment in the CIIAF.

The CIIAF is envisioned to be a systematic, repeatable process to support (major) infrastructure investment decisions in coastal parks. While the framework is not yet fully developed, even the existing framework elements are an important advance as they characterize, for all to see, the key objectives (values) that the directorates consider important for consideration in *any* coastal infrastructure investment that meets the framework's minimum cost threshold. This alone may improve transparency and promote consistency as awareness of the framework grows.

Chapter 1. Introduction to the Decision Context and the PrOACT Framework

Author: Joel H. Reynolds, Ph.D.

Introduction

This chapter overviews both the context motivating development of the Coastal Infrastructure Investment Analysis Framework (CIIAF) and the decision analysis framework upon which it is based (PrOACT). The chapter also summarizes the development status, circa Fall 2024, of the various elements of the CIIAF but does not fully reproduce framework details available elsewhere (Eaton et al. 2024). This background material provides context for the report's primary focus: presenting revised cultural resource-focused objectives and performance metrics and outlining recommended next steps for pilot testing, completion of the remaining framework elements, and continued refinement of the Coastal Infrastructure Investment Analysis Framework (CIIAF).

Background to the Coastal Infrastructure Investment Analysis Framework

Many coastal assets of the National Park Service (NPS) are vulnerable to failure due to coastal hazards, and many of those vulnerabilities are projected to increase due to climate-driven changes in environmental conditions (NPS 2025). Mitigating those hazards requires investment action, increasingly challenging a stewardship strategy focused solely on maintaining all assets in suitable conditions in all locations (NPS 2021). Recognizing this, in November 2021, three NPS directorates established a collaborative team to develop tools and processes for *Adapting Coastal Park Infrastructure to Climate Change Impacts* (NPS 2021). This collaboration between Natural Resource Stewardship and Science (NRSS), Cultural Resources, Partnerships, and Science (CRPS), and Park Planning, Facilities and Lands (PPFL) established the following vision:

Improve facility investment decision-making processes to further incorporate planning for climate change adaptation in coastal park infrastructure. Develop a transparent and analytical process to consistently guide investment decisions across coastal parks for facility protection, adaptation (including maintenance, relocation or removal), mitigation, sustainability measures, restoration, and rehabilitation following storm damage. The process will support decisions regarding investments in coastal park units that are faced with existing and future coastal hazards. (NPS 2021)

The team initially focused on the Bureau-Investment Review Board's (B-IRB) decision processes associated with the Investment Concept (IC) phase (Figure 1). The IC phase concludes with the first formal review (or gate) of the proposed solutions (e.g., ICs) to a facility problem. To consistently and transparently account for existing and future coastal hazards in this earliest phase of solution development and review, the team initiated (June 2022) a collaboration with decision analysts from USGS to *develop a consistent, transparent, and analytical process to consistently inform decisions*

on ICs at coastal parks. That project and its main product are currently referred to as the *Coastal Infrastructure Investment Analysis Framework (CIIAF)*¹.

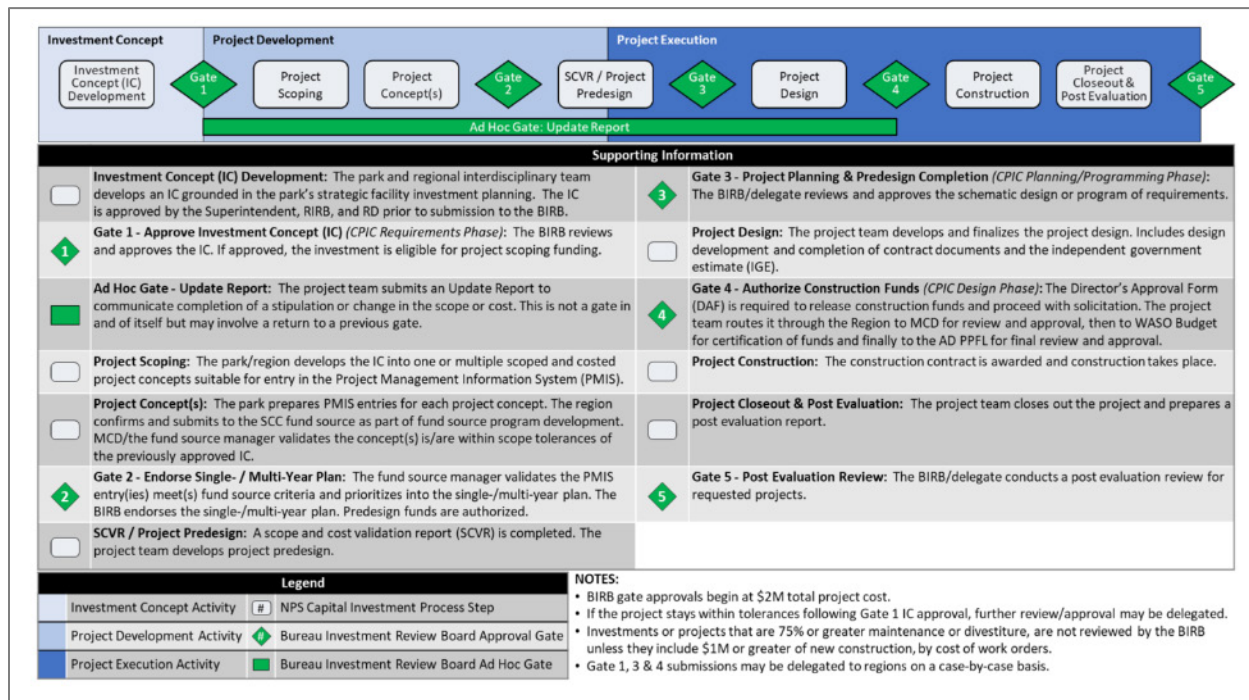


Figure 1. NPS capital investment process (NPS 2023). The CIIAF is intended to be applied as part of the Investment Concept Development phase (upper left), though the exact relationship between the CIIAF and the other components of the IC development process (such as the Natural Hazards Handbook, not shown) is intended to be resolved once the CIIAF is fully developed (Pers. Comm., Tara Pettit, PPFL, Fall 2024).

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The CIIAF was constructed by applying the ProACT decision analysis framework (described in the next section) to the B-IRB decision process for a specific class of IC: ICs that are potential adaptation actions for an asset (facility²) at a coastal park, and whose estimated cost (for at least one of the ICs) exceeds \$2 million (See Appendix 1 in Eaton et al. 2024). The framework is being developed with

¹ The framework was originally referred to as the *Coastal Investment Decision Framework* (Eaton et al. 2024). The name was changed during the project reported here at the behest of the leadership of CRPS to clarify that the framework provides (a) an *analysis* that identifies key value tradeoffs for further discussion in leading to a decision, rather than (b) providing the decision itself.

² While the CIIAF effort uses *infrastructure* in the title, the current focus is strictly on *facilities produced and maintained internally by the park* (buildings, roads and transportation assets), not externally provided systems and services such as power supply, water supply, telecommunications, etc., except when those systems and services have been identified as key supporting infrastructure in the performance metrics associated with the fundamental objective *Resilience to Coastal Hazards (climate and other)*. See Appendix 3 of Eaton et al. (2024).

the intent of using representative park units on the Atlantic, Gulf, and CONUS Pacific Coast regions³.

Initial development involved collaboration with NPS decision makers from four coastal parks: Channel Islands National Park (CHIS), Fire Island National Seashore (FIIS), Gateway National Recreation Area (GATE), and eastern North Carolina parks—Cape Hatteras National Seashore (CAHA), Fort Raleigh National Historic Site (FORA), and Wright Brothers National Memorial (WRBR). The effort also included NPS subject matter experts across a variety of divisions and programs, including Washington Office staff from CRPS; Denver Service Center, Land Resources Division, Major Construction Division, Park Planning and Special Studies, and Southeast Region Facility Management (all within PPFL); Business Management Group; and the Climate Change Response Program, Geological Resources Division, and Biological Resources Division (all within NRSS). See Appendix 1 of this report for a full list of participants. The development process was informed by six test cases from the four parks (Eaton et al. 2024).

Framework development focused on coastal parks because vulnerability assessments exist for all the eastern coastal parks (NPS 2025) and will be completed for the rest of the coastal parks; these vulnerability assessments are a foundational input to the framework (Peek et al. 2022). The framework can be adapted for other, non-coastal hazards, and thus for application to major investment decisions for hazard mitigation at interior parks.

The development status of each element of the CIIAF is summarized below. The exact timing and relationship between the CIIAF and the existing B-IRB IC process will be resolved after full development of the CIIAF (Pers. Comm., Tara Pettit, NPS PPFL, July 31, 2024).

Decision Analysis and the ProACT Framework

Decision analysis is a formalization of common sense for decision problems that are too complex for the informal use of common sense. (Keeney 1982)

The ProACT framework is named from the beginning letters of each of the five key elements that underlie every decision (Hammond et al. 1999): Problem, Objectives, Alternatives, Consequences, and Tradeoffs (Table 1). Distinguishing these elements of a decision helps clarify the sources of that decision's complexities (e.g., accounting for uncertainty in an Alternative's Consequences or resolving an approach to clearly address Tradeoffs from conflicting Objectives) (Goodwin and Wright 2014). This decomposition also clarifies those framework elements that are defined based largely on the (subjective) *value judgments* of the decision makers from those based largely on *technical judgments* of subject matter experts (Table 1). These clarifications are especially useful when a decision is to be made collaboratively by a group of people and/or where transparency in the decision-making process is important (Keeney 2007; Runge and Bean 2020). Their usefulness is

³ The performance metrics for Resilience to Coastal Hazards will require review and, likely, revision for applications in Alaska and/or Pacific or Caribbean Island park units.

magnified when a decision process will be repeated since the decomposition supports transparency and consistency across decision events (Smith 2020).

Table 1. Elements of the ProACT framework (Hammond et al. 1999). Descriptions derived from Hammond et al. (1999) and Smith (2020).

Element	Description	Notes
Problem	The Decision Context: motivation for the decision, who will make the decision, other key actors in the decision, legal and regulatory context, spatial and temporal extent of the decision, timing and frequency of the decision, and other constraints. Defined by the decision makers.	Clarifying the actual problem or decision can be challenging and require multiple revisions.
Objectives	What the decision maker really cares about—their concerns and wishes. The management values they want to achieve by their decision. Defined by the decision makers. Ultimately, for each Objective, one defines measurable attributes (Performance Metrics) to characterize achievement of the Objective by an Alternative. These are often developed with assistance of subject matter experts.	Clarifying the motivating Objectives, and developing effective Performance Metrics, can be challenging and require multiple revisions.
Alternatives	The options the decision makers choose from. Generally developed by subject matter experts.	Specifying alternatives helps to check that each objective is addressed by at least one alternative. If not, planners can discuss whether this was an accidental omission or if there are substantive reasons for not including an alternative (e.g., not relevant, no known assets for this objective).
Consequences	The outcome expected for each of the performance metrics under each alternative. Generally developed by subject matter experts.	—
Tradeoffs	The process the decision makers adopt to address the (likely) tradeoffs among alternatives in achievement of the objectives and decide which alternative to pursue.	The ProACT process illuminates which objectives are in tradeoff, and the magnitude or severity of change in achievement of those objectives across each alternative. Different sets of alternatives can result in different tradeoffs. The tradeoffs clarify in what ways an alternative could perform well and in what ways it could fail.

Developing Objectives and associated Performance Metrics can be challenging and often requires multiple iterations (Bond et al. 2008). This is especially true when the motivating Objectives reflect qualitative values, such as cultural resources (Converse 2020). It can be helpful to consider the process of decision analysis as iterative and use the prompting of a nominally optimal alternative to identify potentially missing or mischaracterized objectives (Converse 2020). For example, if a

specific alternative is identified by the framework as having high relative benefits but by the decision makers as having low relative benefits, that suggests the decision makers are considering additional objectives not yet explicitly incorporated into the framework.

Decision analysis, whether using the ProACT framework or the closely related Structured Decision-Making framework, clarifies the complexities of a decision and provides tools for addressing those complexities (Runge and Bean 2020). Decision analysis does not remove the contentiousness from a decision nor does it make the decision (Runge and Bean 2020). Rather, it “... [makes] transparent the nature of the tradeoffs and the effects of uncertainty, allowing focused and well-informed deliberations among the decision makers and stakeholders” (Runge and Bean 2020).

Coastal Infrastructure Investment Analysis Framework: Elements & Development Status

Development and Products

USGS-led collaborative development of the CIIAF was initiated in June 2022 and continued through June 2023. The final report summarized the development process, framework and priority next steps (Eaton et al. 2024). A Microsoft Excel workbook was created to enable users to apply the framework, with placeholder values for the elements that require further management judgment or input (Eaton et al. 2025). When the framework is fully developed, the workbook will synthesize park staff input on each alternative IC under consideration and generate a summary table and figure highlighting the key tradeoffs among alternative ICs in their achievement of the various categories of fundamental objectives.

Elements

Summary highlights of each of the CIIAF’s ProACT elements follow.

Problem

Develop a consistent, transparent, and analytical process to consistently inform decisions on ICs at coastal parks. The ICs of interest are the potential adaptation actions a park is considering for reducing the vulnerability of an asset (facility) to current and future coastal hazards (e.g., sea level rise, storm surge, coastal erosion). The framework will be applied when at least one of the ICs has an estimated cost of \$2 million or more (thus subject to B-IRB review). The framework is to be filled out by park staff, with assistance from regional and national subject matter experts as necessary.

Objectives

The framework distinguishes seven categories of fundamental objectives (Figure 2). Each category of fundamental objectives was further decomposed into distinct means objectives and, for each of those, one or more performance metrics for assessing the impact of an IC on achieving the benefit characterized by the performance metric (Appendix 2). The performance metrics aim to characterize differences among ICs in terms of their impacts on key values over their design lifetime (relative to the impact expected under an IC of *status quo* or *no new capital investment*. See Appendix 3 in Eaton et al. 2024.

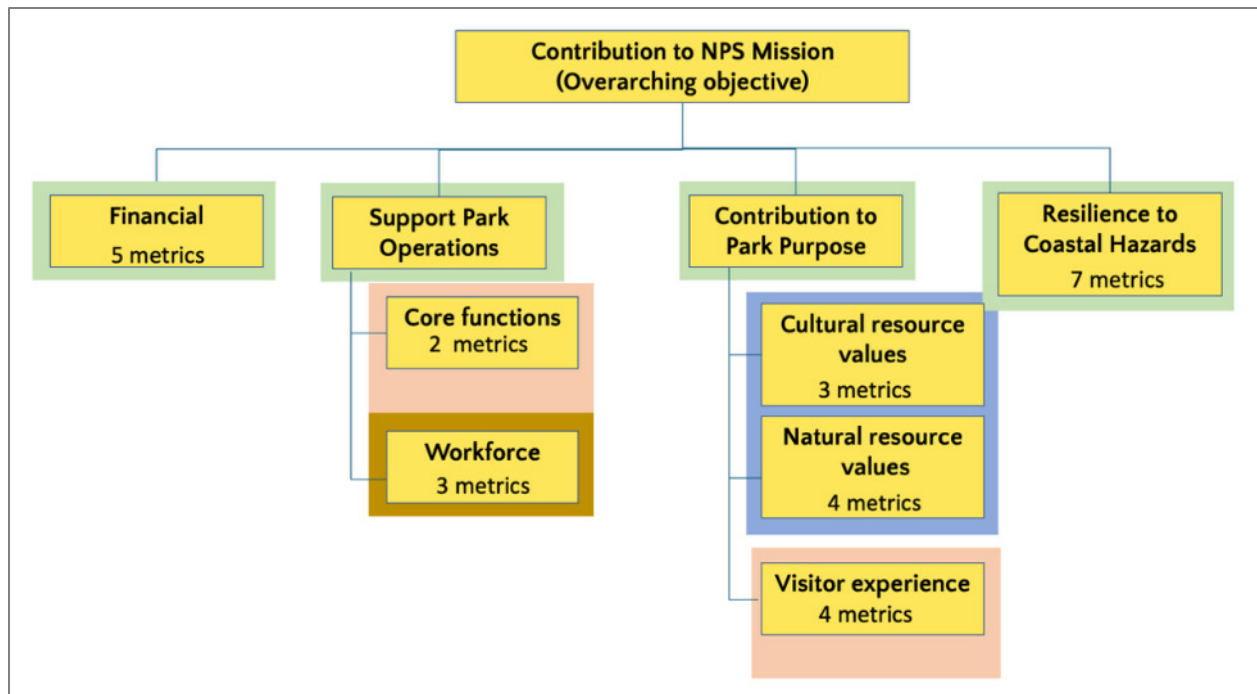


Figure 2. The fundamental objectives (motivating values) for the CIIAF. These include objectives related to financial considerations, support for park operations (distinguishing provision of core functions from support for workforce), contributions to a park’s cultural resource values, natural resource values, and visitor experience, and resilience to coastal hazards (e.g., reducing the vulnerability of the asset to coastal hazards) (Eaton et al. 2024, Appendix 4). Each category of fundamental objectives has been further decomposed into distinct means objectives and, for each of those, one or more performance metrics for assessing the impact of an IC on achieving the benefit characterized by the performance metric. This image was modified from content originally created by USGS.

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Alternatives

The alternatives the decision makers will consider are the various ICs proposed by a park to reduce the vulnerability of the assets to current and future coastal hazards. At minimum, these will include an IC reflecting status quo maintenance and an IC reflecting the park’s preferred adaptation action. They could include ICs associated with fortify, reprogram or reuse, relocate, remove, or other alternative adaptation actions (see Table 3.1 in Appendix 3 in Eaton et al. 2024, specifying alternative investment concepts). The ICs are the potential adaptation strategies identified in Step 4 of most adaptation planning cycles (Miller et al. 2025), thus could be reviewed to ensure they encompass the full range of possibilities across the Resist-Accept-Direct spectrum (Schuurman et al. 2025).

Consequences

For each IC, park staff, possibly with assistance from a subject matter expert, evaluate the expected outcome under that IC for each performance metric. The resulting summary is termed a Consequences Table. Applying the 28 performance metrics highlighted in Figure 2, the Consequences Table will have 28 rows and as many columns as there are proposed solutions.

Tradeoffs

To more easily reveal key tradeoffs between ICs in achievement of the various fundamental objectives, the framework partially summarizes the Consequences Table by distinguishing and characterizing three levels of inherent tradeoffs.

First, for each performance metric, the differences in relative benefit achieved at different outcome levels are characterized using a *value function*, which ranges from 0 to 1.0. The least possible benefit (which may include degradation of the asset) is set to a value of 0, and the greatest possible benefit is set to 1.0, with intervening levels of benefit set to capture the *relative* gain/loss across the levels of achievement (Figure 3). Appendix 4 of Eaton et al. (2024) provides additional examples. The value functions convert the entries in the cells of the Consequences Table into numbers, each between 0 and 1.

Second, the relative importance of the different performance metrics under a specific fundamental objective are characterized by tradeoff weights elicited from the decision makers. For example, performance metrics associated with workforce conditions (Appendix 2) may be assigned the following tradeoff weights by the decision makers: 0.5 for Employee Safety, 0.3 for Employee Working Conditions, and 0.2 for Employee Living Conditions.

Third, the highest level of tradeoffs are the subjective decision-maker valuations among the different fundamental objectives. These allow for summarization of overall relative benefit into a single, ordered dimension termed a Grand Score (see Reynolds 2026a for an example). The framework allows the decision maker to enter these weights to explore the sensitivity of the resulting tradeoffs among ICs.

Characterizing those two levels of tradeoffs (first and second above) enables a synthesis that more effectively reveals the differences among ICs in their relative benefit with respect to each fundamental objective. For example, consider an IC *Solution 1* that has the following ratings for each of the performance metrics under the fundamental objective of Support Park Operations: Workforce – Worker Safety = Improve, Staff Working Conditions = Improve, Worker Living Conditions = N/A. Further, assume each of the performance metrics use the value function shown in Figure 3 (note: there is no requirement that value functions all be the same, this is just an example). Then the synthesis first applies the value function associated with each performance metric to the IC's rating in the Consequences Table—for IC *Solution 1* the results are Worker Safety: 1, Staff Working Conditions: 1, Worker Living Conditions: 0.5. Then the tradeoff weight for a specific performance metric (defined in the paragraph above—Worker Safety: 0.5, Staff Working Conditions: 0.3, Worker Living Conditions: 0.2) is used to calculate a weighted sum for the IC's overall relative benefit with respect to Support Park Operations: Workforce: $0.5 \times 1 + 0.3 \times 1 + 0.2 \times 0.5 = 0.9$. This summary measure, for this IC with regard to this fundamental objective, allows one to easily compare across the similar summary values of other ICs for this fundamental objective, quickly revealing major tradeoffs.

Value Function: How much benefit from each level of a Performance Metric?

1 Start with clear and unambiguous constructed scales (metrics)

2 Decide how the value of the metric changes for each level of the constructed scale

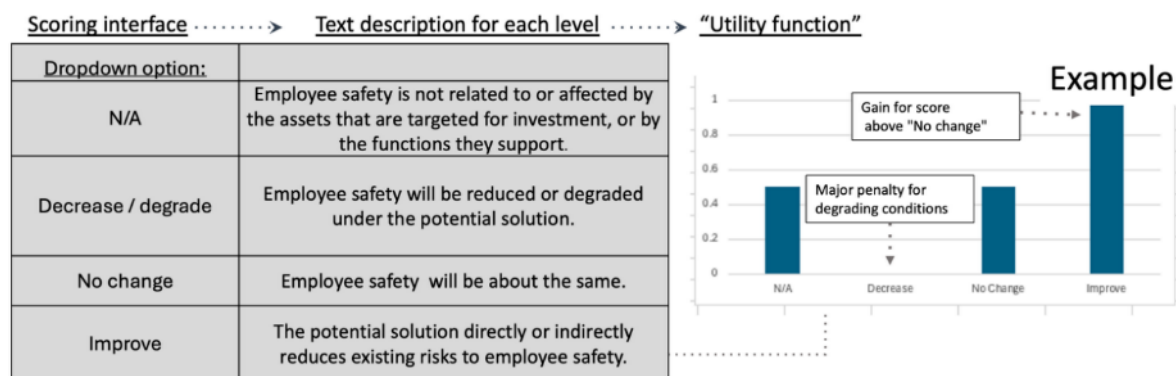


Figure 3. Example value function (lower right corner) for the performance metric characterizing impacts of an IC on *Employee Safety* (labelled *Workforce* in Figure 2). The metric's potential levels (outcomes) are shown, with associated description, on the left. The value function characterizes the differences in relative benefit between metric levels. For example, here the preference for an IC rated as *Improve* compared to one rated as *No Change* ($1.0 - 0.5 = 0.5$) is equivalent to the preference of an IC rated as *No Change* compared to an IC rated as *Decrease* ($0.5 - 0 = 0.5$). If the value assigned to "No Change" was 0.3 rather than 0.5, then the preference for *Improvement* vs. *No Change* ($1.0 - 0.3 = 0.7$) would be more than twice as large as that for *No Change* vs. *Decrease* ($0.3 - 0.0 = 0.3$). Figure modified from Eaton et al. (2024).
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The three types of tradeoffs distinguished by the framework are inherently subjective. They are being made implicitly as part of the current B-IRB process. By forcing explicit characterization of these distinct tradeoffs, the framework provides transparency and clarity, as well as a means of assessing the sensitivity of the overall synthesis outcomes (Grand Scores) to the subjective choices in the tradeoff weights (1, 2, 3).

Development Status

Table 2 summarizes the current development status of the framework's elements. Upon revision of the Cultural Resource means objectives and performance metrics, the intention (Fall 2024) was to test the framework and assess the need for revision of key elements so far defined (e.g., objectives, performance metrics, and their input requirements). Value functions and tradeoff weights will need to be determined following pilot testing of the revised objectives and performance metrics. Chapter 3 outlines recommended approaches for pilot testing, development of the tradeoff component, framework implementation, and longer-term refinement.

Table 2. Development status of each element of the CIIAF as of August 2024 (TBD = to be determined).

Category of Fundamental Objectives	Means Objectives	Performance Metrics	Value Functions	Tradeoff Weights
Financial	Testing Planned	Testing Planned	TBD	TBD
(Park Operations) Core Facilities	Testing Planned	Testing Planned	TBD	TBD
(Park Operations) Workforce	Testing Planned	Testing Planned	TBD	TBD
(Park Purpose) Cultural Resources	In Revision, Testing Scheduled	In Revision, Testing Scheduled	TBD	TBD
(Park Purpose) Natural Resources	Testing Planned	Testing Planned	TBD	TBD
(Park Purpose) Visitor Experience	Testing Planned	Testing Planned	TBD	TBD
Resilience to Coastal Hazards	Testing Planned	Testing Planned	TBD	TBD

Conclusion

The shared interest of the three directorates (PPFL, CRPS, NRSS) to improve the consistency and transparency of coastal infrastructure investments motivated development of the Coastal Infrastructure Investment Analysis Framework (CIIAF). The framework's elements (e.g., problem, objectives, alternatives, consequences, tradeoffs) distinguish and clarify those aspects that reflect the values of the decision makers (problem, objectives, tradeoff weights) from those reflecting technical or subject matter expertise (alternatives, consequences). While undoubtedly open to further refinement, even the existing framework elements are an important advance as they characterize, for all to see, the key objectives (values) that the directorates consider important for consideration in *any* coastal infrastructure investment that meets the framework's minimum cost threshold. Thus, even though incomplete, the framework has already improved the clarity and transparency of the intended process. Presumably the framework and these key objectives provide a reasonable foundation for any similar efforts focused on other hazards, including for interior parks.

The next chapter describes the revised objectives and performance metrics for assessing impacts of potential Investment Concepts on cultural resource values at a coastal park. Testing and use of the framework, once fully developed, are expected to reveal, at least initially, deficiencies and necessary improvements to the means objectives, performance metrics, and (A) and (B) types of tradeoffs. The framework is intended to be developed and refined iteratively. Use of the framework will help decision makers and subject matter experts better articulate the motivating objectives and other framework elements and facilitate the identification of the best-suited IC.

Chapter 2. Objectives and Performance Metrics (Version 3.0) for Characterizing Consequences of Potential Investment Concepts on Cultural Resources

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Perhaps the best practice is developing in decision makers and stakeholders a willingness to see the process of decision analysis as iterative. Once it is recognized that an objective is missing or characterized inappropriately ... it is important to go back and consider how this needs to be integrated into the process. S.J. Converse (2020), pg. 59.

Introduction

The Coastal Infrastructure Investment Analysis Framework (CIIAF) evaluates the consequences of alternative ICs with respect to four broad classes of objectives (*Financial, Support Park Operations, Contribution to Park Purpose, Resilience to Coastal Hazards*; see Figure 2). *Contribution to Park Purpose* encompasses sets of objectives focused on each of three categories of values: cultural resource values, natural resource values, and visitor experience. The initial cultural resources-focused objectives and performance metrics reported in Eaton et al. (2024)—referred to as version 1.0 and provided in this report in Appendix 2—were revised by subject matter experts in the Cultural Resources, Partnerships, and Science Directorate (CRPS) to better align with concepts and terminology used in cultural resources management practices.

That revision, referred to as version 2.0, did not fully reflect and align with important aspects of the PrOACT framework, such as the requirement that an objective focus narrowly enough that achievement be influenced only by the choice of alternative and not by factors beyond that choice (e.g., factors outside the influence of the decision). Decision analysts have identified such desired characteristics for objectives and for performance metrics (summarized in Appendix 3). Those characteristics were applied to the version 2.0 objectives and performance metrics (Appendix 4). The issues identified prompted development of the current CR-focused objectives and performance metrics presented here in version 3.0.

The updated objectives and performance metrics are presented after a brief synopsis of their roles in decision analysis and a brief introduction to fundamental values in cultural resources management. The chapter concludes with recommendations for consideration in testing the version 3.0 CR-focused objectives and performance metrics, which are expanded in Chapter 3 as part of the broader pilot-testing recommendations for the CIIAF.

Background on Objectives, Performance Metrics, and Cultural Resources

Objectives and Performance Metrics in Decision Analysis

Objectives play a central role in every decision analysis (Keeney 2007). Objectives are intended to capture and reflect those things the decision maker(s) wants to achieve (e.g., the decision-maker's values relevant to that decision) (Keeney 2007). Objectives, and their associated performance

metrics⁴, heavily influence the quality of the decision analysis since they determine the types of consequences that matter and, thus, the types of tradeoffs the decision makers must consider in selecting an alternative. Subsequently, they also form the basis for explaining actions and justifying choices to the decision’s stakeholders (Keeney 2007) and so are core to the decision process’ transparency. Their importance is magnified when the decision framework is intended to be used by multiple coastal park units within the National Park System, all of which share the general goal of historic preservation following established guidelines.

Developing adequate objectives and performance metrics often is challenging. This may require multiple iterations of prototyping and pilot testing to articulate effectively both what one really cares about (e.g., the values underlying the objectives) and adequate ways of assessing its achievement (e.g., associated performance metrics) (Bond et al. 2010; Smith 2020). Commonly, stakeholders and decision makers do not fully articulate all their priority objectives when first designing a decision analysis—initial efforts may only identify roughly half of the priority objectives (Bond et al. 2010). Further, even though decision makers and stakeholders may have no difficulty expressing their preferred alternatives, expressing the values underlying those preferences can be inherently difficult with regards to cultural and natural resources (Converse 2020).

Developing performance metrics can be challenging as they should distinguish decision-relevant levels of achievement (i.e., consequences) and be evaluated in a consistent, repeatable way (Keeney 2007). This can be especially challenging for values that are fundamentally qualitative, such as those reflecting consequences on the integrity of cultural resources (Converse 2020).

Background on Cultural Resource Values

NPS Director’s Order 28 defines Cultural Resources (CR) as archeological resources, cultural landscapes, historic structures, museum objects, or ethnographic resources. In the U.S., the importance of a cultural resource is defined as a combination of *Significance* and *Integrity* and is documented by the resource being listed, or being eligible for listing, in the National Register of Historic Places (NPS 1995). Determinations for eligibility and for listing follow industry definitions, established criteria, professional standards, and a standardized process followed by all entities in the U.S., not just the National Park Service (NPS 1995). The National Park Service manages the listing and eligibility processes across the U.S.

Significance of a CR relates to the *why*, *where*, and *when* of its importance and “... is judged ... within its historic context” (NPS 1995, pg. 7). Integrity refers to a property’s capacity to communicate its significance (NPS 1995, pg. 44). Integrity characterizes a property’s alignment with past associations and relates to aspects of age and authenticity. For a property to be eligible for inclusion in the National Register of Historic Places, it must demonstrate significance according to the National Register criteria *and* possess integrity. Evaluating integrity, while at times somewhat subjective, is based on a thorough understanding of a property’s physical characteristics and their

⁴ In the literature, these are also referred to as *attributes* or *performance metrics* or, for shorthand, *metrics*.

connection to its significance. Historic properties either maintain integrity (meaning they convey their significance) or they do not.

The National Register criteria identify seven aspects that, in various combinations, characterize integrity: Location, Design, Setting, Materials, Workmanship, Feeling, and Association (NPS 1995, pg. 48). To maintain historic integrity, a property typically exhibits several, if not most, of these aspects. The preservation of specific integrity aspects is crucial for a property to effectively convey its significance. Identifying which aspects are most vital to a property requires understanding its historical context—why, where, and when it holds significance.

Condition, on the other hand, characterizes the current physical status of aspects of a historic property and is usually stated in terms of decay and deterioration. NPS 28 Cultural Resource Management Guidelines (NPS 1998), Chapter 1, Section C.3 states:

Integrity is not the same as condition. The condition of a resource is defined in terms of deterioration; integrity is defined in terms of correspondence with associations in the past. Condition is a matter of rot and rust; integrity is a matter of age and authenticity. All physical things have a condition; they do not all have historical integrity. On the other hand, all things with historical integrity also have a condition. The condition of a resource during its period of significance is part of its integrity.

Condition can usually be stated as poor, fair, good, or excellent. Historic properties may have both high integrity and excellent condition if they have been well maintained in accordance with the Secretary of Interior's Standards for the Treatment of Historic Properties. A historic property may have excellent condition but poor integrity if maintenance work on the property was not in accordance with the Secretary of Interior's Standards. A historic property can retain integrity even if in poor condition—poor condition does not automatically render a historic property ineligible for the National Register of Historic Places (Historic Hawaii 2024). However, condition can degrade to such a degree that a historic property no longer has integrity (capacity to communicate significance).

The remaining presentation uses the term *historic properties* to encompass historic structures, archeological resources, and cultural landscapes, while also considering ethnographic resources and museum collections separately to consider their unique qualities within the lens of the potential impacts of an IC.

CR-Focused Objectives and Performance Metrics, Version 3.0

Objectives

Version 3.0 has seven objectives (Figure 4), all fundamental, all derived from the core value of minimizing loss of a CR's integrity due to implementation of the IC. Six objectives focus on the IC's potential direct impact on integrity and condition for each of the three types of CR: Historic Properties, Museum Collections, and Ethnographic Resources. The seventh focuses on the source of understanding of the potential impact(s). Each of the revised objectives has all the desired characteristics identified in the decision analysis literature. Pilot testing is required to assess whether

this *set of objectives* is adequate or if additional revisions are needed to meet the desired characteristics of the set listed in Appendix 3. See Chapter 3, Section 1 (Pilot Testing) for recommended elements of that assessment.

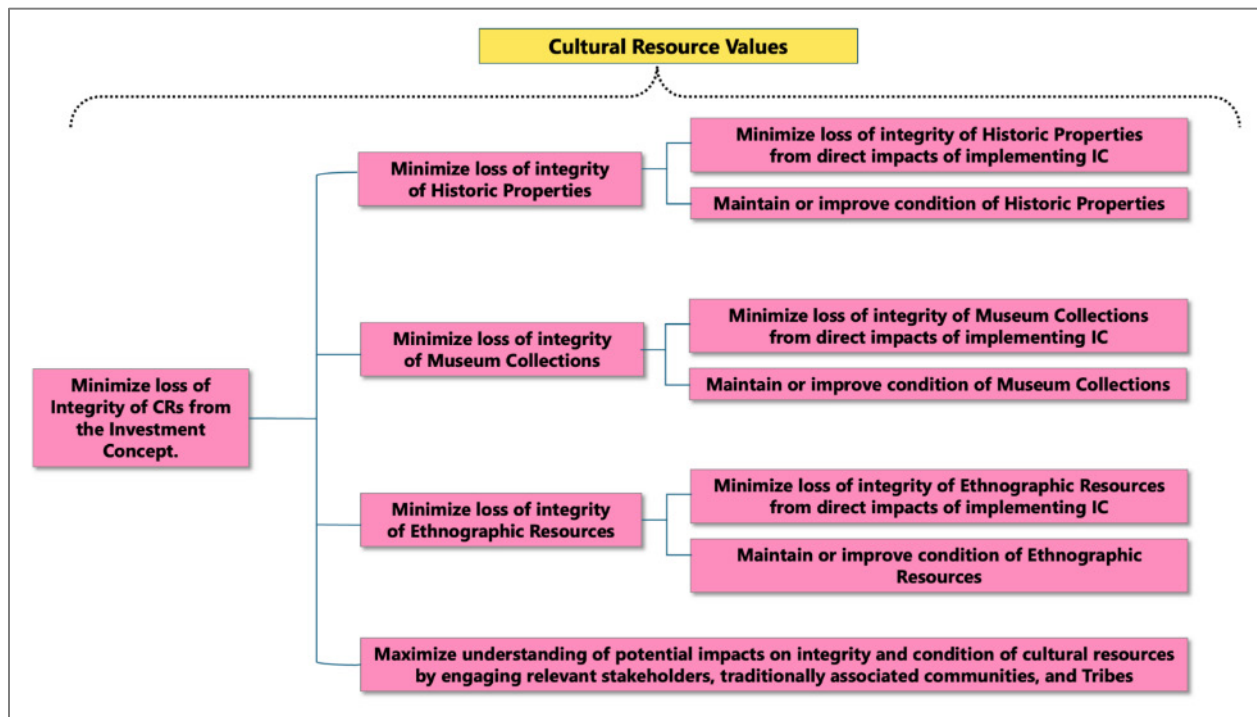


Figure 4. Revised draft cultural resource-focused hierarchy of fundamental objectives for use in CIIAF (version 3.0, January 30, 2025). Moving left to right clarifies the specific meaning of a fundamental objective of Cultural Resource management in this decision context, the CIIAF. See text for further details on integrity and condition.

NPS

Performance Metrics

Version 3.0 has seven performance metrics (Figure 5, which further unpacks Figure 4). The metrics reflect the important distinction that while integrity cannot be improved, conditions might: e.g., positive outcome levels in Performance Metric 1.2 (which will be referred to as PM1.2 using the numbering in Figure 5) versus PM1.1. Further, the outcome levels of PM1.1, 2.1, and 3.1 distinguish the case where an IC may potentially degrade integrity to the point where significance is lost (Figure 5).

For PM1.1 through 3.2 (Figure 5), the single outcome level *Cannot be evaluated due to lack of necessary information* was included rather than distinguish between uncertainty regarding potential IC impacts versus uncertainty regarding presence or location of CRs. The outcome levels of PM4 seek to balance comprehensiveness with being operational, given the potential complexity of multiple consulted parties and multiple potential impacts. Each PM appears to have all of the desired properties identified in the decision analysis literature (Appendix 3), though pilot testing is required to determine this. See Chapter 3, Section 1 (Pilot Testing) for recommended elements.

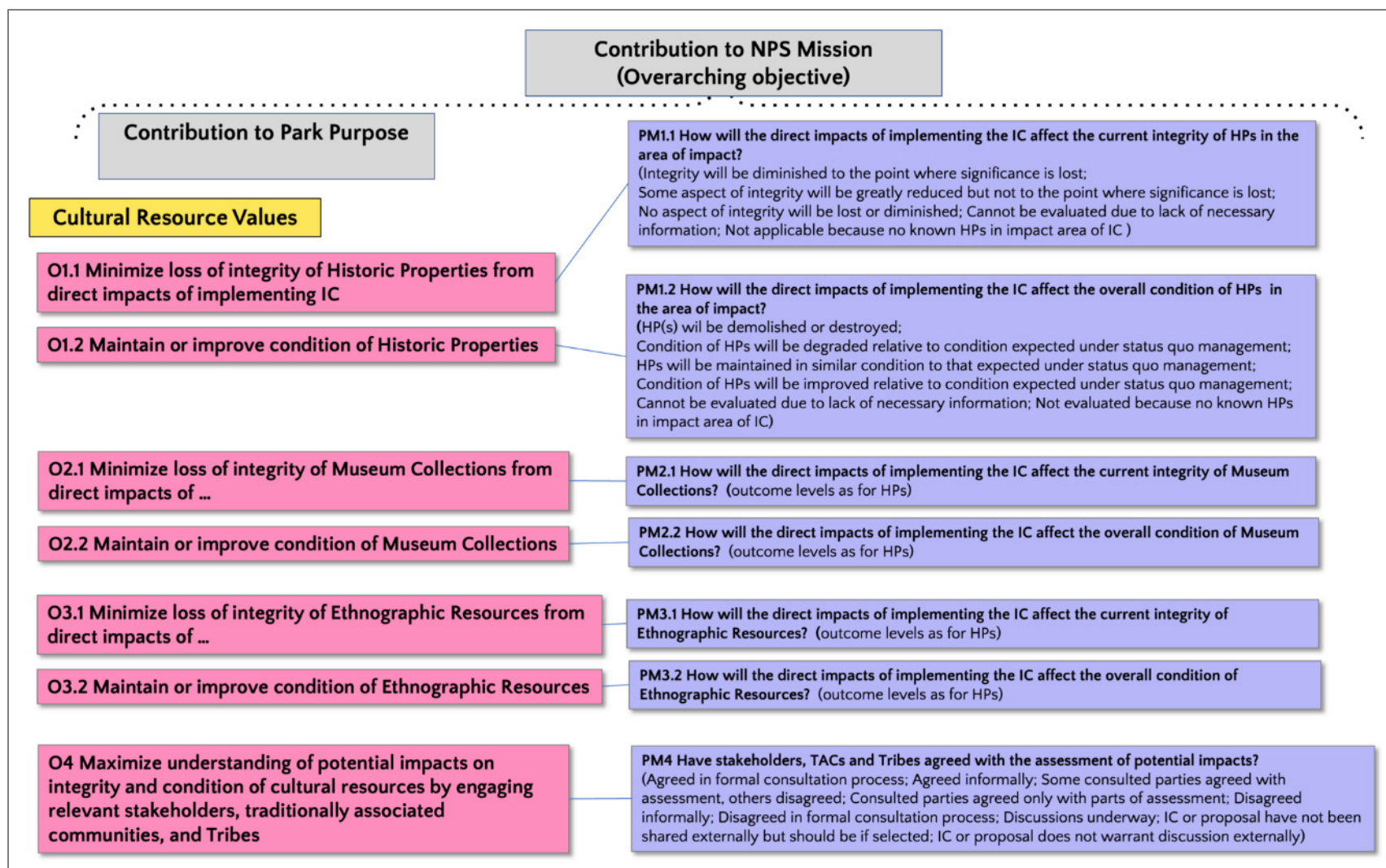


Figure 5. Revised draft cultural resource-focused performance metrics for use in CIIAF (version 3.0). O denotes Objective, PM denotes Performance Metric. O4 and PM4 follow definitions in 36 CFR 800.2: Participants in the Section 106 process. For each performance metric, users select the most applicable option from those listed in parentheses.

NPS

Process Envisioned for Applying Each CR Performance Metric

Each performance metric is intended to be filled out by relevant park unit staff, potentially with support from Regional or National CR staff and key stakeholders. Key resources for evaluating the performance metrics include the Cultural Resources Inventory System (CRIS), archeological survey reports, Museum Collections Management System (MCMS), cultural landscape inventories, historic structure reports, and Historic Property Project Documentation (HPPD). Park, regional, and national cultural resources specialists from a variety of disciplines can assist teams with identifying potential effects of an IC on integrity and condition of a CR.

Comment on Version 3.0

In developing these objectives, the authors recognized that the objective focused on the source of understanding of potential impacts (O4, Figure 5), e.g., *consultation* with stakeholders, Tribes, and traditionally associated communities, is equally appropriate and applicable to other NPS values beyond cultural resources (e.g., natural resources, visitor experience). The authors recommend that consideration be given to generalizing this objective in the CIIAF so it captures understanding of potential impacts on broader scope of values, for example, viewshed, access, NPS capacity to maintain and control visitor impacts, etc. This recommendation is discussed further in Chapter 3.

Recommended Next Steps

The version 3.0 objectives and performance metrics would benefit from testing and, potentially, further refinement. This could be approached as one element of a pilot testing exercise (Bond et al. 2010; Converse 2020; Keeney 2007). For efficiency, such testing could employ the full CIIAF (updated with the version 3.0 CR elements)—e.g., testing of all the draft objectives and performance metrics, not just those focused on CR. This would provide an opportunity for the non-CR objectives and performance metrics to receive similar sustained attention as the CR objectives have and ensure the parks involved in the pilot testing benefit from the holistic analysis provided by the CIIAF.

Regardless of approach, the assessment should seek feedback specifically on whether the revised CR performance metrics and the *set* of revised CR objectives meet the desired characteristics identified in Appendix 3. The questions suggested below focus on those goals; while not exhaustive, they provide a foundation for developing the assessment. While phrased in terms of the version 3.0 CR objectives and performance metrics, analogous questions should be asked of the other objectives and performance metrics in the CIIAF (e.g., Natural Resources, Visitor Experiences).

- Any confusion, concerns, or operational challenges in evaluating an IC with respect to any of the PMs? Do the pilot testers have suggestions on alternative PMs that would address the same “information need” but be easier to implement?
focal characteristic: Operational (Appendix 3)
- Any unease or concerns raised in evaluating the consequences of an IC due to a tester identifying *differences in consequences* they feel are not currently reflected in the available outcome levels of *that PM*? Should the set of potential outcomes be expanded (new levels added and outcome descriptions refined) to distinguish an important outcome that is currently

obscured or masked?

focal characteristic: Direct (Appendix 3)

- Any unease or concerns raised in evaluating the consequences of an IC that stem from a tester identifying *consequences* that they see as related to the objectives but that are not captured by any of the current PMs? Does a new PM need to be added that specifically focuses on a currently ignored type of consequence?

focal characteristic: Comprehensive (Appendix 3)

- Any unease or concerns raised in evaluating the consequences of an IC that stem from a subject matter expert identifying *consequences* they see as important to *CR values* (in the broad sense) but that are not captured by the current objectives and PMs (Figures 4 and 5)? Rephrased, do the objectives adequately distinguish between the alternatives?

focal characteristic: Complete (Appendix 3)

NOTE: The last two questions distinguish the roles of objectives and PMs in the more general question: Would the testers be comfortable with a decision reached after considering the consequences summarized by the CIIAF? If not, why not? What consequences are not reflected?

- Are some PMs especially challenging to evaluate? Do they require more effort than seems warranted given the decision context?

focal characteristic: general effort required to evaluate a PM

Summary

Objectives and their associated performance metrics are central to every decision analysis (Keeney 2007) and generally require multiple iterations of development to be articulated effectively (Bond et al. 2010). Thus, the need to further refine the CR-related objectives and performance metrics should be both expected and welcomed. The revision reported here reflects key distinctions in types and levels of potential IC impacts on CRs, including the potential for positive impacts on condition and potential for such negative impacts on integrity that National Register significance no longer holds. It is recommended that the revision be assessed in application, ideally via a pilot testing exercise designed to incorporate relevant additional guidance on objective development (e.g., Keeney 2007; Bond et al. 2010; and Clemen and Reilly 2014).

Chapter 3. Considerations and Priorities in Next Steps of Developing the CIIAF

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Introduction

The CIIAF is envisioned to be a systematic, repeatable process to support infrastructure investment decisions in coastal parks (NPS 2021). The breadth of this vision warrants ensuring adequate pilot testing throughout the framework’s development process. Testing also contributes to socializing the framework in the sense of ensuring those parks engaged in framework assessments actively contribute to the framework’s development. Each phase of testing should, ideally, be conducted across a range of parks and infrastructure decisions to ensure the framework elements under review are assessed under a broad variety of decisions.

Such testing will benefit any future extension of the CIIAF. Potential extensions raised in prior discussions include modification to create a framework suitable for decisions regarding portfolio allocation across multiple facilities and/or multiple parks, and expansion of the framework to consider hazards appropriate to non-coastal parks. Consideration should also be given to ensuring the framework is suitable across the variety of park units in the Service, including historical parks, seashores, recreational areas, and parks focused on natural resources.

The comments below address immediate next steps in advancing development of the CIIAF (Sections 1, 2, and 3) and select tasks for its longer-term development. This list supplements, but does not replace, the list of future tasks collaboratively developed by NPS and USGS and reported in Eaton et al. (2024) starting on page 7.

Recommended Next Steps

1. Pilot Testing Full Suite of Current Objectives and Performance Metrics

In terms of the PrOACT framework (described in Chapter 1), the current CIIAF has been developed through the C component—Consequences: applying the CIIAF to a coastal-facilities problem produces a Consequences Table compiling the expected outcome of each potential IC on each of 32 performance metrics (PMs). The last undeveloped component is the T component—Tradeoffs (the value functions and tradeoff weights). Given the strong dependence of that component on the objectives and PMs, one could either test and revise current objectives and PMs prior to further development of the tradeoff component or as discussed in Section 2, Developing the Last Framework Element—Tradeoffs, do both simultaneously. Involvement of Decision Analysts to help facilitate and evaluate testing would improve efficiency and effectiveness.

1.1. Testing of the Objectives and PMs

Testing of the objectives and PMs should focus on their adequacy, individually and collectively, with respect to the desirable characteristics summarized in Appendix 3.

1.2. Priority Features to Assess

A list of priority features to assess is provided under the Recommended Next Steps section of Chapter 2. While phrased in terms of the cultural resource objectives and PMs, analogous questions are applicable to each of the other objectives and PMs in the CIIAF.

1.3. Essential Information Sources

The testing process should capture feedback on the ability of relevant park unit staff to conduct each evaluation (e.g., score each PM). Are there PMs that require specialized resources or expertise from network, region, WASO programs or elsewhere? Are more expansive examples/definitions required in the Scoring Guidance to clarify understanding and identification of, for example, Ethnographic Resources? The implementation guidance should be updated to capture those potential resources and address those needs (e.g., Annotated Scoring Guidance with Metrics⁵).

1.4. Excel Workbook Implementation⁶

If the testing process uses the current Excel workbook implementation, consider capturing feedback, such as the workbook's ease of use and adequacy of the guidance for scoring (both internal to the workbook and in the updated Scoring Guidance). Seek to gain insight into any issues arising in scoring when there are multiple resources (e.g., multiple historic properties, multiple ethnographic resources) expected to be impacted by an IC (see Scoring Guidance Historic Properties notes).

1.5. Incorporate Prior Pilot Feedback

The pilot testing's summary of feedback and recommended updates should incorporate the feedback captured by the original USGS team from the original six case studies (see Appendix 3 in Eaton et al. 2024). Currently, only the feedback and suggestions related to Cultural Resource Values and associated objectives and PMs have been addressed—all other await the next round of updating.

1.6. Direct Versus Indirect Impacts

In pilot testing, seek to discern if there is clear benefit in distinguishing among ICs that directly target a CR versus those that may only indirectly impact a CR.

1.7. Feasibility Objective

Consider modifying the Financial fundamental objective to the broader concept of Feasibility and incorporating consideration of staff capacity.

2. Developing the Last Framework Element—Tradeoffs (Value Functions and Tradeoff Weights)

The last framework component left to be developed is the value functions associated with each PM, the tradeoff weights used to summarize benefits within a category of objectives (e.g., Cultural

⁵ Annotated Scoring Guidance with Metrics available in supplemental materials for this report (Eaton et al. 2026; Reynolds 2026b).

⁶ Excel Workbook Implementation of the CIIAF (revised) available in supplemental materials for this report (Eaton et al. 2026; Reynolds 2026a; Reynolds 2026c).

Resources, Natural Resources, Visitor Experience, Resilience to Coastal Hazards), and the tradeoff weights used by the investment review board(s), regional- or bureau-level. This component enables the framework to (quickly) reveal key tradeoffs across ICs in their benefits across all categories of objectives, focusing IRB discussions on the underlying values and tradeoffs of greatest importance. Eaton et al. (2024) discusses these in more detail, clarifying who should be involved in defining each of these elements and providing sources for further guidance on developing these and assessing them (see Needs for Further Framework Development and Tradeoffs and Value Functions: from Consequence Matrix to Quantified Performance). This step requires active involvement of Decision Analysts with experience eliciting value functions and tradeoff weights, ideally in the context of resource management decision making.

While this step is presented as a follow-up to Pilot Testing (Section 1), it may be feasible and more beneficial to approach this in combination with the Pilot Testing described in that section. Such a combined approach may enable participants to better understand the framework's overall functioning in (relatively quickly) surfacing the major tradeoffs among ICs to focus discussion and debate, as well as help socialize the framework. A combined approach could enable each pilot study to develop its own value functions and tradeoff weights rather than attempt to develop consistent tradeoffs for application across all coastal infrastructure investment decisions in a single effort; upon accumulating sufficient pilot studies, one could then review the study-specific tradeoff details to discern emerging commonalities for informing a single tradeoff component to be applied consistently across such decisions. Strongly encourage discussion of this approach with an experienced decision analyst.

3. Updating the CIIAF, Scoring Documentation, and Excel Implementation

In preparing the next update of the CIIAF to address the insights from pilot testing, consideration should be given to three comments (below) raised during the current project. Involvement of Decision Analysts might make addressing the second comment more efficient and effective but does not seem a necessity given the information in Appendices 3 and 4.

3.1. PM4.1 Engagement and Consultation

PM4.1 of the cultural resource-focused PMs addresses engagement and consultation (broadly interpreted) to better understand possible cultural resource impacts (Figure 5). The concept of and benefits of such consultation (in a broad sense, not formal consultation) with Tribes, traditionally associated communities, and stakeholders may be equally applicable to other categories of Park Purposes (e.g., natural resources or visitor experience). Consider the value of creating parallel PMs focusing on this aspect for these other values under Park Purposes.

3.2. Climate Change Mitigation

Consider a PM focused on climate change mitigation, possibly under Support Park Operations. (Pers. Comm., NPS facility personnel, August 12, 2024).

3.3. Clarify the CIIAF's Focus

Consider ways to clarify the CIIAF's focus. For example, clarify that the framework applies to facilities produced and maintained internally by the park (e.g., buildings, roads, transportation assets), rather than externally provided systems and services such as power supply, water supply, or telecommunications, except when those systems and services have been identified as key supporting infrastructure in the performance metrics associated with the fundamental objective of Resilience to Coastal Hazards (climate and other) (Pers. Comm., NPS facility personnel, August 12, 2024).

4. Socializing the CIIAF Among Parks

Efforts to advance framework development should consider the secondary long-term goal of socializing the framework among parks by engaging additional parks in various next steps. This would ensure adequate input and insights from individual parks as well as advance awareness of the framework and its underlying structure (PrOACT). Consider other actions to raise awareness of the framework among potential user groups. This step could benefit from the advice of Decision Analysts, but their sustained engagement does not seem necessary as part of socializing.

5. CIIAF Implementation Tool

When the framework is fully developed and stabilizes (i.e., the need for revision declines), consider the benefits and costs of other forms of implementation, such as a stand-alone app or web interface, or another form that better aligns with the larger process of IC development and design. Discussions with Decision Analysts regarding the pros and cons of alternative implementations would likely be informative and insightful.

6. Resolve Role and Sequencing with Other Elements of IC Development Process

As the framework nears full development and its content stabilizes, engagement should increase with the Major Construction Division of PPFL to resolve the timing and role of the framework in the larger, evolving IC development process (Figure 1). Among other topics to be resolved are clarifying which decisions require application of the framework (and which do not) and the relationship between the framework and the Natural Hazards Handbook. Decision Analysts could contribute to clarifying the information dependencies among elements, but this is largely a task for NPS staff.

7. Other Applications

Development of the framework raised interest in developing a similar decision analysis tool for identifying portfolios of ICs addressing a suite of facility problems. The current framework, when fully developed, may be useful for small-scale versions where a park (for example) is deciding among a small set of combinations of ICs, each addressing a distinct problem; this should be discussed with an experienced decision analyst to understand feasibility and necessary pilot testing. The scope of the framework may be extended to externally provided systems and services; this should be discussed with an experienced decision analyst to understand feasibility and necessary modifications or constraints. Discussions with decision analysts may reveal perspectives and potential applications beyond these.

8. Adapting Framework to Non-Coastal Hazards

In terms of framework components, the link to coastal hazards rests mainly in the Resilience to Coastal Hazards objectives and performance metrics (Figure 2). Presumably the rest of the framework components remain appropriate for infrastructure investment decisions addressing other hazards. Once the CIIAF is fully developed and its content stabilized, one could consider making framework versions that address other hazards of major concern in facility investments, such as fire, flooding (non-coastal), and drought. Developing such variants would leverage the investment in the CIIAF and likely mainly require development of the new hazard-specific objectives and performance metrics, review of the other existing framework components to flag any necessary revisions, and then iterative pilot testing to refine and socialize the new framework. Engaging Decision Analysts to facilitate this would improve efficiency and effectiveness.

Further, the CIIAF's general conceptual structure and major categories of objectives provide a foundation for approaching NPS decisions regarding matters other than infrastructure. Even if specific objectives and performance metrics are not transferable, modification of the foundational structure and concepts will make development of similar frameworks more efficient.

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Appendix 1. Participants in USGS-Led CIIAF Development

See Table 3 for participants in the USGS-led CIIAF development of the CIIAF.

Table 3. Participants in USGS-led development of the CIIAF. Sup. = Superintendent, BMG = Business Management Group, BRD = Biological Resources Division, CCRP = Climate Change Response Program, DSC = Denver Service Center, GRD = Geological Resources Division, LRD = Land Resources Division, MCD = Major Construction Division, PPSS = Park Planning and Special Studies, SER Disaster PM = Southeast Region Disaster Program Management, SER RFMD = Southeast Region Facility Management Division, WC = Wildlife Conservation, YOSE NRD = Yosemite National Park Natural Resources Division; B-A-H = Booz Allen Hamilton (contractor); CRAB WG = Coastal Resist-Accept-Direct [RAD] Adaptation Blueprint Working Group.

Name	Affiliation
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Jen Nersesian ^A	Sup.-GATE
Cat Hawkins-Hoffman ^B	NRSS-CCRP
Nicole Athern	YOSE-NRD
Rebecca Beavers	NRSS-GRD and CCRP
Charles Borders	SER Disaster PM
Chris Close	PPFL
Alan Ellsworth	NRSS-CCRP
Carey Feierabend	PPFL-DSC
Jason Gibson ^B	BMG
Grace Hilbert	PPFL-PPSS
Marty Hylton	CRPS and CCRP
Brendan Moynahan	NRSS-BRD
Ethan McKinley	Sup.-CHIS
Brett Nickels	PPFL-MCD
Tara Pettit	PPFL-PPSS
Joel Reynolds	NRSS-CCRP
Alexcy Romero	Sup.-FIIS
Brad Shattuck ^B	SER RFMD
Tonya Summerlin	PPFL-LRD
Jeneva Wright	CRPS and CCRP
Mitch Eaton	USGS
Karen Jenni	USGS
Abby Lawson	USGS

^A Co-Chairs.

^B Also member of CRAB WG.

Table 3 (continued). Participants in USGS-led development of the CIIAF. Sup. = Superintendent, BMG = Business Management Group, BRD = Biological Resources Division, CCRP = Climate Change Response Program, DSC = Denver Service Center, GRD = Geological Resources Division, LRD = Land Resources Division, MCD = Major Construction Division, PPSS = Park Planning and Special Studies, SER Disaster PM = Southeast Region Disaster Program Management, SER RFMD = Southeast Region Facility Management Division, WC = Wildlife Conservation, YOSE NRD = Yosemite National Park Natural Resources Division; B-A-H = Booz Allen Hamilton (contractor); CRAB WG = Coastal Resist-Accept-Direct [RAD] Adaptation Blueprint Working Group.

Name	Affiliation
Simeon Yurek	USGS
Teressa Bryant	B-A-H
Additional subject matter experts from CHIS, FIIS, GATE, CAHA/FORA/WRBR	—

^A Co-Chairs.

^B Also member of CRAB WG.

Appendix 2. CIIAF Objectives and Performance Metrics (Version 1.0)

This appendix presents the initial (version 1.0) objectives and performance metrics in the CIIAF as reported in Eaton et al. (2024): Financial (Figure 6), Supporting Park Operations (Figure 7), Cultural Resource values contributing to Park Purpose (Figure 8), Natural Resource values contributing to Park Purpose (Figure 9), Visitor Experience values contributing to Park Purpose (Figure 10), and Resilience to Coastal Hazards (Figure 11). All but those focused on Cultural Resources remain current.

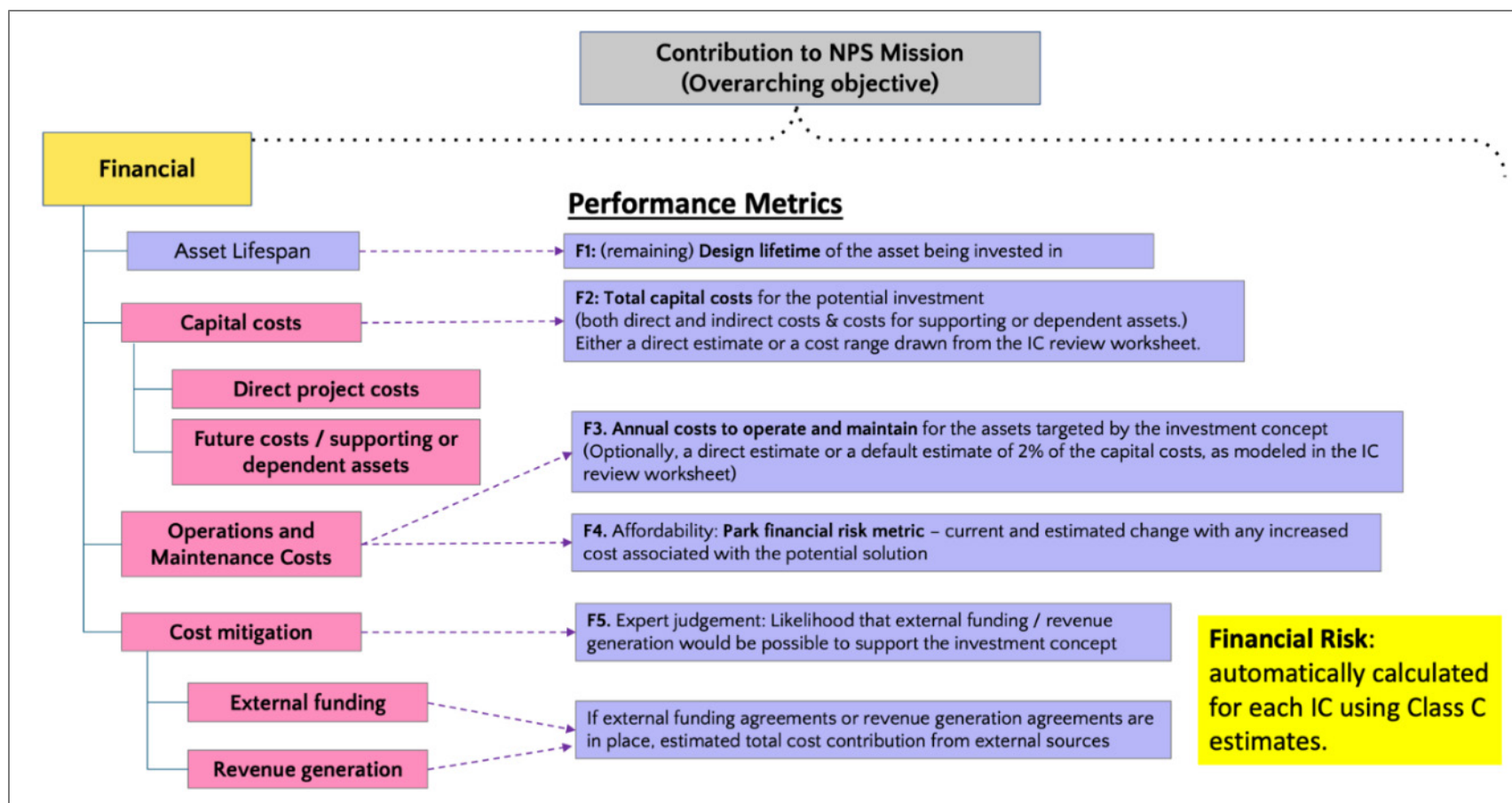


Figure 6. Means objectives (left-hand column) and performance metrics (right-hand column) under the fundamental objective of financial considerations. Figure modified from USGS 2022.

NPS / USGS

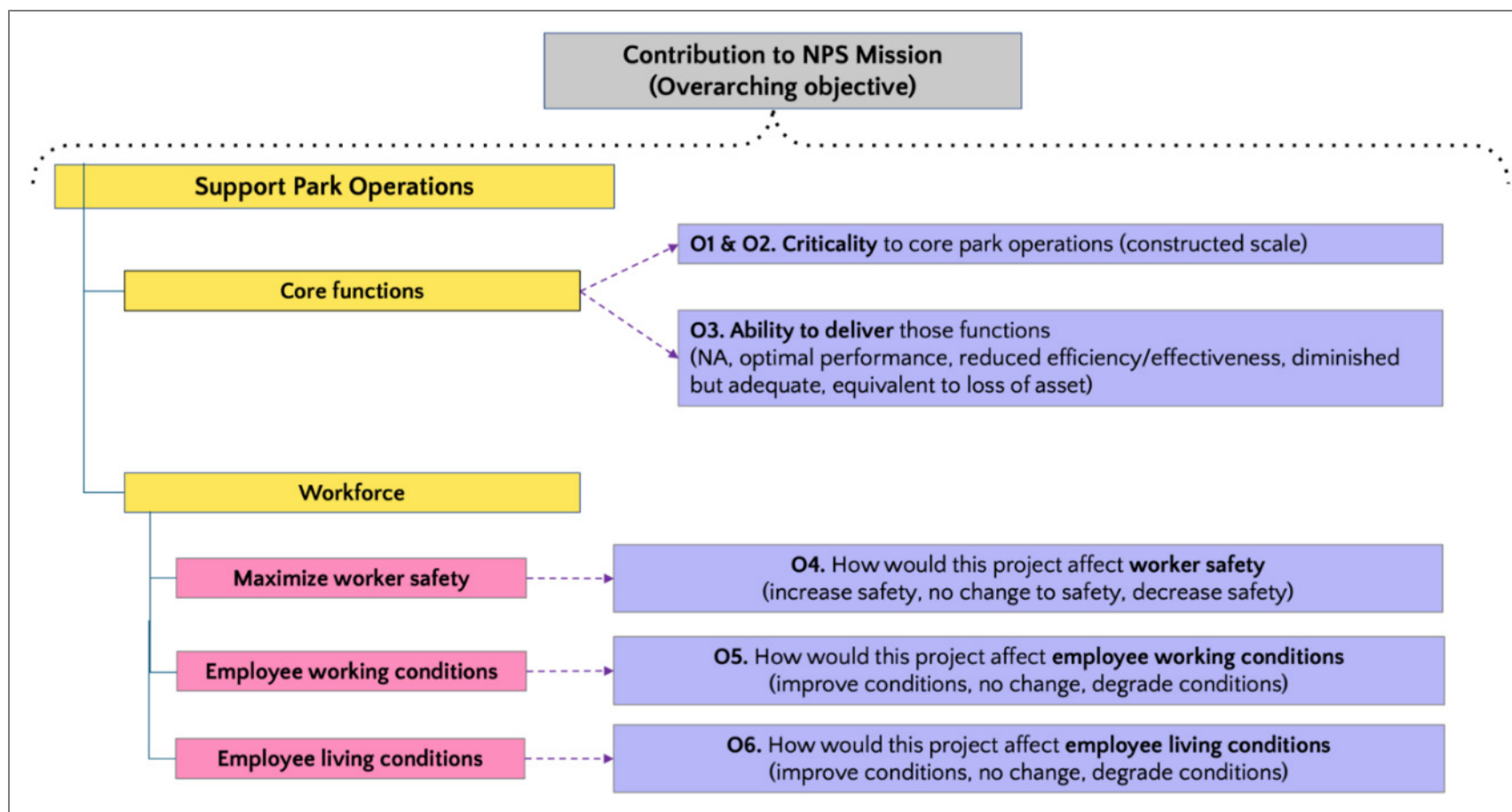


Figure 7. Means objectives (magenta boxes in left-hand column) and performance metrics (right-hand column) under the fundamental objectives of core functions and workforce (both under Supporting Park Operations). For performance metrics O3–O6, users select the most applicable option from those listed in parentheses under the metric. Figure modified from USGS 2022.

NPS / USGS

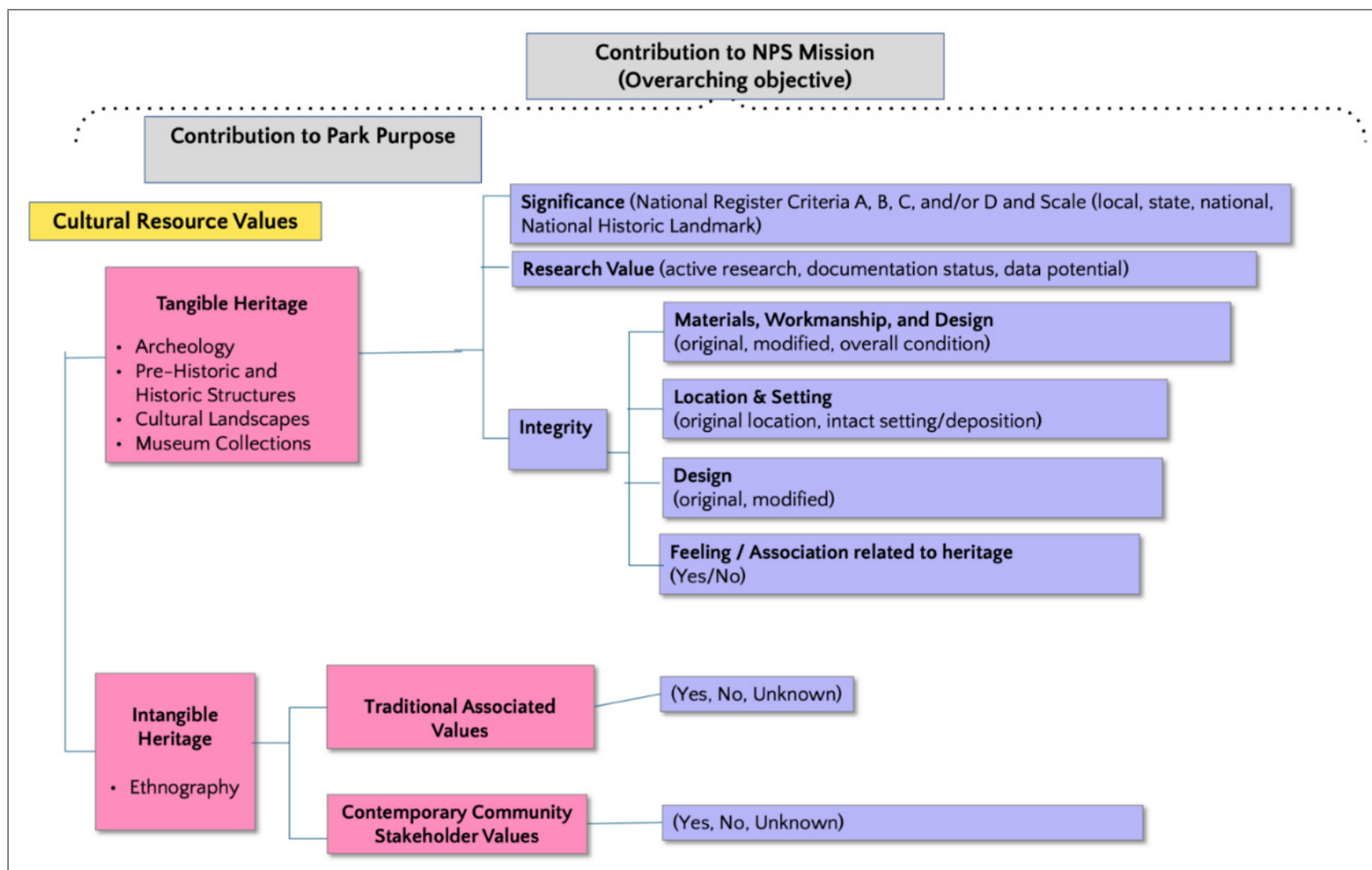


Figure 8. Means objectives (magenta boxes in left-hand column) and performance metrics (right-hand column) under the fundamental objectives of Cultural Resource Values (under *Contribution to Park Purpose*). For each performance metric, users select the most applicable option from those listed. Figure modified from USGS 2022.

NPS / USGS

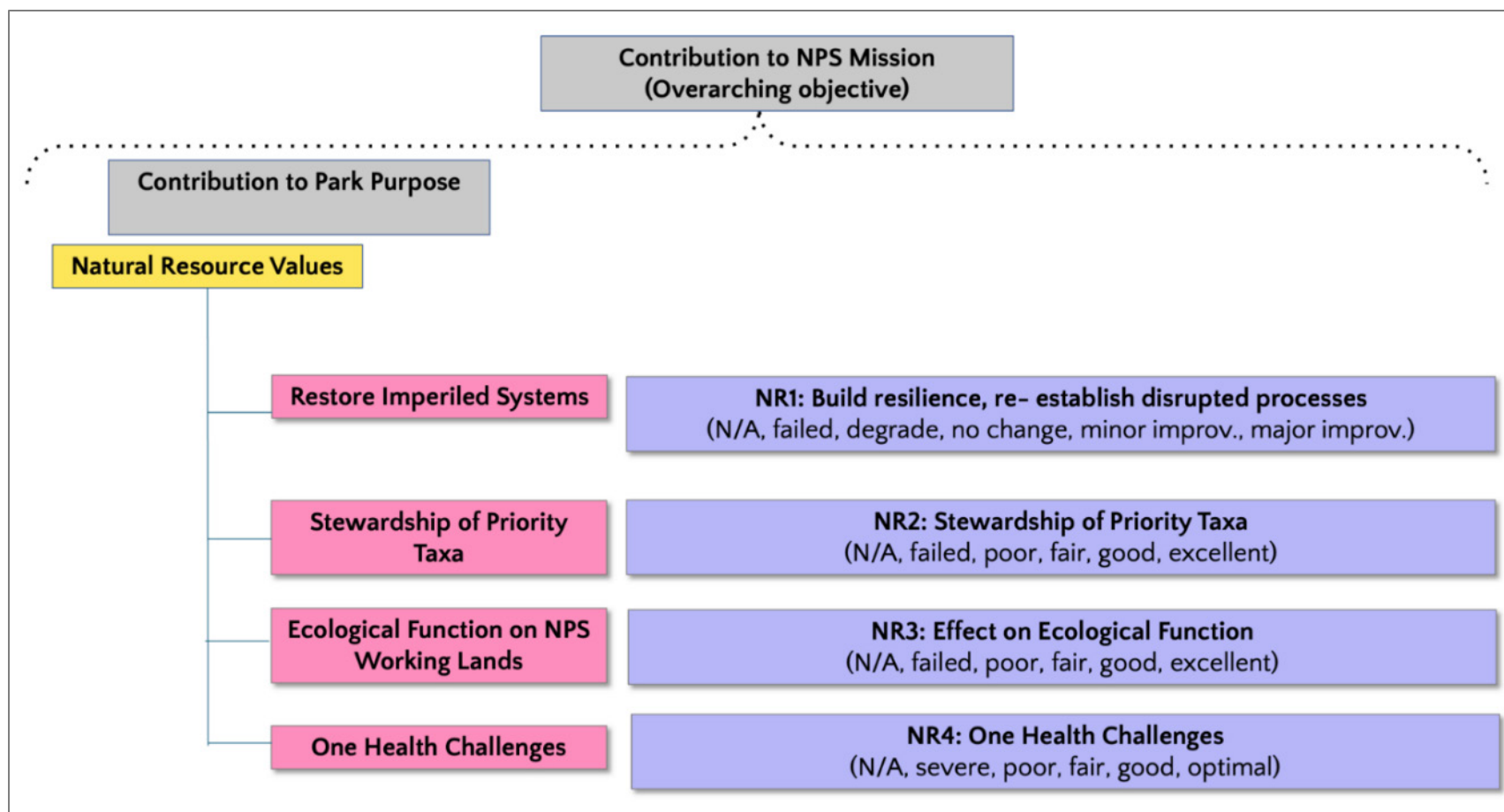


Figure 9. Means objectives (magenta boxes, left-hand column) and performance metrics (right-hand column) under the fundamental objective of Natural Resource Values (under Contribution to Park Purpose). For each performance metric, users select the most applicable option from those listed in parentheses under the metric. Figure modified from USGS 2022.

NPS / USGS

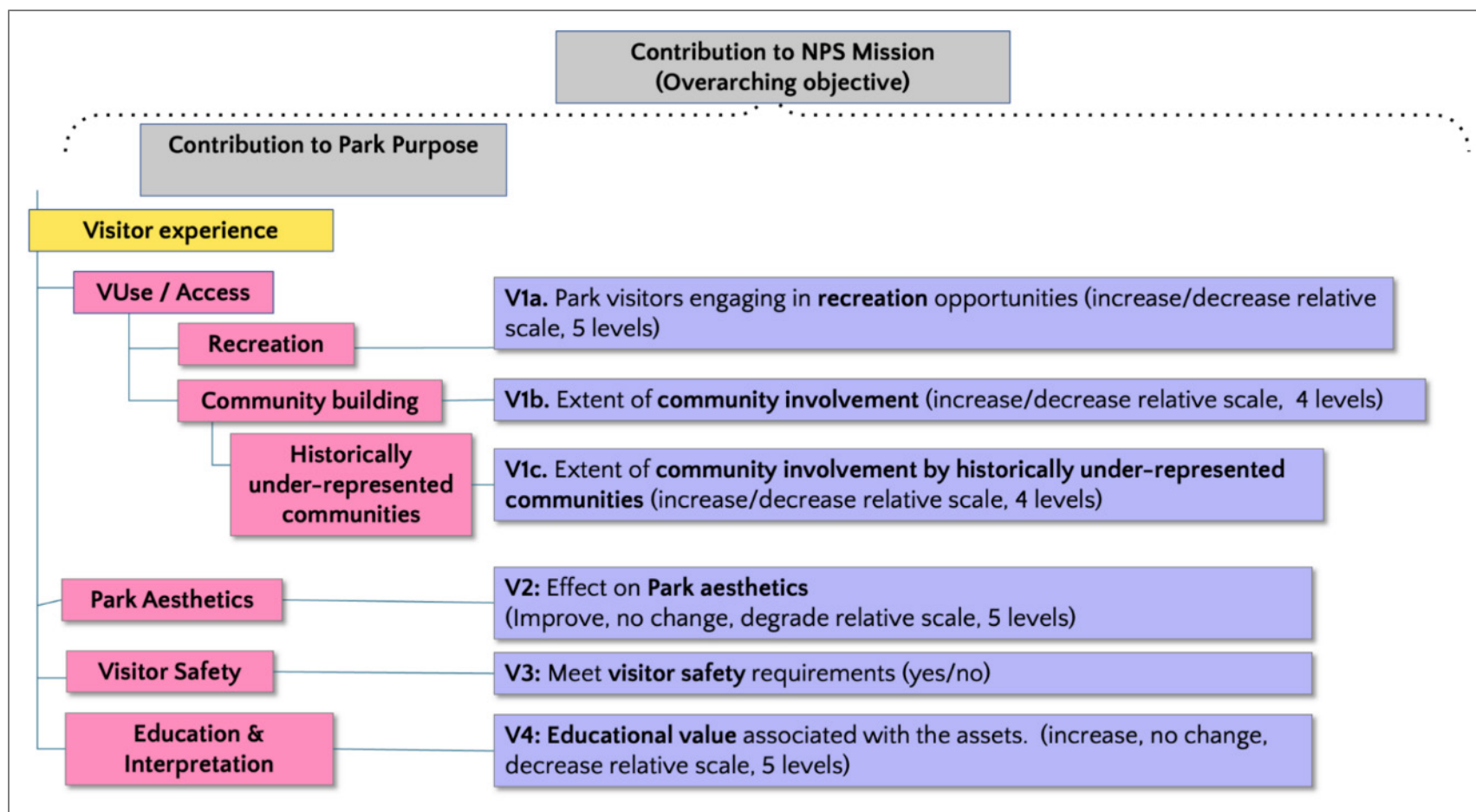


Figure 10. Means objectives (magenta boxes, left-hand column) and performance metrics (right-hand column) under the fundamental objective of Visitor Experience (under Contribution to Park Purpose). For each performance metric, users select the most applicable option from a list; the options are briefly described in parentheses under each metric. Figure modified from USGS 2022.

NPS / USGS

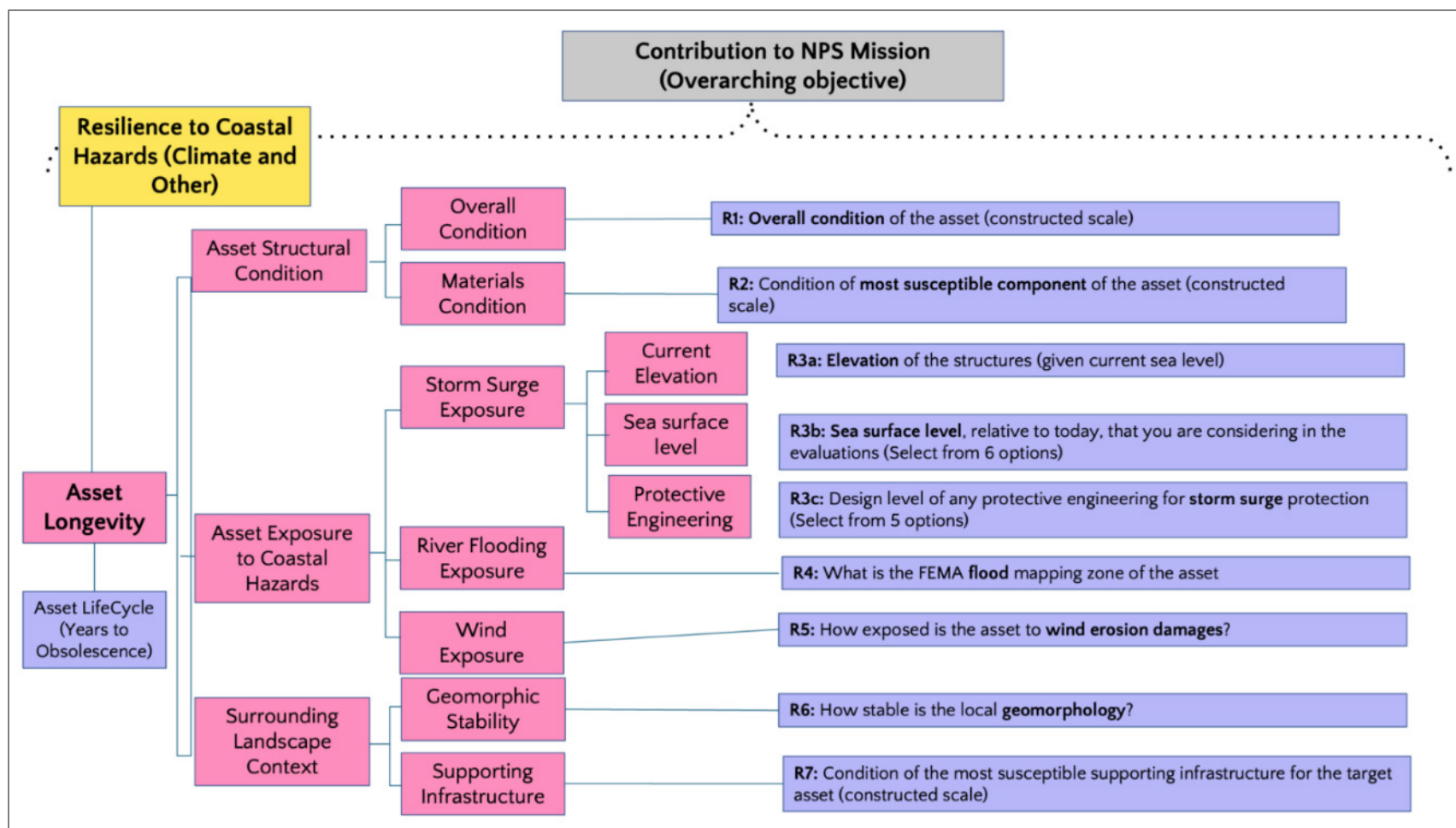


Figure 11. Means objectives (magenta boxes, left-hand columns) and performance metrics (right-hand column) under the fundamental objective of Resilience to Coastal Hazards. The performance metrics incorporate all elements of the coastal facility vulnerability protocol (Peek et al. 2022). Figure modified from USGS 2022.

NPS / USGS

Appendix 3. Desired Characteristics of Effective Objectives and Performance Metrics

The process of developing effective objectives and performance metrics can benefit from guidance on specific desirable characteristics that have been identified in the decision analysis literature (Clemen and Reilly 2014; Keeney 2007; Keeney and Gregory 2005). These characteristics are *universal*—they are relevant to the objectives and performance metrics of *any* decision analysis problem. Using these characteristics as criteria for assessing the adequacy of a set of proposed objectives and performance metrics may reveal issues and prompt improvements.

Note: the term *desirable* reflects that while a decision analysis will be more effective and, possibly, transparent and simpler, when the objectives and performance metrics have these characteristics, many decision contexts may not allow them to be achieved due to lack of development time or resources for the complexity of the underlying values; hence, they should not be termed *required characteristics*.

Desired Characteristics for Objectives

Certain characteristics are desirable in any objective for any decision problem (Table 4). Central to these are a focus on *fundamental objectives*—the things that decision-makers value either just because or due to policy or regulation—in contrast to *means objectives* that are a process or means to achieve a more fundamental end state (Keeney 2007). Means objectives often are useful in guiding development of performance metrics.

Table 4. Desired characteristics of an objective (Keeney 1992; Keeney 2007). See text for further description.

Characteristic	Example
Is a fundamental objective.	Ex: <i>Minimize loss of Integrity</i> is fundamental given the definition in the National Register process.
Can be effectively stated using a (directional) verb and a noun.	See example above.
Must be essential and controllable.	Is affected by the potential alternative actions under consideration. See text for further clarification.
Must be controllable.	Is defined narrowly enough to only be affected by the alternative actions. See text for further clarification.

Most fundamental objectives focus on tangible outcomes from the decision. However, in decisions involving multiple decision makers and/or undertaken in the context of government processes, the fundamental objectives often may include process objectives related to the manner the decision is made (e.g., such as related to engagement of key stakeholders) or strategic objectives related to long-term implications of a decision, such as ensuring learning to inform similar decisions in the future (Keeney 1992).

Fundamental objectives for a decision are often illustrated in a hierarchy that unpacks, as one moves across the hierarchy, those specific aspects of a higher-level objective that are relevant to the current decision context (e.g., the CIIAF). This decomposition can continue, clarifying and refining a fundamental objective into more-specific components (still objectives), until a level is reached where it is feasible to metric achievement of each of the *lowest level* or *most specified* objectives (by a performance metric).

A challenge in developing effective objectives is to ensure they are focused and specified narrowly enough to be able to metric achievement, yet not too narrowly. These two characteristics (*narrow enough, not too narrow*) are termed, respectively, *controllable* and *essential* (Table 4). An objective is *controllable* if the level of achievement is only influenced by the alternatives (e.g., in the current application—the ICs) under consideration in the decision analysis *and* will not or cannot be influenced by other decisions or actions separate from the choice of alternative in this decision (e.g., achievement of the objective is fully under the control of the decision). An objective is *essential* if each of the alternatives influence or impact the level of achievement of the objective. The assessment results below further discuss these concepts (Keeney 1992).

In addition to these desirable characteristics for each individual objective in the decision analysis, there are also desirable characteristics for a *set* of objectives relative to the motivating decision context (Table 5). These include ensuring all important values for the decision are represented (*completeness*) and seeking to avoid overlap among objectives.

Table 5. Desired properties of a set of fundamental objectives (Keeney 2007).

Property	Description
Complete	All important consequences of alternatives in a decision context can be adequately described in terms of the set of fundamental objectives.
Non-redundant	The fundamental objectives should not include overlapping concerns.
Concise	The number of objectives, and sub-objectives, should be the minimum appropriate for quality analysis.
Specific	Each objective should be specific enough so that consequences of concern are clear and attributes can readily be selected or defined.
Understandable	Any interested individual knows what is meant by the objectives.

Desired Characteristics for Performance Metrics

Performance metrics are intended to precisely define what is meant by an objective, to *adequately describe the consequences* of each alternative with respect to the objective (Keeney 2007). Desirable

characteristics of a performance metric (Table 6) are applicable regardless of the measurement scale of the performance metric.⁷

Table 6. Desirable properties for a performance metric (paraphrased from Keeney and Gregory 2005).

Property	Description
Unambiguous	A clear relationship exists between the actual consequences and the metric's description of the consequences.
Comprehensive	The levels of the metric cover the range of possible consequences for the corresponding objective and the value judgments (e.g., better, good, worse) implicit in the levels are reasonable.
Direct	The levels directly describe the consequences of interest.
Operational	Information to describe the consequences is available and accessible (e.g., one can apply the metric to an alternative); if appropriate to the decision context, value tradeoffs can be reasonably made among alternatives.
Understandable	Any interested individual can readily understand the consequences and, if appropriate, the value tradeoffs in any given decision.

⁷ Decision analysis, and other fields, distinguish different types of measurement scales, with the most common being Natural, Proxy, and Constructed. Natural scales directly measure the objective and are easily interpreted (e.g., measure costs in terms of US \$). Proxy scales indirectly measure the objective or only partly measure the objective (e.g., number of accidents as a measure for an objective to minimize fatalities); because they are partial or indirect, they are harder to interpret. Constructed scales are created to directly measure an objective when there is no natural scale available (e.g., V2 in Figure 11). All definitions paraphrased from Keeney and Gregory (2005).

Appendix 4. Synthesis of Assessment of Effectiveness of Version 2.0 Cultural Resources Objectives and Performance Metrics

Subject matter experts in Cultural Resources, Partnerships, and Science (CRPS) revised the cultural resources-focused objectives and performance metrics in Eaton et al. (2024) (Figure 8; Appendix 2) to better align with concepts and terminology used in NPS Cultural Resources Management Practices. That revision is termed *version 2* and presented in Figure 12. This appendix summarizes insights from using the desired characteristics summarized in Appendix 3 to assess that revision.

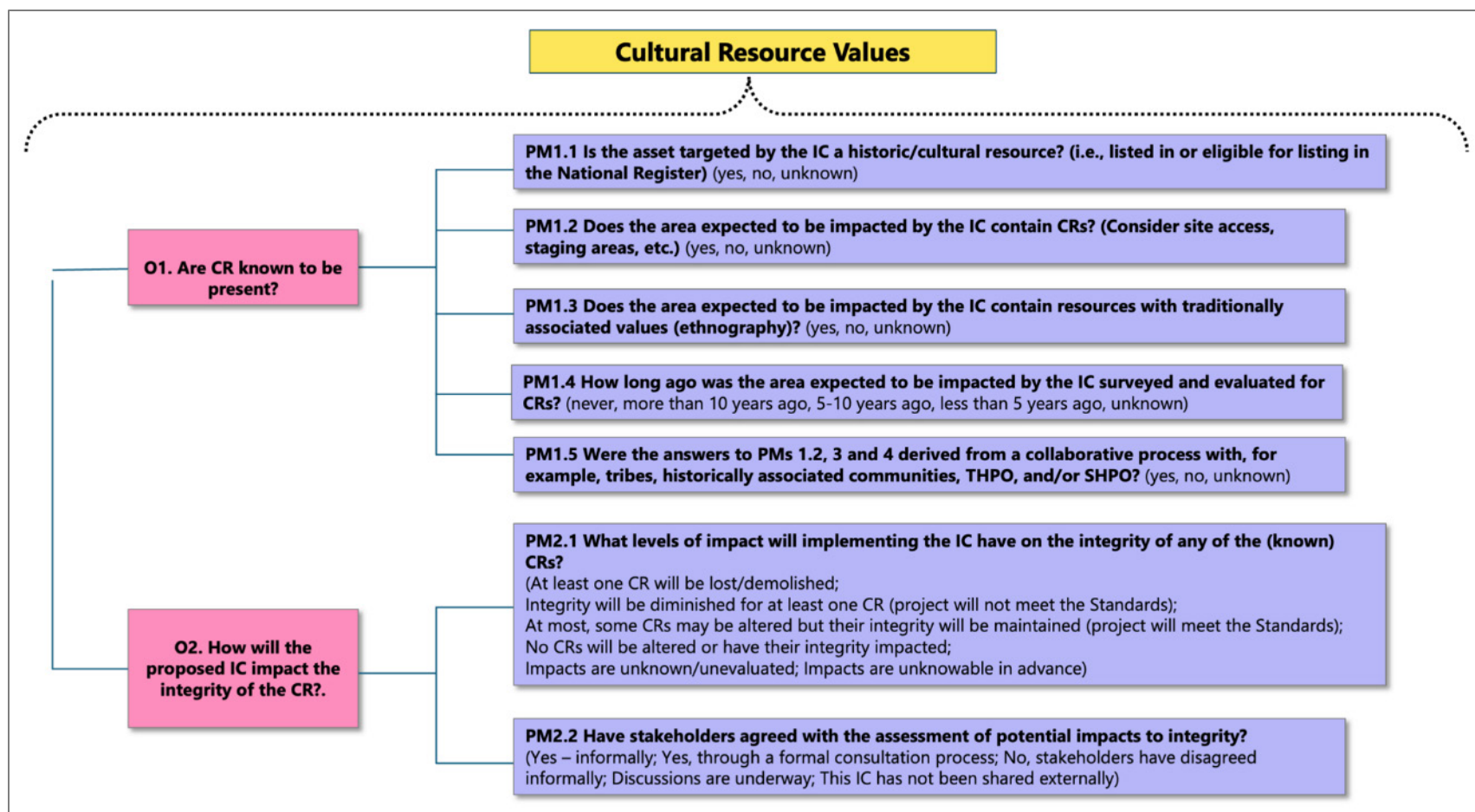


Figure 12. Cultural resource-focused objectives and performance metrics for use in CIIAF (version 2.0, August 29, 2024). For each performance metric, users select the most applicable option from those listed in parentheses. Cultural Resource subject matter experts developed this prior to deeper understanding of the ProACT framework and the desired characteristics of objectives and performance metrics. IC = Investment Concept; CR = Cultural Resource(s). PMs will be evaluated by park unit staff, so answers of “unknown” may be reviewed and modified by CR professionals (e.g., archeologists) to reflect specialized information (e.g., GIS analyses of potential for buried archeological deposits).

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Version 2.0 CR Objectives and Performance Metrics

There are two objectives and seven associated performance metrics (Figure 12). Objective 1 assesses the potential presence of known cultural resources in the area to be impacted by the IC and has five associated performance metrics. Objective 2 assesses the potential impact of the IC on the *Integrity* of each known CR and has two associated performance metrics.

Assessment Results

Objectives

Individual Features (Table 4)

Objective 1 focuses on current knowledge regarding presence of CRs and the quality of that knowledge, which are not *fundamental* values but rather *means* towards assessing Objective 2. The objective isn't *essential* since current knowledge of the presence of CRs is not affected by any IC implemented in *the future*. CONCLUSION: drop Objective 1.

Objective 2 focuses on a value, *Integrity*, that is *fundamental* to cultural resource management, given the relevant legislation, regulations, and policy. While not stated as a (directional) verb and noun, the objective can be rephrased as “Minimize loss of integrity of CRs from the IC”. The rephrased objective is *essential* (each IC may impact the integrity of CRs in the area) and *controllable* (since just focused on impact of ICs). CONCLUSION: revise Objective 2 as proposed.

Collective Features (Table 5)

Only Objective 2 remains under consideration. Its *specificity* would be improved by breaking it into an objective focused on direct impacts from implementing the IC and an objective focused on long-term impacts of the IC on the rate of degradation of integrity. The objective would be more specific and understandable if it was decomposed into sub-objectives, each focused on a distinct class of CRs, such as archeological and historic properties. Even then, a set of revised objectives developed strictly from Objective 2, does not seem complete. CRPS should consider if they have a strategic fundamental objective around learning regarding the effectiveness of the IC in reducing rate of loss of integrity relative to status quo maintenance. CONCLUSION: Ensure the next iteration of Objectives incorporates these refinements.

Performance Metrics

Given the need to revise some of the objectives, comments on PMs are limited to illustrative highlights with respect to the desirable properties of performance metrics (Table 6).

PM1.4 evaluates the quality of the information used for evaluating possible impacts of ICs. Presumably, the IC decision process will proceed using existing information unless the lack of critical information on locations of CRs is such that no evaluation of IC impact on CRs is feasible. CONCLUSION: Add an outcome to PM2.1 to specifically flag this situation rather than dedicate a separate PM to the issue.

Loss of significance of a CR can often only be understood by the people for whom the resource is significant, and thus consultations (formal or informal) may be the only source of that information.

PMs 1.5 and 2.2 are intended to record when consultation (informal or formal) with stakeholders have occurred. CONCLUSION: Combine those PMs into one and associate the resulting PM with a new sub-objective targeting maximizing knowledge of potential impacts on *Integrity*, which could be nested under a new objective suggested above on maximizing longer term learning.

PM2.1 is direct but not comprehensive as it is feasible for there to be ICs that improve condition either in an absolute sense (e.g., restoring a cultural landscape or removing non-contributing elements to a historic structure) or in a relative sense (e.g., slowing, relative to status quo, the rate of loss of integrity of an archeological site due to erosion or other factors) for some CRs.

CONCLUSION: Expand the PM's feasible outcomes to capture these positive outcomes.

PM2.1's properties with regard to being understandable and operational likely would be improved by decomposing the single PM into five, one for each class of CR—Historic Property, Archeology, Cultural Landscapes, Ethnographic Resources, Museum Collections/Objects—in the area of impact of the IC. Further, one might consider separating each CR-class specific PM into individual PMs targeting each dimension of integrity: location, design, setting, materials, workmanship, feeling and association. Clarifying guidance on the definitions of *altered* and *integrity maintained* are likely required to reduce ambiguity and improve the operation of these PMs. Unambiguity would also be improved by refining the last two achievement levels to *impacts cannot be evaluated because of lack of necessary CR inventory data* and *impacts are unknowable in advance because of aspects of the IC (such as involving a novel treatment or approach)*. CONCLUSION: Revise PM2.1 following these recommendations.

PM2.2 is direct, operational, and understandable. The PM would be comprehensive with the addition of one more feasible outcome: *not required or necessary*. CONCLUSION: Add that feasible outcome.

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