NEPA AND CONDITION-BASED MANAGEMENT IN PRACTICE:

A FRAMEWORK AND CASE STUDY OF THE SPRUCE BEETLE EPIDEMIC AND ASPEN DECLINE MANAGEMENT RESPONSE IN SOUTHWEST COLORADO

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August 2024 • CFRI-2407

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Document Development Statement

This project, initiated by CFRI staff, aims to document the collaborative planning process of the Spruce Beetle Epidemic and Aspen Decline Management Response (SBEADMR) as an example of a condition-based management (CBM) strategy. This case study is intended for planners, parties interested in national forest management activities, and policymakers considering a CBM strategy. We hope this paper offers helpful insights, an organizing framework, and a template for planners to enhance their CBM strategies. The information and conclusions presented are based on the authors' project experiences and a review of project documents

Acknowledgements

The authors would like to thank CFRI staff Tyler Beeton and Kevin Barrett for valuable feedback during draft development. We thank Angela Hollingsworth for her help creating the layout, graphics, and figures. Thanks to Jackie Edinger of CFRI for creating the document's maps. We thank members of the USFS planning teams, Ecosystem Management Coordination (EMC), and the Office of General Council (OGC) for providing valuable conversations around condition-based management; specifically, Steve Stadelman, Jamie Rosen, and Annette Fredette. Thanks to Brooke Simmons, Kelsey Newton, and the entire Collaborative Adaptive Management focal area at CFRI for feedback developing the select, validate, and evaluate framework. This project was funded by the Colorado Forest Restoration Institute through the Southwest Forest Health and Wildfire Prevention Act.

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Publication date: August 2024

Photo Credit: Vausha Snyder[1], Grand Mesa Uncompahgre and Gunnison National Forests

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Suggested Citation: Dunn, J, Brown, HLC, and Cheng, AS (2024). NEPA and Condition-Based Management in Practice: A Framework and Case Study of the Spruce Beetle Epidemic and Aspen Decline Management Response in Southwest Colorado. Colorado Forest Restoration Institute. CFRI-2407.

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EXECUTIVE SUMMARY

This paper provides a framework to explore condition-based management through National Environmental Policy Act (NEPA) compliance for the Spruce Beetle Epidemic Aspen Decline Management Response (SBEADMR) project. Condition-based management supports responsiveness and flexibility between planning and implementation in natural resource management (USDA Forest Service EMC 2023). Aimed at adapting forest management to spruce bark beetle outbreaks and aspen decline, the SBEADMR project exemplifies the dynamic nature of CBM. CBM and conventional NEPA differ in their levels of project versatility, which is determined across a spectrum throughout the NEPA process (Figure 1). Project versatility is the ability to develop options for and adapt to changing or unexpected site-specific conditions by selecting the locations, timing, and types of management activities to deploy.

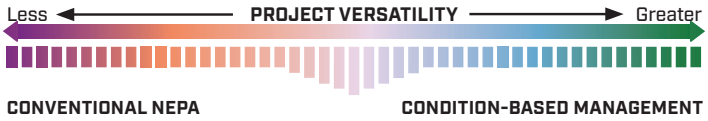


Figure 1. Project versatility spectrum. Adapted from: Condition-Based Management and NEPA Planning Infographic (Dunn et al. 2024). The colored spectum bars represent the locations, timing, and management options to assign depending on landscape conditions. Project versatility levels are adjusted throughout the NEPA process based upon the project's goals and objectives.

We use a framework that summarizes the necessary ingredients for a CBM project adapted from USDA Forest Service (USFS) to classify key components of the CBM strategy: select, validate, and evaluate. CBM selection criteria designates which conditions to address with management activities and where. For SBEADMR, the USFS along with a working group conducted a mapping exercise to segment the landscape into what they called potential treatment areas (PTAs). Validation involves gathering information to ensure that the management activity will address current site-specific conditions, and the likely impact of management activities are within the range of the environmental effects evaluated in the NEPA document. The SBEADMR NEPA validation components include the effects analysis, silvicultural prescription matrix, and project design features. Monitoring and adaptive management cycles are used to evaluate whether the activities are meeting desired goals and identify potential adjustments. SBEADMR participants use an adaptive implementation process that includes a post-treatment review to to evaluate management activities and make project adjustments.

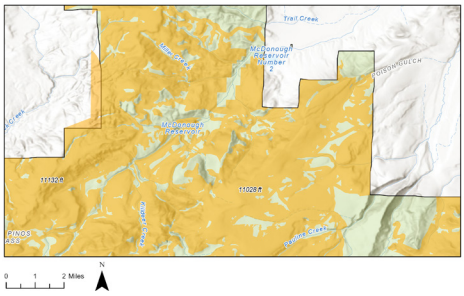
Figure 2. SBEADMR landscape on the Grand Mesa Uncompahgre and Gunnison National Forests in Southwest Colorado. Beetle-killed spruce trees are interspersed with live trees across a large area.

The SBEADMR project was well suited for CBM, because it responds to spruce beetle disturbance and sudden aspen decline—stressors that are highly uncertain in terms of its spatial and temporal variability. CBM is one strategy to address rapid change and uncertainty on landscapes, but may not be necessary for all projects. Conventional NEPA is still sufficient on landscapes where goals and objectives are discrete in place and time, management activities are short in duration, and/or site conditions have a high degree of predictability. CBM is controversial, and opponents challenge that it violates fundamental laws and procedures for NEPA compliance. CBM is not meant to circumvent the NEPA process or create less work. Instead, the CBM approach shifts some work from NEPA preparation to project implementation, and relies on a robust collaborative process to help meet the site specificity and public engagement requirements of NEPA.

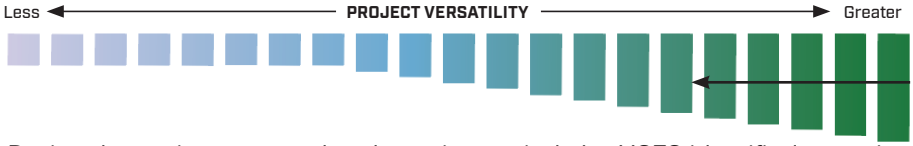
Public engagement along with input from place-based collaboratives can help shape the appropriate level of versatility for a CBM NEPA project (Huayhuaca et al 2023). Box 1 (Versatility of the SBEADMR CBM NEPA) illustrates the iterative changes to versatility for the SBEADMR project.

Box 1. Versatility of the SBEADMR CBM NEPA

Map A

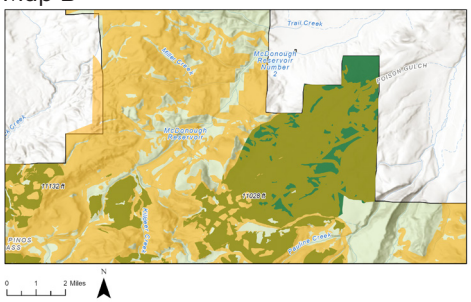


Grand Mesa, Uncompahgre, and Gunnison National Forest Boundary
Initial PTAs

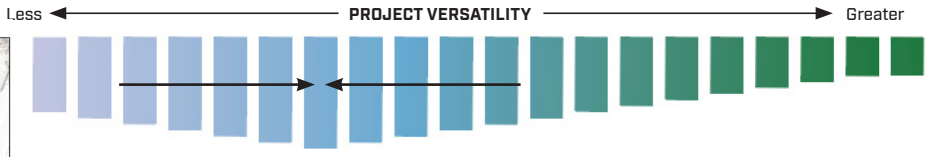


During the project proposal and scoping period, the USFS identified areas in the GMUG National Forests for potential management activities to address spruce beetle mortality. Public comments reflected concerns about the project's scale and lack of specificity on how management activities would be selected, validated, and evaluated within the project area. The USFS responded to these comments by organizing a prioritization exercise with the working group to refine the project area into priority treatment areas (PTAs). This began to reduce the project's versatility level, as demonstrated on the spectrum above. Map A shows a portion of the initial PTAs.

Map B

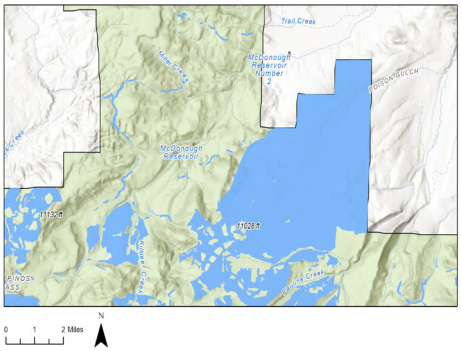


Grand Mesa, Uncompahgre, and Gunnison National Forest Boundary
Initial PTAs
Retained PTAs
Added PTAs

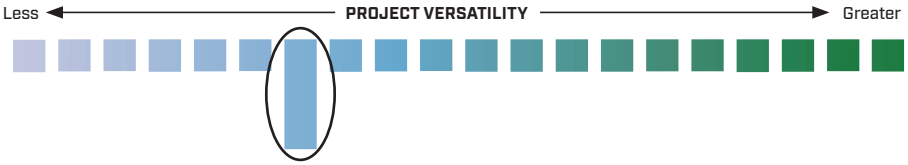


The USFS and working group hosted a mapping exercise to narrow the project's scale. The working group, public, and USFS iteratively refined and augmented site selection criteria and potential management activities. In addition to refining PTAs (Map B), the USFS also addressed comments and updated validation and evaluation procedures. The arrows on the spectrum illustrate that the USFS is honing in on the appropriate level of project versatility.

Map C



Grand Mesa, Uncompahgre, and Gunnison National Forest Boundary
Final PTAs



The signed SBEADMR decision finalized the potential locations and types of management activities to deploywithin an 8-12 year timeline (Map C). The decision included commitment to the selection, validation, and collaboratively developed evaluation criteria, along with sustained public engagement. The map shows the final PTAs, and the spectrum demonstrates a finalized level of project versatility.

Adapted from: Condition-Based Management and NEPA Planning Infographic (Dunn et al. 2024).

1. INTRODUCTION

Forested landscapes of Western North America face increasing vulnerability to rapid and extensive ecosystem changes due to the absence of fire, past forest management (or lack thereof), and a warming climate (Prichard et al. 2021). The increased frequency, extent, and severity of forest disturbances such as wildfires and insect outbreaks, coupled with changing climatic conditions' effects on post-disturbance recovery, have raised concerns about the resilience of national forest lands managed by the USDA Forest Service (USFS), and the capacity of current planning approaches to address disturbance. The conventional USFS approach to planning and implementing forest management activities such as tree cutting and prescribed burning has relied on assumptions of predictably stable forest conditions at small geographic scales (e.g., stand-by-stand compartments in a 6th-level watershed, up to 15,000 acres) and on limited timeframes (approx. 1–3-year implementation window). Environmental impact analyses required under the National Environmental Policy Act (NEPA) are also based on similar assumptions. Such approaches potentially limit the ability of USFS managers to proactively address rapidly changing forest conditions.

To overcome these limitations, the USFS has increasingly been utilizing condition-based management (CBM). CBM differs from conventional NEPA, and supports responsiveness and flexibility between planning and implementation in natural resource management (USDA Forest Service EMC 2023, Box 2). This paper explores the concept of CBM within the context of NEPA and its application by the USFS in addressing increasing frequency and severity of forest disturbances. We take a case study approach focused on the Spruce Beetle Epidemic Aspen Decline Management Response (SBEADMR) project, a large-scale CBM project in southwest Colorado intended to adapt forest management locations and activities to evolving spruce bark beetle outbreaks and aspen decline on approximately 120,000 acres of the Grand Mesa, Uncompahgre, and Gunnison (GMUG) National Forest.[1] The SBEADMR Final Record of Decision (ROD) was released in July 2016 and implementation ramped up in federal fiscal year (FY) 2017. The project is scheduled for completion after FY 2025.

1. Note: the project was never specifically called "condition-based management" and the term does not appear in any SBEADMR documents.

Box 2. CBM Builds in Greater Project Versatility

Both conventional NEPA and condition-based management (CBM) support landscape-level planning, but are characterized by **different levels of project versatility: the ability to develop options for, and adapt to changing or unexpected site-specific conditions by selecting the locations, timing, and types of management activities to deploy.** The level of versatility for both a conventional NEPA project and a CBM project can be envisioned along a spectrum (below). The NEPA Record of Decision (ROD) finalizes the project's versatility level and provides the decision-making structure for implementation.

CONVENTIONAL NEPA **CONDITION-BASED MANAGEMENT**

Project versatility spectrum adapted from: Condition-Based Management and NEPA Planning Infographic (Dunn et al. 2024). The colored spectum bars represent the locations, timing, and management options to assign depending on landscape conditions. Project versatility levels are adjusted throughout the NEPA process based upon the project's goals and objectives.

NEPA with less versatility

- Locations, timing, and types of forest management activities are prescribed during the planning process and prior to the project decision.
- The proposed action identifies specific management activities that take place on pre-designated sites.

CBM NEPA with greater versatility

- A framework is developed for assigning forest management activities to conditions, ideally in collaboration with individuals and entities interested in and affected by the project.
- Locations, timing, and types of forest management activities are choosen from a menu of possible activities based on site conditions.
- The proposed action includes procedures to determine the type and location of management activities under given conditions. Actual conditions require validation before implementation.

This exploration is not meant to endorse CBM or the SBEADMR project. Instead, it describes how CBM was conceptualized in the SBEADMR Final Environmental Impact Statement (FEIS) and ROD. It further explores how CBM was operationalized and evolved during the implementation of SBEADMR projects for the purposes of learning and adaptation. This case study is relevant for planners, parties interested in and affected by national forest management activities, and policymakers considering the CBM strategy.

Consider:

- How could a CBM approach assist in selecting sites, validating site conditions prior to implementation, and evaluating outcomes of management activities (Box 3)?
- How might the CBM approach employed in the SBEADMR project be desirable and/or feasible for planning on your landscapes?
- What roles, capacities, and commitments would be necessary for CBM to be utilized on your landscapes?
- What is missing from the CBM approach taken in the SBEADMR project that would be necessary for CBM to work on your landscapes?

1a. CONDITION-BASED MANAGEMENT: A USFS APPROACH

NEPA mandates that planners from federal land management agencies use existing data and information to predict a comprehensive range of environmental effects for a proposed action and potential alternatives; the details of the proposed actions and their anticipated impact on the environment must be disclosed to the public. In a CBM approach, the proposed action is the menu of potential management activities available to choose from within the project boundary, given possible environmental impacts.

Box 3. The CBM approach is used to select, validate, and evaluate management activities*

USFS Ecosystem Management Coordination Guidance:

"At the onset of project planning, known or expected environmental conditions are examined as well as a range of possible management activities. This is done by using mid-scale and site-specific data of current conditions to propose a variety of appropriate treatments to meet the purpose and need and move toward desired conditions. **This framework of expected environmental conditions, possible management activities, and likely outcomes are what is disclosed and assessed throughout the NEPA environmental analysis process. Then, once a NEPA decision is made but prior to implementation, current site conditions are confirmed where implementation is to occur. The appropriate management activities are assigned for the site conditions at that time according to the selection criteria and range of management activities in the NEPA analysis and decision. If adjustments are needed to what was proposed, these are made within the constraints of the identified and analyzed range of possible management activities and design features**."
(emphasis added, USDA Forest Service EMC 2023)

Managers and their collaborative partners define, assess, and ultimately sign on to: a framework for **site selection**, criteria for **validating conditions** on the ground for proposed management activities, and **evaluating the outcomes** of those activities.

SELECT	Consult NEPA document for selection criteria to determine which conditions to address with management activities and where.
VALIDATE	Gather information to ensure conditions and likely impacts of management activity are within the range of environmental effects evaluated in the NEPA document.
EVALUATE	Monitoring and adaptive management cycles evaluate whether activities are meeting desired goals and identify potential adjustments.

Table 1: Defining three components of condition-based management. Adapted from: Condition-Based Management and NEPA Planning Infographic (Dunn et al. 2024).

*bold, colored text is used in Box 3 to indicate how each element of the select, validate, evaluate framework presented here relates to USFS Ecosystem Management Coordination guidance on CBM.

The underlying assumption of this requirement is that the environment itself is stable and change is predictable – an assumption grounded in the scientific thought at the time NEPA was enacted (late-1960s) that ecosystems tended towards predictable stable-state equilibria (Glickman and Page 2022). While the dynamic nature of ecosystems is now conventional wisdom, the up-front predictive requirements imposed by NEPA remains a *perceived* barrier to federal land managers taking more flexible, adaptive approaches in response to changes in environmental conditions.

Changing forest disturbance regimes and increased disturbance impacts have prompted USFS managers to devise alternatives to the conventional planning approach by proposing a range of forest management actions that anticipate changing conditions at large geographic scales over longer timeframes.

According to the USFS:

> "Condition-based management (CBM) allows managers to make landscape-level decisions while reserving flexibility to respond to on-the-ground conditions and confirm the right treatment is prescribed and conducted at the right time. This is important because project surveys and implementation planning can take years to complete (especially for landscape-scale projects), and conditions may have changed by the time the agency is ready to implement activities on any particular part of the project area" (USDA Forest Service EMC 2022).

1b. BACKGROUND AND CONTROVERSY

The origins of CBM have been a subject of debate. It has often been linked with the concept of ecosystem management, which advocates for forest management strategies to align with ecological processes, such as fire, at appropriate spatial scales (Robbins 2012). Land managers also recognize that the environment is dynamic; predicting actions and environmental consequences for a specific geographic area limits rapid response when conditions change significantly within a short period of time (e.g. insect or disease outbreak). CBM was initially used by federal agencies for noxious weed treatment and rangeland management to enhance manager flexibility to adjust management actions based on on-the-ground conditions. More recently, projects that have utilized a CBM approach occur on larger landscapes (50,000 to 1 million acres) and/or in geographies more prone to large-scale environmental disturbance such as fire, insects, or disease outbreaks.

CBM differs from conventional NEPA compliance in the way expected environmental conditions, possible management activities, and likely impacts are assessed and disclosed. Conventional NEPA compliance focuses on detailed proposed actions on specified sites. In a conventional NEPA analysis, resource surveys and specialists' reports are completed during the planning phase to document potential impacts to resources. When a USFS proposed action relies on a CBM strategy, the USFS claims compliance with NEPA requirements by identifying potential geographic locations of proposed activities while also providing sufficient flexibility to alter course after the NEPA decision. The proposed action for a CBM project is a range of potential management activities that will be applied depending on a range of possible conditions within the planning area. Potential impacts on resources are estimated by analyzing the effects of the range of activities on the range of generalized conditions. For example, the decision would disclose the general environmental effects of mechanical thinning in a spruce-fir stand, without identifying the specific location of the activity. CBM hinges on managers retaining the ability to respond as conditions change post-NEPA decision based on updated pre-implementation assessments of on-the-ground ecological resource conditions. In short, site-specific resource surveys or other information gathering are conducted after the NEPA decision, but prior to implementation.

CBM is controversial for both USFS personnel and among many entities interested in and affected by national forest management decisions and actions. The CBM strategy changes the way the USFS assesses environmental impacts per NEPA requirements (USDA Forest Service 36 CFR Part 220 Proposed Rule, Federal Register vol. 84, no. 114, pp. 27544-27559). As such, major concerns with adopting a CBM approach are that proposed actions would not be restricted to specific sites, and environmental impact analyses could be insufficient. Agency managers might then have too much discretion to carry out activities that would have detrimental environmental impacts without having to analyze and disclose them, thereby violating NEPA and possibly other environmental laws and regulations.

Because resource assessments and final determination of site-specific activities occur post-decision, the CBM site validation workflow is not subject to the appeals and objections process. This is a chief controversy with the CBM strategy. Brown et al. (2022) argue that CBM does not meet the NEPA requirements of disclosing site-specific consequences of an action during the NEPA process, and fails to allow for public comment to: 1. identify issues the agency may have overlooked; 2. encourage agencies to adopt different mitigation measures or alternatives; and 3. hold agencies accountable when they ignore public comments or contrary scientific evidence. The legal

landscape surrounding CBM remains dynamic, with conflicting verdicts from federal courts adding complexity to its implementation. In the court case, Southeast Alaska Conservation Council v US Forest Service (413 F. Supp. 3d 973 (D. Alaska 2019)), the Alaska federal district court ruled against the USFS for the lack of site-specificity and accountability in the CBM-based "Prince of Wales Landscape Level Analysis Project" for the Tongass National Forest. However, federal courts have upheld other USFS CBM projects.[2] Even as the legal thresholds of the CBM framework are worked out in federal courts, CBM projects continue to be enacted by the USFS. The SBEADMR project on the GMUG National Forest is one such example.

2. SBEADMR Case Study

The SBEADMR FEIS includes a compendium of appendices that outline an adaptive implementation process that specifies when public engagement will take place before on-the-ground work commences. The ROD commits the GMUG National Forest to adhere to this process. The conception of the SBEADMR project drew upon previous projects that utilized continuous collaborative engagement with interested parties from project inception through implementation, most notably the Uncompahgre Plateau Collaborative Forest Landscape Restoration Project (UP-CFLRP).

2a. SBEADMR DESCRIPTION AND NEPA DEVELOPMENT TIMELINE[3]

Since the early-2000s, the spruce beetle (*Dendroctonus rufipennis*) has caused significant mortality in Engelmann spruce (*Picea engelmannii*) forests across the southern Rocky Mountains (Mattson et. al 2019). To address this forest disturbance, as well as sudden aspen decline (SAD) afflicting the area's quaking aspen (*Populus tremuloides*), the GMUG proposed a CBM strategy to conduct silvicultural

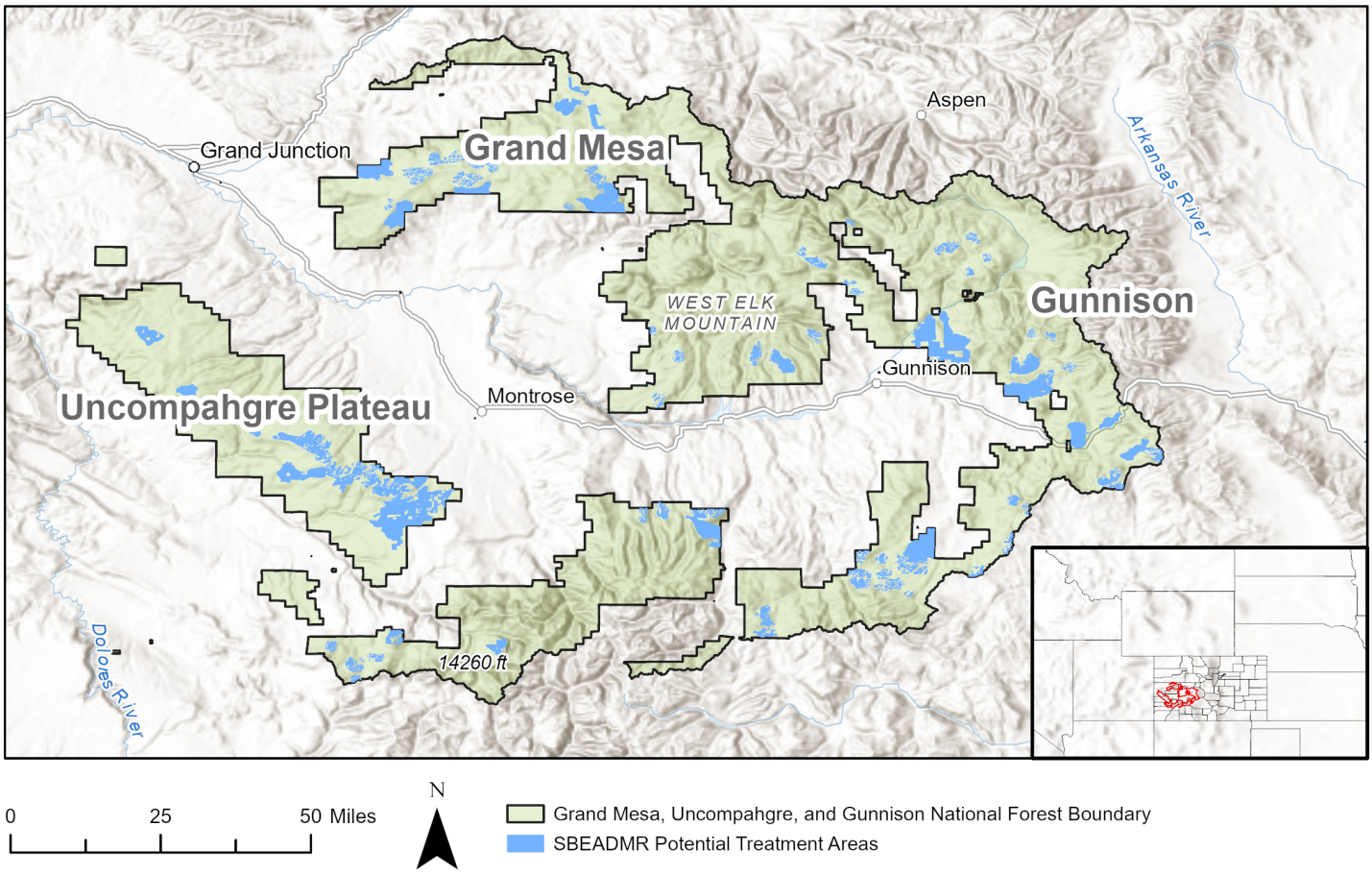


Figure 3. Spruce Beetle Aspen Decline Management Response (SBEADMR) Project Map

[2] See: ERIC NAVICKAS, et al., Plaintiffs, v. SCOTT CONROY, et al., Defendants. No. 1:10-cv-3004-CL (D. Or. Feb. 25, 2013) In the Ashland Forest Resiliency Project defendants claimed a NEPA violation, alleging non-compliance with soil erosion requirements. The court sided with the USFS, citing the ROD's allowance for minor implementation changes to better meet management objectives amid uncertainties, including mitigation efforts to prevent soil erosion.); WildEarth Guardians v. Conner, No. 17-1334 (10th Cir. 2019 In the Tennessee Creek Project environmental assessment, Wild Earth Guardians appealed the decision, asserting the need for additional Canadian lynx analysis and the USFS's failure to prepare an EIS. The courts sided with the USFS, concluding the worst-case lynx impact scenario in the analysis was sufficient.); NORTH CASCADES CONSERVATION COUNCIL, Plaintiff, v. UNITED STATES FOREST SERVICE 2:22-CV-00293-SAB (E.D. Wash. Jan. 17, 2024) Courts ruled The Twisp Restoration Project's CBM strategy satisfied the hard look standard by providing a reasonably thorough discussion of environmental consequences and an adequate level of detail for the proposed action.

[3] The description and timeline provided for SBEADMR in this context have been derived from project meeting notes and narratives from the SBEADMR NEPA documents. These are available at: https://cfri.colostate.edu/projects/sbeadmr/

treatments on up to 120,000 acres of spruce forest over an 8–12-year timeframe (Figure 3). Specifically:

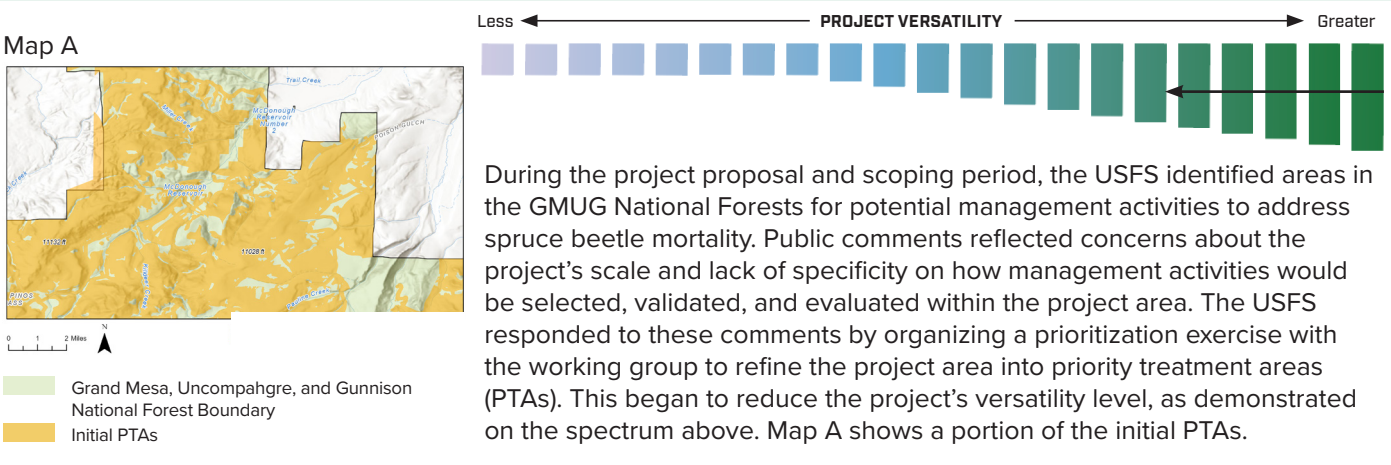
> "The purpose of the project is to reduce the safety threats of falling, dead trees and of managing wildfires on the landscape (safety); improve the resiliency of stands at-risk of insect and disease (resiliency); and to treat affected stands via recovery of salvageable timber and subsequent re-establishment of desired forest conditions (recovery)" (USDA Forest Service, 2016).

The USFS initiated the SBEADMR project in July 2013 and provided information to community groups, news media, and local boards of county commissioners about the spruce beetle activity in the forest. The USFS posted legal notices in local media outlets to solicit project comments and mailed scoping letters to interested parties. In these scoping notices, the USFS introduced a versatile management approach due to the uncertain nature of spruce beetle disturbance in the project area (Figure 4). This approach was justified on the grounds that future management activities needed to adapt to changing forest conditions over a longer period of time. The proposal was open for suggestions, and it would continuously evolve based on iterative feedback received throughout the NEPA process.

Early in the scoping phase, it became evident that community members and groups wanted the USFS to provide more opportunities for collaboration with the public and other outside interests. The USFS sought advice and assistance from the Public Lands Partnership (PLP). The PLP was formed in 1992 to address public land issues in west central Colorado through collaborative learning and dialogue processes (USDA Forest Service 2016). The PLP offered to facilitate collaborative learning meetings to help foster clearer understandings about the ecological changes occurring, and the new-at-the-time CBM strategy being proposed by the USFS. The USFS gathered common concerns from these meetings and developed a project questions-and-answers document published in July 2014. In August 2014, a science symposium was held in Montrose, Colorado, to discuss the science related to the environmental impact analysis. In September 2014, the USFS hosted a public field trip to discuss the management activities proposed in the project area and to visit affected timber stands.

By Fall 2014, sufficient momentum had built up among participants to continue this collaborative engagement throughout the NEPA planning process, not just during the scoping phase. In October 2014, The PLP helped assemble a working group composed of local and regional public and private organizations, including forest land managers, county commissioners, forestry processors and loggers, conservationists, water providers, recreation representatives, wildlife and fish experts, and academics; as well at-large members of the general public (USDA Forest Service 2020).

Working group meetings overlapped with both the preparation and finalization of the SBEADMR EIS. The PLP convened and facilitated the working group meetings and the USFS presented information on different project topics identified by the group. These topics included the project's purpose and need statement, goals and objectives of the proposed action, and the adaptive process for project implementation. The working group also created an internal science team composed of researchers from the Colorado Parks and Wildlife, Colorado State University (CSU), and the USDA Forest Service Rocky Mountain Research Station. The science team had expertise in forest ecology, silviculture, wildlife biology, and collaborative governance. The working group formalized ground rules and a voting system for making suggestions to improve the SBEADMR NEPA document.



During the project proposal and scoping period, the USFS identified areas in the GMUG National Forests for potential management activities to address spruce beetle mortality. Public comments reflected concerns about the project's scale and lack of specificity on how management activities would be selected, validated, and evaluated within the project area. The USFS responded to these comments by organizing a prioritization exercise with the working group to refine the project area into priority treatment areas (PTAs). This began to reduce the project's versatility level, as demonstrated on the spectrum above. Map A shows a portion of the initial PTAs.

Figure 4. Scoping and project versatility.

This working group continued to meet until September 2016, when it transitioned to the Adaptive Management Group (AMG). The purpose of the SBEADMR AMG is to assist the GMUG in applying the adaptive management process over a multi-year timeframe in accordance with the FEIS and ROD (SBEADMR AMG Operations Manual accessed at: https://cfri.colostate.edu/wp-content/uploads/sites/22/2024/05/SBEADMROperations-Manual.pdf. January 2024). The GMUG Forest Supervisor signed the ROD for the FEIS in July 2016. Implementation of the first treatments under the SBEADMR ROD commenced in 2016 (FY 2017). The collaborative implementation process began in early 2017 with further refinement of the structure, process, and expected outcomes of the AMG. The first SBEADMR Annual Stakeholder Meeting took place in January 2017, and is still convened yearly.

2b. SBEADMR EIS CBM COMPONENTS

This section describes how CBM components were conceptualized in the SBEADMR EIS (Table 2; refer to Box 3 for more information about the select, validate, and evaluate framework of a CBM approach). The SBEADMR EIS's CBM components were developed and refined through an iterative process over a period of about two-and-a-half years that involved a range of interested and affected individuals and entities.

SELECT	Prioritizing treatment areas.
VALIDATE	Effects analysis, silvicultural prescription matrix, and design features.
EVALUATE	Adaptive implementation and post-treatment review

Table 2: Select, validate, and evaluate framework in the SBEADMR EIS.

SELECT: PRIORITIZING TREATMENT AREAS

The selection criteria for a CBM project defines why and how land managers segment the landscape by potential condition. Further site-specific validation takes place through resource surveys or other information gathering prior to implementation. The selection criteria can be supported by a wide variety of geographic information systems (GIS)-based decision support tools such as quantitative wildfire risk assessments (QWRAs), potential operational delineations (PODs), or other spatial data products.

As the SBEADMR EIS developed, the working group identified a crucial need for the USFS to establish more precise selection criteria, marking a shift towards a less versatile approach (Box 4). The working group and the USFS engaged in a process to focus and prioritize potential management activities within the original broader SBEADMR proposal area that aligned with the project's overarching objectives to reduce threats to safety (falling trees), improve the resiliency of trees to insects and disease, and to recover salvageable timber. The group called them Priority Treatment Areas (PTAs). To facilitate the delineation of these PTAs, the working group enlisted the expertise of the SBEADMR Science Team to work alongside GMUG staff to map initial PTAs.

The initial designation and refinement of PTAs occurred through an iterative process of overlaying GIS data layers to include existing roads and geographic areas deemed suitable for forest management, and exclude areas based on land designations (i.e., Wilderness Areas), steep slopes, sensitive ecological features, habitat for sensitive species, etc. Additional coarse-scale attributes discussed at the broader landscape scale included public safety considerations, the extent of harvestable acres, and overarching vegetation characteristics. The group also explored fine-scale attributes at the implementation level such as stand age, species composition, and levels of mortality within vegetation. These iterative discussions resulted in acreage adjustments to the project's PTAs (Table 3). The finalized PTAs help guide out year planning and are used in the public comment process for project implementation.

VALIDATE: EFFECTS ANALYSIS, SILVICULTURAL PRESCRIPTION MATRIX, AND DESIGN FEATURES

EFFECTS ANALYSIS

The effects analysis for a CBM project uses available information to predict the likely impact of potential management options on the range of potential conditions. The location and activity are validated with updated site-specific information prior to implementing the management activity to ensure it will address current site conditions. For a CBM NEPA, the analysis of environmental effects requires an examination of both the existing conditions within the overall project landscape and the potential impacts resulting from addressing those conditions with management activities (USDA Forest Service EMC 2023). For SBEADMR, the effects analysis

Type of Treatment	Initial Proposed Acreage	Acreage Range Change	Final Acreage
Commercial	164,000-278,000	46,000-113,000	60,000
Non-commercial	101,000-132,000	65,000-77,000	60,000

Table 3. This table represents the iterative nature of the spatial extent of a CBM project, and how collaborative input can change the acreage authorized for potential management activities.

assumed that all acres within the identified PTAs would be treated – a maximum estimated impact approach to effects analysis. The logic was that the maximum number of acres in PTAs were unlikely to be treated; therefore, the actual treated acres would have lesser environmental impact than the maximum impact analyzed.[4]

SILVICULTURAL PRESCRIPTION MATRIX

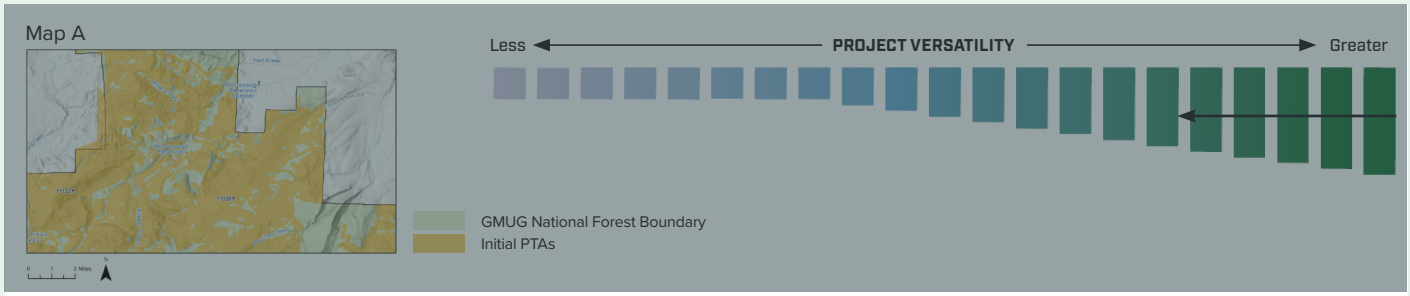
During the selection and/or validation process (depending on how the NEPA practitioner designs the CBM strategy) the management activity is selected and finalized. Management activities for SBEADMR are selected using a silvicultural prescription matrix (SPM), which was developed with input from the working group and the public. Public comments prompted changes to prescriptions for salvage logging operations in spruce-fir forests between the draft and final EIS (USDA Forest Service 2016). The SPM presented in the EIS uses Oliver and Larsen's (1996) stages of stand development following major disturbances (for details see SBEADMR EIS Appendix A). The SPM limits management options for treatments (i.e., management activities) during project implementation, and assigns treatments for different landscape conditions to accomplish SBEADMR's purpose and need.

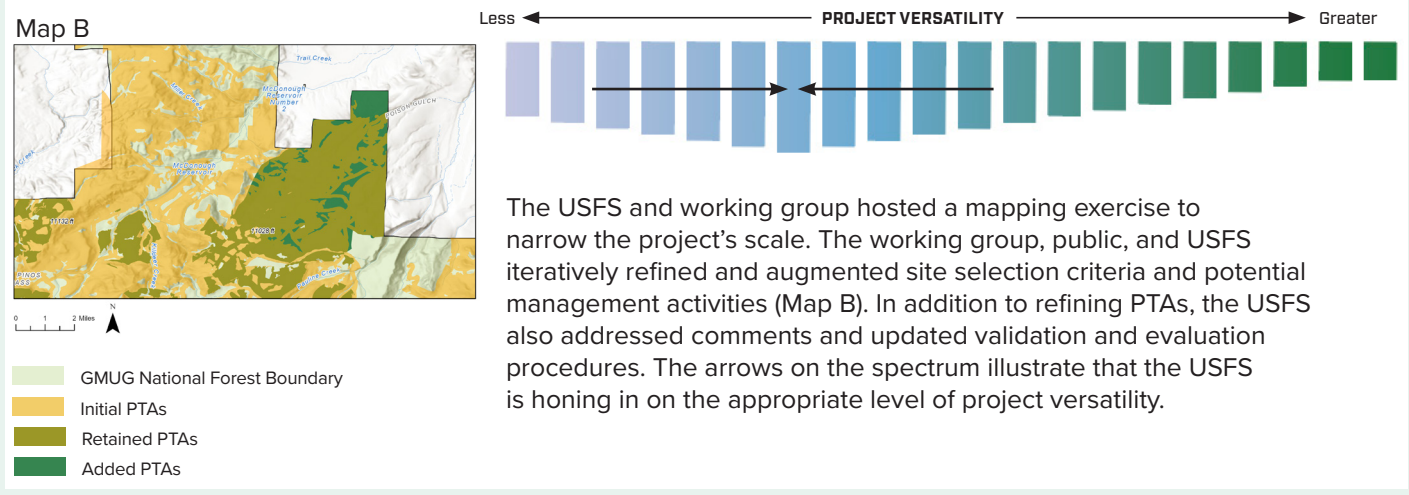
[4]The USFS issued guidance in 2023 suggesting: "Don't analyze the worst-case scenario, but the "expected," "anticipated," or "most likely" scenario or alternative" (EMC 2023).

Box 4. Moving along the versatility spectrum during planning

As the USFS and collaborative participants developed the SBEADMR EIS, a primary objective was to design a decision-support tool for identifying Priority Treatment Areas (PTAs). To identify PTAs, the group needed to balance tradeoffs for multiple interests and concerns, and in doing so they moved the project along the versatility spectrum (see Map B).

With the help of the working group, the USFS conducted a GIS-based mapping exercise to identify the PTAs. During this exercise, participants discussed tradeoffs for meeting project objectives. For example, the group discussed the high cost of complex tree removal required to meet the project's objective of reducing risk in the wildland-urban interface (WUI), and timber industry representatives explained that harvesting only in the WUI would be insufficient to offset high operational costs. Timber industry representatives explained that areas with less complexity needed to be prioritized as well to make the project economically viable and support local industry. This discussion illustrates the importance of having the USFS and interested parties collaborate as a means to developing shared priorities and creating mutual understandings of the level of versatility required for successful project implementation.





The USFS and working group hosted a mapping exercise to narrow the project's scale. The working group, public, and USFS iteratively refined and augmented site selection criteria and potential management activities (Map B). In addition to refining PTAs, the USFS also addressed comments and updated validation and evaluation procedures. The arrows on the spectrum illustrate that the USFS is honing in on the appropriate level of project versatility.

When conditions in a PTA would require treatment not included in the SPM to accomplish SBEADMR's purpose and need, the treatment area is dropped from further management consideration or supplemental NEPA analysis must be completed. For example, during SBEADMR implementation managers identified an area to remove spruce beetle-infested trees. However, the slope was greater than 40%, and the SPM did not include a management activity for timber harvest on slopes that steep. The GMUG planning team prepared a supplemental information report (SIR) for NEPA compliance to add cut-to-length tethered logging—an option for tree harvest on steep slopes—as an additional management activity for hillslope conditions greater than 40%.

DESIGN FEATURES

Design features are established practices to minimize or prevent undesirable environmental effects (USDA Forest Service 2016). The SBEADMR project and NEPA effects analysis relied heavily on design features, which serve as guiding principles for mitigating potential impacts to specific resources during project implementation (Figure 5). The SBEADMR environmental effects analysis disclosed the potential consequences of management activities on resources, and listed the resource's applicable design features. The SBEADMR pre-treatment checklist is used to determine the appropriate design features to implement. For instance, the soil effects analysis described the environmental consequences to soils in all PTAs receiving treatment, and designated that any mechanical ground-based activity activates the design feature for soil compaction. This design feature mandates a 15% soil disturbance threshold for a management area, as stipulated in the GMUG forest plan (USDA Forest Service 2006). Comparable design features were similarly applied across other ecological resources.

The public had concerns about lack of site-specific mitigation measures if unanticipated resource impacts occurred during project implementation, and requested clearer indicators of management activity effects. The USFS responded by developing a Decision-Making Triggers for Adaptive Implementation matrix that outlines thresholds of environmental effects from management activities and adaptive measures to take to ensure that impacts remain within anticipated bounds during project implementation (Figure 6). This matrix took inspiration from Schultz and Nie's (2012) framework on decision-making triggers within adaptive management. Triggers were categorized as red-light triggers—standards that must not be breached, and yellow-light triggers, which indicate a negative impact on a resource and signal the need for mitigatory steps, a shift in management strategy, or a reduction in the pace of implementation. Design features are also used to link the effects analysis to project implementation and monitoring. Participants in SBEADMR use a pre-treatment checklist (see SBEADMR FEIS Appendix C) to document and select relevant design features prior to implementation. The selected design features determine what resources to assess during project monitoring, and whether impacts of management are within the environmental thresholds outlined in the SBEADMR EIS. Ineffective design features are evaluated for potential adjustments.

EVALUATE: ADAPTIVE IMPLEMENTATION AND POST-TREATMENT REVIEW

During project implementation new knowledge is generated, and capturing that knowledge is useful for subsequent management activities. One way to capture and re-incorporate this knowledge is through monitoring and adaptive management cycles that evaluate whether management activities are meeting desired goals, and

Identi-fier	Design Feature	Source / Citation	Applicable to Treatment (Yes, No, As Modified)	If no, provide justification (i.e., resource not present) If modified, identify modification and rationale for how the resource is equally/better protected
Air Quality Objectives: Comply with Clean Air Act requirements.				
AQ-1	Prescribed burning operations will comply with the State of Colorado air quality regulations.	Clean Air Act		
(TSHR-7)	Use suitable road surface stabilization practices and dust abatement supplements on roads with high or heavy traffic use (See FSH 7709.56 and FSH 7709.59).	FS National BMPs		
Project lead/Fire & Fuels specialist signature_____				

Figure 5. Design features are established practices to minimize or prevent undesirable environmental effects. Design features are activated when triggered by the potential management activities' impact on a resource. Figure 5 is the worksheet for the Air Quality (AQ) design feature. When prescribed fire is the proposed management activity, AQ-1 is activated to ensure that the burning operations are consistent with state regulations. This worksheet is a validation tool used before implementation to update current landscape information and ensure the management activity is consistent with the NEPA analysis and demonstrates compliance with legal, policy, and Forest Plan requirements. To better protect the resource, small modifications can be made to the design feature, based on the resource's current condition. Before advancing an activity to implementation the field specialist and project lead must sign off on the design features worksheets for each potentially impacted resource (Source: Appendix C: Pre-Treatment Checklist SBEADMR FEIS).

Desired Condition	Indicator(s)	Unit of Measure	Methods	Scale	Frequency	Yellow Light Trigger	Adaptive Action	Red Light Trigger	Adaptive Action	Regulatory Requirement
Management of the Treatment for: Vegetation, Wildlife, Visuals Objectives										
Maintain structural diversity of vegetation at the watershed scale (diversity unit - 6th HUC).	5-12% or more of vegetation at 6th field watershed unit is in an old growth forest classification, where biologically feasible.	Habitat structural stages 4A, 4B and 4C.	Prior to treatment planning, determine the amount of live 4A, 4B and 4C in watershed.	Diversity unit - 6th field HUC	During treatment planning OR complete quick assessment at the watershed scale prior to treatment planning.	Amount of habitat structural stages 4A, 4B, 4C pre-treatment is less than 20%.	**Limited overstory mortality** - Design treatments to ensure minimum old forest classifications are maintained. **High overstory mortality** - retain pockets of live habitat structural stages 4A, 4B and 4C to the greatest extent practicable.	Amount of habitat structural stage 4A, 4B and 4C pre-treatment is less than 5%.	Same as yellow.	**LRMP**
Maintain soil productivity, minimize human-caused erosion and maintain integrity of associated ecosystems (III-73 01a)	Past activities and proposed activities would contribute to a combined detrimental soil disturbance that is above or approaching the 15% threshold of a treatment unit.	Percent of detrimental soil disturbance within a treatment unit (DSD includes: compaction, rutting, burn severity, displacement, surface erosion and mass movement).	Implement Design Features WQSP-4, 5A, 5B, and 7B in accordance with requirements of the treatment design checklist. Spot check treatment units using accepted soil monitoring protocols.	Treatment	Pre-treatment checklist and, as triggered, post-treatment monitoring	Pre-treatment review in FACTS (treatment database) confirms past ground-based activities in proposed treatment area.	Complete pre-treatment survey to determine detrimental soil disturbance percentage. Work with IDT to design treatment to maintain the cumulative detrimental effects from project implementation	Upon completion of pre-treatment survey and considering net impact of proposed treatment, it is determined that net detrimental soil disturbance post-treatment would exceed	Modify treatment boundaries and/or exclude this treatment until further soil restoration activities completed.	LRMP

Figure 6. Decision-Making Triggers excerpted from the Adaptive Implementation Matrix for SBEADMR. The matrix outlines the range of desired conditions, the indicators for those conditions, and adaptive actions to take when the outcomes of management activities are undesirable. The desired condition to "maintain structural diversity of vegetation at the watershed scale" is measured by the habitat structural stages of mature trees (4A, 4B, 4C). 4A are mature trees (greater than 9" diameter base height) with crown cover under 40%, 4B are mature trees with 40-69% crown cover, and 4C are mature trees with 70-100% crown cover. When management activities put the landscape condition outside of the indicator (5%-12% or more of old growth vegetation(4A, 4B,4C)), there are predetermined adaptive adjustments that managers can take to mitigate or avoid this undesired outcome (USDA Forest Service 2016).

identify potential adjustments (Barrett et al. 2021). Participants in the SBEADMR project use an adaptive implementation process that includes a p-ost-treatment review as a monitoring and adaptive management tool. Evaluation tools are an optional component with CBM, and must be consistent with NEPA regulations.

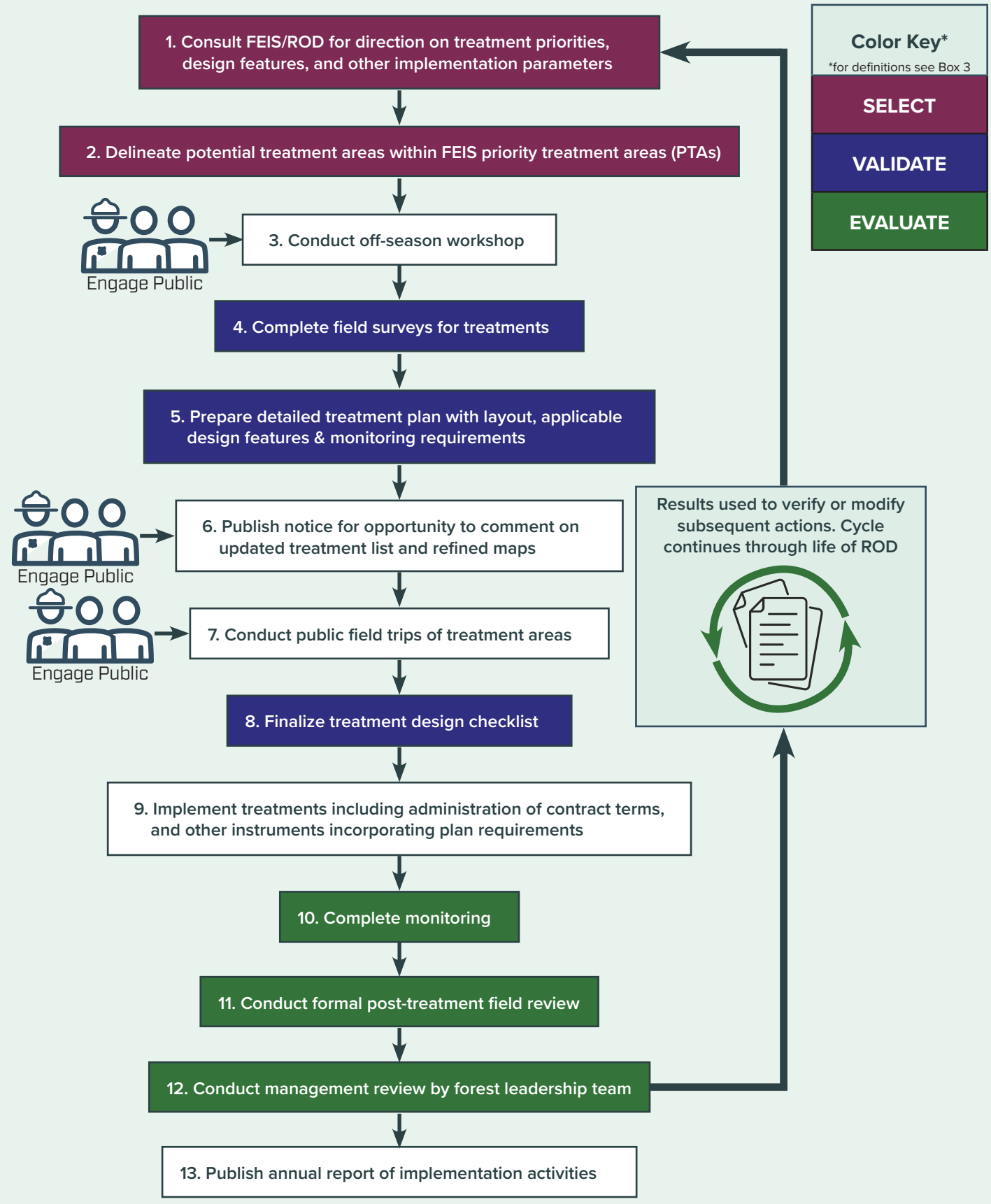
The SBEADMR FEIS/ROD specified an adaptive implementation process to define treatment locations and design, determine monitoring questions, review and evaluate the effects of treatments, and adjust management towards desired conditions (SBEADMR FEIS Appendix E). The adaptive implementation process was collaboratively developed using information from public comments and conversations within the working group meetings. One concern of the working group was that monitoring would be voluntary once the project moved to implementation. To increase accountability, the working group crafted language to better articulate the timing, structure, and results of interested parties' collaboration in the monitoring and adaptive management process. USFS personnel had previous monitoring experience with the Uncompahgre Plateau-CFLRP, and suggested this framework as a basis for SBEADMR's monitoring protocol. The CFLRP model for monitoring was more formal than what was initially proposed for the SBEADMR project.

After the DEIS was released (May 2015), the working group decided to reach an agreement concerning the adaptive implementation and monitoring model for SBEADMR. The agreement included key ingredients of organizational structure, articulation of the groups' role, and seats at the table to represent broad and diverse interests. Participants decided to continue collaboration through the SBEADMR working group rather than forming a new entity. A subcommittee was formed to research collaborative governance and adaptive management examples found in other group decision-making models. The group developed a formal structure which coalesced into the adaptive implementation and monitoring cycles found in Appendix E of the FEIS (Box 5). The key modifications made to the adaptive implementation process based upon comments received in the DEIS and the working group's suggestions are summarized below:

- Conducting off-season workshops with interested parties and science team.
- Refining treatment plan and implementation instructions.
- Publishing notice for public to comment on updated treatment plans/lists.

Box 5. SBEADMR Adaptive Implementation and Monitoring Framework

The Adaptive Implementation and Monitoring Framework from Appendix E of the SBEADMR FEIS. This framework summarizes how participants in the SBEADMR project select, validate, and evaluate management activities with public engagement.



- Conducting field trips in management areas.
- Working group engagement in post-activity field reviews.

The adaptive implementation process included a post-treatment review to assess treatment effectiveness, document silvicultural prescriptions of planned treatments and design feature effectiveness, and determine the need for adaptations in future management (refer to Appendix D SBEADMR EIS). The primary focus was on obtaining and reviewing observable evidence of how effectively design features were implemented. Per the EIS, design features were intended to be jointly assessed during scheduled annual field trips and meetings involving USFS implementation teams, the GMUG Forest Leadership Team (FLT; comprising line officers and key staff), and interested and affected individuals and entities. The post-treatment review includes a treatment summary scorecard which members of the AMG and the public use to grade these design features, fostering transparency and accountability between the USFS and interested parties. These treatment reviews were also intended to inform mandatory reporting to regulatory agencies. For instance, design features related to Canadian lynx habitat quality can be reported to the US Fish and Wildlife Service to verify compliance with federal management standards (i.e., Endangered Species Act compliance). Interested parties are able to utilize these treatment reviews, coupled with treatment monitoring results, to formulate recommendations for adjustments to the implementation process and identify any overlooked agency issues.

3. SBEADMR ADAPTIVE IMPLEMENTATION: COLLABORATIVE ORGANIZATION AND PROCESS

The ROD serves as the definitive point that solidifies a CBM project's level of versatility, and documents the commitment to the selection criteria, site-specific validation, and evaluation process (Figure 7). The ROD defines the bounds for which the project is able to adapt to changing conditions encountered on the ground.

The ROD for the SBEADMR project was signed on July 5th, 2016 with an 8-12 year implementation window. Concurrently, the SBEADMR working group held its last meeting in September 2016 and transitioned into the AMG. This transition was guided by the recommendations of the collaborative governance subcommittee (an entity that had been established in July 2015 when the working group desired to institute a more formal adaptive management

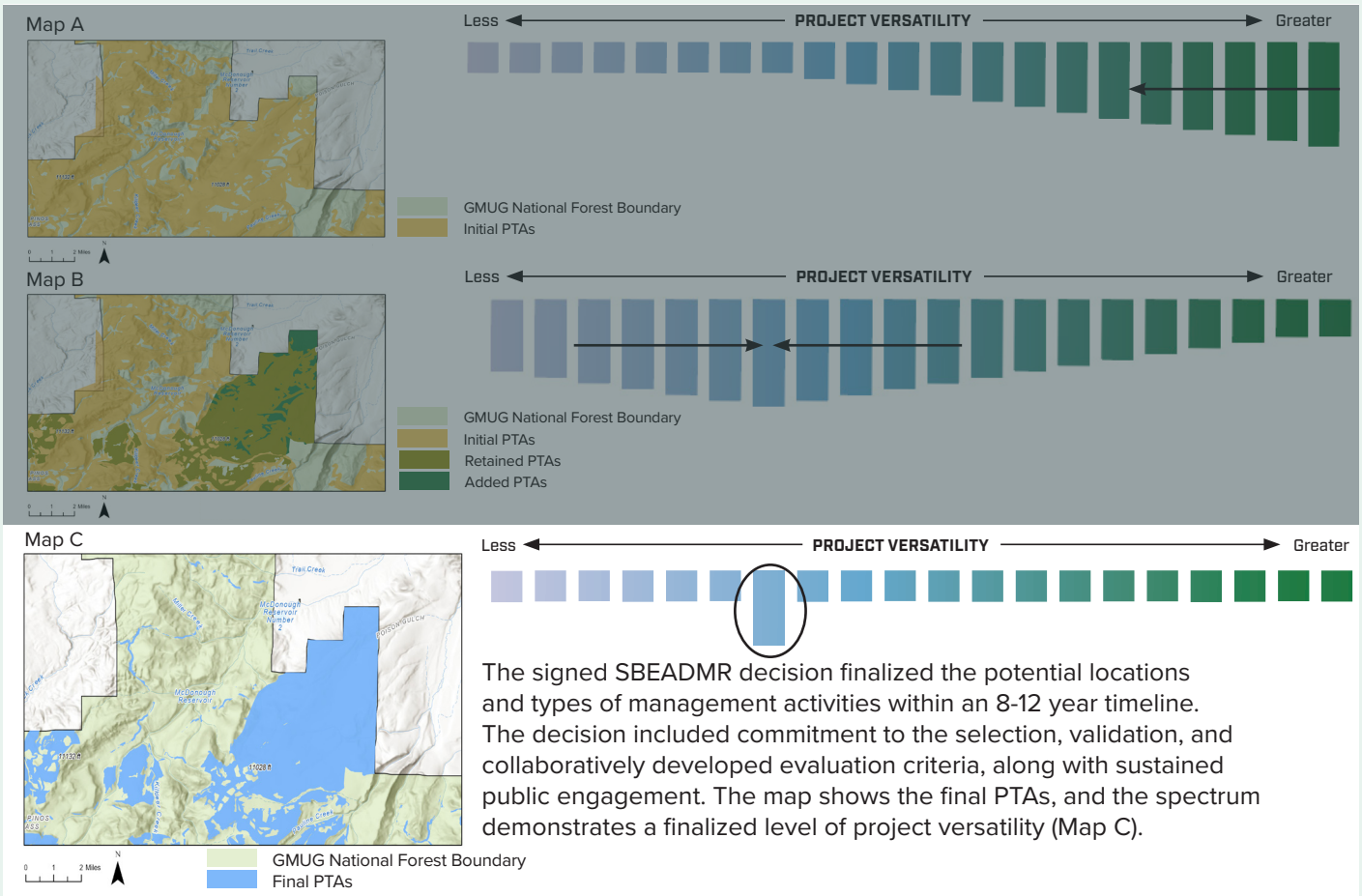


Figure 7. Final Environmental Impact Statement (FEIS), Record of Decision (ROD), and project versatility.

process). The AMG's first order of business was delineating its formal structure, encompassing purpose, participants, and procedures. Functionally, the AMG was intended to operate in close conjunction with the USFS, functioning as a multi-party collaborative entity with delineated roles and responsibilities in the adaptive management of SBEADMR treatments. The AMG consisted of eighteen locally elected officials, environmental advocates, forestry processors, loggers, community representatives, water providers, recreation enthusiasts, education interests, and wildlife experts. In a bid to engage the local community, the AMG released a press statement and dispatched letters to local organizations introducing the newly established group and extending an invitation for local involvement. The operational processes guided the frequency of annual meetings, public accessibility, provisions for public comments, and the utilization of consensus-based decision-making.

At the behest of the AMG and other project partners, the GMUG convened a Science Team composed of researchers from Colorado Parks and Wildlife, CSU, and the US Forest Service Rocky Mountain Research Station. The Science Team's purpose was to collect, analyze, and report on data gathered through project monitoring and answer questions raised by the AMG above and beyond the FEIS. The convergence of purpose, participants, and processes culminated a Memorandum of Understanding in June 2017. The AMG's activities are organized on an annual calendar (Figure 8) around a project monitoring and recommendation matrix that outlines roles, data acquisition, field excursions, reporting requisites, and the procedure for modifications to the implementation framework (Figure 9). The AMG uses the data gathered by the Science Team—and documented in the SBEADMR Project Monitoring and Recommendation Matrix—to recommend project adjustments to the GMUG FLT. While the USFS holds the final authority in reviewing and deciding upon any changes within the process, the matrix is a mechanism for transparent and accountable decision-making.

The calendar and matrix (Figures 8 and 9) are critical to operationalizing the SBEADMR CBM strategy, as they facilitate communications and interactions between the AMG, Science Team, GMUG FLT and resource specialists, and the general public. The annual engagement calendar exemplifies the heightened workload that implementing a CBM strategy may require during project implementation.

3a. DOCUMENTING ADAPTATIONS TO MANAGEMENT BASED ON MONITORING

SBEADMR activity is chronicled in the annual community reports. The SBEADMR Project Monitoring and Recommendation Matrix and the community reports provide transparency and accountability within the collaborative adaptive implementation process. Changes to the implementation process include (for a complete list see SBEADMR community reports):

- Design feature modified to clarify that slash piles must be a pyramid shape and not in windrows.

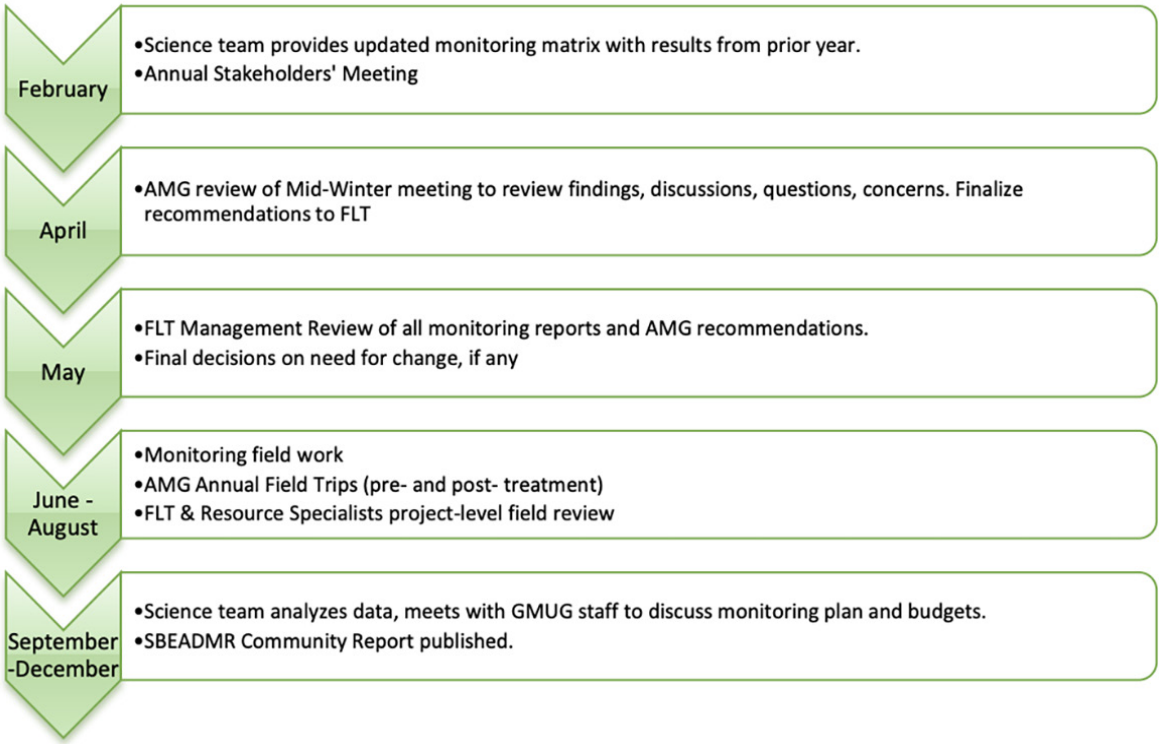


Figure 8. Typical Year of Engagement in the SBEADMR CBM Process.

Goal or Decision Trigger	Monitoring Actors and Activities	Results and Interpretation to Date	AMG Recommendation	FLT Management Review Conclusion	Comments
Maintain soil productivity, minimize human-caused erosion, eliminate or minimize soil damage from machine pile burning, and maintain integrity of associated ecosystems (Decision Trigger, FEIS, Table 6, pp. 44-45)	GMUG resource specialist conduct spot inspections and post-treatment monitoring	To date, treatment design checklists have been completed for thirty-nine treatments. All checklists indicate treatments are designed commensurate with this requirement. A total of 17 treatment units in 5 SBEADMR timber sales were monitored for postharvest soil disturbance in 2021 to determine detrimental soil disturbance associated with management activities. Results show that 3 out of the 17 SBEADMR sale units exceed the 15% disturbance limitations. Two additional units are at 15%. This suggests that over a quarter of the randomly picked SBEADMR treatment units are at or surpass required soil quality disturbance standards. See Appendix B for additional details and summary table and chart. Future monitoring will be conducted to determine how soils and vegetation recovers.	Recommend additional design criteria or other means to ensure treatment impacts remain below the 15% disturbance limitations	GMUG Soil scientist and Admin team will review the units with soil disturbance over 15% to better understand the issue. Review findings will be reported at Spring 2023 AMG meeting.	GMUG Forest Plan and Regional direction requires that detrimental soil disturbance does not exceed 15% of an activity area (e.g. timber sale unit).
Continue the public participation and collaborative learning that occurred during the planning phase, encourage and support the continuation of collaborative workgroup efforts throughout implementation (FEIS Appendix E, Public Engagement in Adaptive Implementation, Goal p. 2)	Science team questionnaire and AMG participation tracking (6a-b)	The SBEADMR process is generally meeting its goals of diverse participation, collaborative learning, developing shared understanding and agreement, transparency, responsiveness, trust- and relationship-building, and a participatory collaborative process. Refer to Appendix D. for an in-depth summary of survey results and opportunities for improvement.	Recommend AMG review and prioritize the recommendations for improvement. Recommend additional outreach from AMG to groups identified in survey responses.	Approve AMG recommendation. FLT supports increased involvement with recommended groups	Paonia District Ranger Levi Broyles announced in 2022 Annual Stakeholder breakout session that more detailed treatment plans for the Bald Timber Sale are available; this is an opportunity for interested stakeholders to connect with Ranger District staff for review and more specific information on treatments

Figure 9. Excerpt from the SBEADMR Project Monitoring and Recommendation Matrix. The Goals and Decision Triggers from the SBEADMR EIS and ROD were created to operationalize the Decision-Making Triggers for Adaptive Implementation (Figure 5). Figure 8 outlines the goals or decision triggers of the SBEADMR decision, the persons responsible for gathering the different types of monitoring data related to those goals, current monitoring results and interpretation, and how the AMG uses those results to recommend project adjustments to the USFS Leaders Team (FLT). The FLT has final authority for any changes. Source: Adaptive Implementation Report for 2022

- Design feature modified to strengthen temporary road closure methods and to reduce sub-soiling from the current 8–12-inch ripping depth to 3-8 inches to improve soils' ability to revegetate.
- Design feature modified to eliminate placement of slash piles two tree lengths or greater from residual stands.
- Step 6 of the Adaptive Implementation Process (Appendix E of the FEIS) was modified to clarify the type of input sought from the public during the 30-day informal comment period.
- The annual 30-day comment period was moved from late summer/early fall to after the annual stakeholder meeting so participants can comment immediately after seeing the most current outyear treatment plans.
- The GMUG also introduced a new online map-based commenting platform (an ArcGIS StoryMap) to facilitate more site-specific feedback.

4. CONCLUSION

In this case study we have documented the key components of the CBM strategy for the SBEADMR EIS and how they were collaboratively developed through an iterative process involving a range of interested and affected individuals and entities. We used a "select, validate, and evaluate" framework to categorize and describe the

SBEADMR CBM strategy. We used the term versatility to describe how the SBEADMR project was developed and how participants identified the potential locations, timing, and types of management activities to deploy. The SBEADMR project's adaptive implementation process provides planners, interested and affected entities, and policymakers insight into how complex and dynamic CBM can be. The SBEADMR project has required substantial time, attention, and energy from USFS planners, specialists and line officers, and from the public. While the SBEADMR FEIS did not face litigation, the CBM approach was heavily critiqued, and the project remains controversial in terms of its overall purpose and need, and the amount of work implemented.

CBM is one strategy to address rapid change and uncertainty on landscapes, but may not be necessary or appropriate for all projects. The SBEADMR project was well suited for CBM, because it was a response to spruce beetle disturbance and sudden aspen decline, stressors that are highly uncertain in terms of their spatial and temporal variability. Conventional NEPA is still appropriate on landscapes where goals and objectives are discrete in place and time, management activities are short in duration, and/or site conditions have a high degree of predictability. CBM is not meant to circumvent the NEPA process or create less work. The CBM strategy shifts work from NEPA preparation to project implementation and relies on a robust collaborative process to help meet the site specificity and public engagement requirements of NEPA.

Acronyms and Abbreviations:

AMG-Adaptive Management Group
CBM-Condition-Based Management
CFLRP- Collaborative Forest Landscape Restoration Project
CSU-Colorado State University
DEIS-Draft Environmental Impact Statement
EIS-Environmental Impact Statement
EMC- Ecosystem Management Coordination
FEIS-Final Environmental Impact Statement
FLT-Forest Leadership Team
GIS-Geographic Information Systems
GMUG -Grand Mesa, Uncompahgre, and Gunnison
NEPA-National Environmental Policy Act
POD-Potential Operational Delineation
PTAs-Potential Treatment Areas
PLP-Public Lands Partnership
ROD-Record of Decision
SAD-Sudden Aspen Decline
SBEADMR- Spruce Beetle Epidemic Aspen Decline Management Response
SPM-Silvicultural Prescription Matrix
QWRA-Quantitative Wildfire Risk Assessment
UP-CFLRP- Uncompahgre Plateau Collaborative Forest Landscape Restoration Project
USFS- United States Forest Service
WUI-Wildland Urban Interface

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