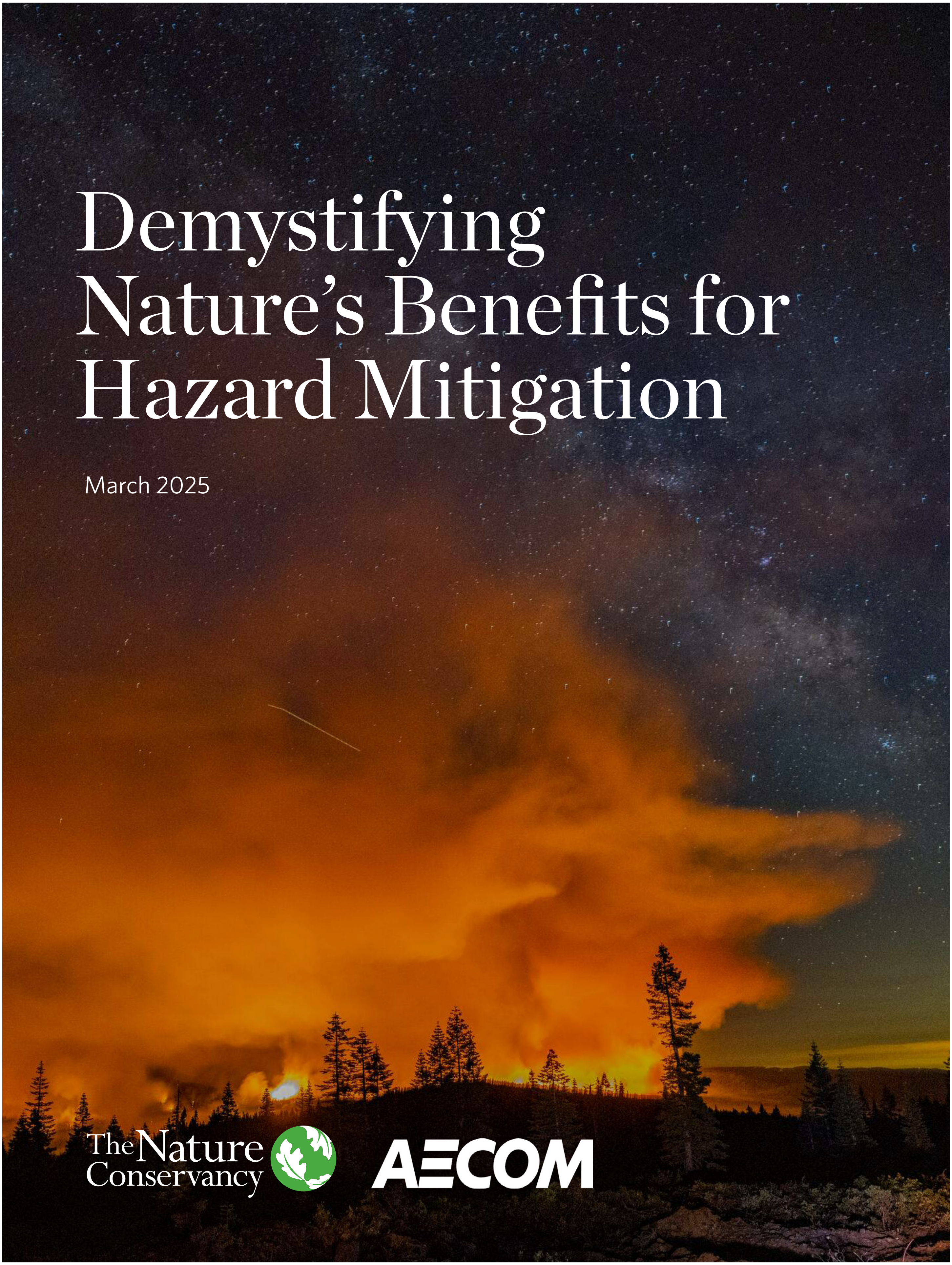
Demystifying Nature's Benefits for Hazard Mitigation

March 2025



The Nature Conservancy

AECOM

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Cover photo: The Dixie Fire burned near Butte Meadows in the Lassen National Forest. © Stuart Palley

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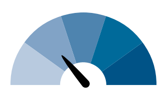
Acronyms and Iconography

ASCE	American Society of Civil Engineers
ASR	Aquifer Storage and Recovery
BCA	Benefit-Cost Analysis
BCR	Benefit-Cost Ratio
BRIC	Building Resilient Infrastructure and Communities
FEMA	Federal Emergency Management Agency
FMA	Flood Mitigation Assistance
FMAG	Fire Management Assistance Grant
HMA	Hazard Mitigation Assistance
HMGP	Hazard Mitigation Grant Program
HMP	Hazard Mitigation Plan
NBS	Nature-based Solutions
NOFO	Notice of Funding Opportunity
NRCS	National Resources Conservation Science
PDM	Pre-Disaster Mitigation
PUL	Project Useful Life
SFHA	Special Flood Hazard Area
SHMO	State Hazard Mitigation Officer
UNFCCC	United Nations Framework Convention on Climate Change
USACE	U.S. Army Corps of Engineers
WFRB	Wildlife-Friendly Recharge Basin
WUI	Wildland Urban Interface

Throughout this document, several icons are used to highlight information that may be important for applicant and subapplicant consideration throughout the FEMA HMA process. This may include information that relates to frontline communities, key FEMA HMA eligibility criteria, drought project types, and additional resources that may be useful when developing an application.


DROUGHT


HAZARD MITIGATION GRANT PROGRAM (HMGP)


EFFECTIVE AT MITIGATING RISK


FLOODING

COST EFFECTIVE


FEMA BCA TOOLKIT


WILDFIRE


TECHNICALLY FEASIBLE


FEMA BCA TOOLKIT HELPLINE


RESOURCES


COMPLIANT WITH FEDERAL, STATE, AND LOCAL LAWS

1. Introduction

The primary and intended audience of this document includes the community of practitioners who work in the nature-based solutions (NBS) space (e.g., biodiversity and/or restoration fields) but are less familiar with the FEMA approach to hazard mitigation. The secondary audience encompasses traditional hazard mitigation practitioners who may be primarily interested in utilizing a nature-based or hybrid approach to hazard mitigation to ultimately increase social, ecological, and economic co-benefits, which may also make their projects more competitive for FEMA funding. To use this document, readers should first familiarize themselves with the variety of FEMA Hazard Mitigation Assistance (HMA) funding programs that are available, as well as the requirements to perform a BCA and obtain the resulting benefit-cost ratio (BCR) to deem if the project is considered cost-effective. Resources can be found on FEMA's HMA website.[1]

This resource is meant to serve as a guide for the incorporation of nature-based elements into FEMA applications and funded projects to reduce risk for communities, quantify and qualify nature-based project components during the BCA process, and obtain more cost-effective (higher than 1.0) BCRs through the use of NBS to reduce climate risk for communities, while enhancing resiliency. There are numerous resources available for project proponents looking to complete a BCA and determine which project benefits—both quantitative and qualitative—can be included in the BCR, and the available FEMA guidance on NBS-specific benefits is continuing to expand every year. This document aims to make the BCA process more approachable for all project proponents by providing examples, resources, and guidance to help complete a BCA for three distinct hazard mitigation project types (drought, flooding, and wildfire) utilizing NBS.

The purpose of this document is to:

1. Provide justification for the Federal Emergency Management Agency's (FEMA) benefit-cost analyses (BCAs) to value the use of nature-based elements as a cost-effective means to hazard mitigation;

2. Outline risk reduction actions that are eligible to include in BCAs—specifically addressing drought, flooding,[2] and wildfire mitigation;

3. Create a guide for project proponents to complete required mitigation benefit analyses specific to nature-based solutions (NBS) projects that mitigate climate hazard risks;

4. Identify areas where NBS may be excluded from, and could be incorporated into, the FEMA BCA process; and

5. Highlight additional resources to help justify and quantify utilization of NBS for hazard risk reduction in BCAs that have historically favored traditional hazard mitigation techniques. Available resources for both traditional and NBS mitigation projects are linked throughout this document, but do not represent an exhaustive list.

1 Hazard Mitigation Assistance Grants—FEMA (fema.gov)

2 For the purposes of this document, flooding hazards include both riverine and coastal settings. These scenarios will be discussed separately in later sections.

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2. The FEMA BCA Process

Section 2 aims to explain the tools and resources provided by FEMA—particularly those resources aimed to support NBS projects—to help subapplicants complete a BCA and calculate the BCR for a given project, the types of benefits that can be included in a BCA, and the general timeline for producing a BCA within the overall grant application timeframe.

FEMA provides funding opportunities for pre- and post-emergency or disaster related projects to support communities impacted by natural hazards. These opportunities include hazard mitigation activities—sustainable actions that reduce or eliminate long-term risk and the associated loss to people and property from future disasters. Funding for hazard mitigation projects is administered through the Hazard Mitigation Assistance (HMA) grant program, which includes the Hazard Mitigation Grant Program (HMGP), Building Resilient Infrastructure and Communities (BRIC), Flood Mitigation Assistance (FMA), HMGP Post-Fire Assistance, and Pre-Disaster Mitigation (PDM) grants. Each grant program has different eligible project types, may only be available for certain states or applicant types (such as Tribes), and use unique combinations of selection criteria. Often the state acts as the main "applicant" to FEMA for grants, and the actual entity preparing

FEMA defines hazard mitigation as "any sustainable action that reduces or eliminates long-term risk to people and property from future disasters." Ultimately, FEMA seeks to break the cycle of disaster damage, reconstruction, and then repeated damage by funding projects that include long-term solutions to reduce impacts from disasters in the future. Furthermore, FEMA recognizes that changing climate conditions may impact how hazard mitigation practices evolve over time, and vice versa. For that reason, FEMA also considers climate mitigation an important action for communities to consider when planning for the future. Climate mitigation is defined by FEMA as the "reduction of greenhouse gas emissions and levels in the atmosphere to reduce the severity of human-caused climate change." Projects may include implementation of nature-based solutions; conservation, preservation, and restoration of vital ecosystems; utilization of resilient infrastructure design and enforcement of disaster resilient building codes, including future conditions data into community planning; and utilization of low carbon alternatives during construction or implementation of low-carbon or net-zero energy when rebuilding.

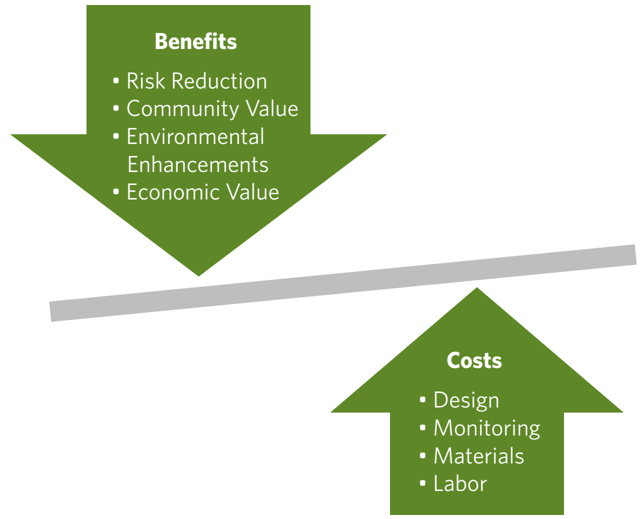
Within other communities of practice, such as the climate adaptation community, climate mitigation is defined similarly, but may recognize different actions as climate mitigation projects. For example, the United Nations Framework Convention on Climate Change (UNFCCC) defines climate mitigation as "decreasing the amount of emissions released into the atmosphere and reducing current concentration of carbon dioxide by enhancing sinks." While similar to the FEMA definition, the UNFCCC focuses on changes in economic and human systems to reduce overall greenhouse gas emission (e.g., increasing renewable energy usage and applying new technologies like electric vehicles) and increasing natural areas that act as a carbon sink (e.g., forests). These measures work in tandem to mitigate potential future impacts from climate change by reducing current atmospheric carbon dioxide conditions.

Sources: FEMA's Climate Essentials for Emergency Managers; UNFCCC Introduction to Mitigation the grant application is considered the "subapplicant." These grants provide funding for mitigation projects for a wide range of hazard types; here we will focus on drought, flooding, and wildfire. All projects submitted for HMA funding must meet required HMA eligibility criteria—provide risk reduction benefits, demonstrate cost-effectiveness, and meet environmental and historic preservation requirements and floodplain management requirements.[3]

When applying for HMA grants, FEMA requires that the subapplicant provide evidence that the project is cost-effective, meaning the benefits provided by the project outweigh the cost to implement the project. This verification is typically done through a BCA, a method that aims to understand the future risk reduction benefits of a hazard mitigation project and compares those to the overall cost of the project. The result of a BCA is a BCR, and the objective is to achieve a BCR that is greater than 1.0, which indicates that the project benefits are equal to or greater than the cost of the project. The BCA process can be intimidating for some project proponents and often cited as a major barrier to accessing FEMA funding, but it can also be a useful tool to compare alternatives of a proposed project from the standpoint of costs accrued and benefits derived over the entire project useful life (PUL).

The FEMA BCA process has been especially challenging for projects with nature-based approaches. Since the introduction of BCAs for FEMA grant programs in the 1980s and 1990s, most of the focus has been on projects for individual structures, such as acquisitions, elevations, floodproofing, and wind retrofits. BCA guidance, default approaches, and eligible project types have only recently begun to acknowledge and support NBS. Even with this support, NBS input data and justifications have been hard to obtain due to time, cost, and availability constraints.

> **The project useful life (PUL)** is the estimated number of years that the project is expected to remain effective, assuming proper maintenance. Within the BCA process, the PUL is the period of time in which benefits are accrued and then discounted for net present value. This provides an annual benefit value and is considered the total benefit amount provided by the project.
>
> Source: FEMA's Key Elements of the Benefit-Cost Ratio



BCA. Key components of benefit-cost analysis

Additional Resources for FEMA BCA Process

While many of the resources linked throughout this document are from FEMA, state-level emergency management agencies, including the California Office of Emergency Services (Cal OES), provide additional resources that subapplicants may utilize as they are developing BCA's for their funding applications. Links to BCA best practices for drought, flooding, and wildfire mitigation projects are below.

Drought:
FEMA's Benefit-Cost Analysis Tool for Drought Projects

Flooding:
FEMA's Benefit-Cost Analysis Tool for Floodproofing Projects

Wildfire:
FEMA's Benefit-Cost Analysis Tool for Wildfire Projects

3 Overarching Philosophy: Undertaking Mitigation with Nature-Based Solution Techniques – FEMA (fema.gov)

Subapplicants also have challenges in accessing funding for approaches considered by FEMA to be untested or unfamiliar, regardless of the project meeting BCR requirements. Although FEMA is continually working to incorporate ecosystem service benefits as part of the BCA process, integration of NBS project types into the BCA process remains challenging. More discussion on this is included in Section 3, below, and further exploration on specific observations is included in previous work conducted by The Nature Conservancy and Earth Economics: "Stress Testing the BCA Toolkit with Nature-based Solutions."[4]

2.1 FEMA BCA Tools and Resources

Showing cost-effectiveness is required by the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act, 1988), a federal statute governing federal disaster response and preparation, for all projects submitted to the HMA grant program. While this is typically done through a subapplicant submitted BCA, there are a handful of instances in which a new BCA does not need to be performed, see Figure 1 below for more information.[5] However, subapplicants will often need to perform a new BCA for their project. This is typically completed through FEMA's BCA Toolkit. This Microsoft Excel-based tool is designed to input data about the proposed project, subsequently using that data to calculate both costs and benefits, ultimately producing a BCR. The Toolkit necessitates numerous project metrics and uses hazard, risk, economic, and project benefit data to calculate the BCR. Some columns within the Toolkit may not be applicable for certain project types; those marked with an asterisk are required. To further characterize the present value of expected yearly benefits for hazard mitigation projects, the BCA Toolkit incorporates a standard discount rate. This value accounts for the fact that benefits that are experienced sooner are more valuable and reduces the value of future benefits experienced by the project. The current rate is 3.1% for all HMA programs, which was substantially lowered in 2024, along with other policy changes, in an effort to reduce complexity and promote equity.[6] This value is built into the BCA Toolkit and can't be changed.

New BCA NOT Required	New BCA IS Required
Streamlined BCA • Projects eligible for Pre-Calculated Benefits (see Section 2.2.1) • Substantially damaged structures—a structure in the Special Flood Hazard Area (SFHA) for which the total cost of repairs is at least 50% of the structure's market value prior to the damage occurring	All projects submitted to FEMA HMA programs that **do not meet** the outlined criteria for a streamlined BCA **or** have a project cost greater than $1 million when submitted to the BRIC or FMA programs
Descriptive Narrative • Projects submitted to the BRIC and FMA progams with total cost less than $1 million may provide a descriptive narrative in place of a BCA	

Figure 1. A new BCA is required for every project submitted to the FEMA HMA funding programs unless the criteria described above are met.[7-9]

4 Stress Testing the BCA Toolkit with Nature-based Solutions – The Nature Conservancy, Earth Economics (scienceforconservation.org)
5 Exemptions – FEMA (fema.gov)
6 FEMA Policy: Benefit-Cost Analysis Discount Rate and Streamlined Cost-Effectiveness for Hazard Mitigation Assistance and Public Assistance Programs – FEMA (fema.gov)
7 Benefit-Cost Analysis: How to Complete a Streamlined BCA – FEMA (fema.gov)
8 Notice of Funding Opportunity for Fiscal Year 2023 Building Resilient Infrastructure and Communities Program – FEMA (fema.gov)
9 Cost-Effectiveness and Benefit-Cost Analysis Technical Assistance for Communities – FEMA (fema.gov)

The FEMA BCA Toolkit is a tool that subapplicants should use to complete a BCA, with helpful tips and definitions included therein.

The FEMA BCA Toolkit incorporates benefits derived from NBS projects as the value of the ecosystem services provided by the types of land cover that are created or enhanced and those that are protected within the project footprint. One major challenge that is often noted is the lack of FEMA-specific guidance on incorporating NBS benefits into the BCA Toolkit. This document points to several resources that FEMA, or other entities, have developed within the last few years to help subapplicants overcome this obstacle, but more information is needed to fully understand the intricacies of including NBS benefits within the BCA process.

Another development that has supported more NBS projects being submitted for FEMA HMA funding applications was the removal in 2021 of the requirement that mitigation projects must achieve a 0.75 BCR using traditional benefits only before NBS benefits could be applied.[10] This policy change broadened the eligibility of nature-based projects and encouraged more subapplicants to incorporate NBS benefits into their projects.

The resources described herein are not an exhaustive list, and subapplicants should review FEMA's BCA website for additional information.[11] First, subapplicants should review the Notice of Funding Opportunity (NOFO) to understand which HMA program might be the best fit for their project and for which they might meet eligibility criteria. Some programs, such as the HMGP, provide funding after federally declared disasters for specific states. Other programs, such as BRIC, are annual programs that are nationally competitive (further detailed in Section 2.3 below, see Table 1). Since states act as the applicants to FEMA, local subapplicants should first review their state's emergency management agency's website (specifically the division that contains the State Hazard Mitigation Officer [SHMO]) for information such as NOFO, submission requirements and timelines, and links to FEMA regional and national guidance. For nationally competitive programs, NOFOs are typically updated for each fiscal year and can be found on FEMA's website.[12] Subapplicants should also review the BCA Reference Guide,[13] supplemental information,[14] and any other instructional materials[15] that may be relevant to their project. Third, technical assistance may be provided through the SHMO or through contacting the FEMA BCA Toolkit Helpline.[16]

The FEMA BCA Toolkit Helpline serves to support subapplicants through the BCA process by phone or email.

FEMA's BCA Toolkit Helpline

- Technical Assistance with BCA Process
- Answer Questions about Supporting Data Sources for BCA
- Answer Questions about BCA, Cost Effectiveness, and FEMA BCA Software
- Provide Guidance on BCA Process

How to Reach the Helpline

Call Toll-Free: **1-855-540-6744**
Monday through Friday, 9 a.m. to 5 p.m. ET
bchelpline@fema.dhs.gov

10 Using Ecosystem Service Benefits in the Benefit-Cost Analysis Policy – FEMA (fema.gov)
11 Benefit-Cost Analysis – FEMA (fema.gov)
12 Notices of Funding Opportunities – FEMA (fema.gov)
13 Final BCA Reference Guide – FEMA, Department of Homeland Security (fema.gov)
14 Supplement to the Benefit-Cost Analysis Reference Guide – FEMA, Department of Homeland Security (fema.gov)
15 Resources to Support Benefit-Cost Analysis – FEMA (fema.gov)
16 State Hazard Mitigation Officers – FEMA (fema.gov)

2.2 Project Benefits

The primary benefit that FEMA considers for hazard mitigation projects is risk reduction to life and property by minimizing the impact of hazards. However, FEMA is increasingly recognizing a broader range of environmental and social benefits that can be included as part of the subapplicants' BCA. The project benefit categories currently considered under the FEMA BCA method include:

- **Avoided physical damage** — damage to infrastructure including buildings and contents, roadways, utilities, and critical facilities
- **Avoided loss of service/loss of function** — public facilities, critical facilities, utilities, roads, and bridges
- **Avoided injury or death** — tornado and hurricane safe rooms
- **Avoided displacement costs** — lodging and meals to relocate from residential and non-residential buildings
- **Avoided emergency management costs** — sandbagging, evacuation, and road closures
- **Avoided NFIP administration costs** — structure acquisition and demolition, structure elevation
- **Ecosystem services benefits** — improvement of natural functions, structure acquisition and demolition, retention ponds
- **Social benefits** — residential properties, mental health treatment costs, and loss of productivity

2.2.1 Pre-Calculated Benefits

For some mitigation project types, FEMA has pre-calculated a level of benefit to provide general cost-effectiveness values for those projects. Pre-calculated benefits eliminate the requirement for subapplicants to develop their own BCA for eligible project types, thereby streamlining the BCA process. Project types where pre-calculated benefits may be applicable include:

- Acquisitions, elevations, and mitigation reconstruction in the SFHA,
- Acquisitions of repetitive loss and severe repetitive loss structures outside of the SFHA,
- Residential and non-residential hurricane wind retrofits,
- Residential tornado safe rooms,
- Post-wildfire mitigation (soil stabilization, flood diversion and reforestation), and
- Generators for hospitals.

However, subapplicants should be aware that these pre-calculated benefits should not be used to determine project costs or be used in place of a project budget. In addition, these benefits cannot be combined with benefits derived from a traditional BCA/BCR calculated through the BCA Toolkit or other FEMA-approved methodologies. If it is determined that the pre-calculated benefits are not greater than the project cost, the subapplicant is encouraged to complete a traditional BCA using the BCA Toolkit.

Urban Flooding. People wade through floodwaters to cross the street at the Highway 1 exit in Mill Valley. © California King Tides Project

Furthermore, subapplicants should also note that the ecosystem services values are pre-defined by FEMA but are not considered pre-calculated benefits in the context of determining cost-effectiveness. These benefits are pre-defined to provide standard values for subapplicants to use when determining the value of benefits derived from natural ecosystems. This provides an accessible way for subapplicants to include these benefits within their BCA, without having to perform and justify complex calculations. More detailed information can be found in the call-out box titled "FEMA's Ecosystem Service Valuations" in Section 3.1.

More information on pre-calculated benefits can be found on the FEMA website.

2.2.2 Quantitative vs. Qualitative Benefits

In many cases, an economic value can be associated with the benefits described above through calculating the costs of damages avoided. These quantifiable benefits are what is used to calculate the BCR. However, if the project includes benefits that cannot be quantified (e.g., aesthetic value, preservation of open space, etc.), these will not be included in the calculation of the BCR but may be described in the BCA narrative for additional benefit consideration. A strong narrative describing qualitative benefits is recommended for all HMA applications, but particularly for the BRIC program, which includes evaluation scoring criteria used for the grant selection process.[17] The descriptive benefit narrative can also discuss benefit categories where data and analysis funding availability and lack of detailed documentation may have limited what was included in the BCA calculations. For example, the benefit narrative may include a description about interruption of electrical services during a disaster event, but not include BCA calculations due to unavailable electric service data and lack of documentation of past event disruptions. Furthermore, most indirect benefits, such as changes in future economic development or employment, may not be eligible benefits within the BCA Toolkit. Subapplicants must provide documentation and justification to draw a definitive connection between project completion and reduced impact, in order to include a benefit in the BCA Toolkit. For example, downstream benefits may be included with sufficient justification as an avoided cost, although not directly in the project footprint.[18]

2.3 Application Timeline

For each HMA grant program, the application process may vary. Table 1 below provides a general overview of application timelines for each funding program. State emergency management agencies typically require subapplicants to provide advanced notification of interest and may limit which potential subapplicants can submit full grant applications. The SHMO's office may require a high-level rough BCA based on estimated values to get a general sense of the potential cost-effectiveness of the project, Therefore, BCAs should be started early in the project development phase to ensure that FEMA's cost-effectiveness eligibility is being met and to help determine the most appropriate alternative for the project in the scoping process. When beginning development of the project and identifying elements for the BCA, subapplicants should consider any lead time for technical studies or data collection, as well as the date when all application materials must be submitted for the selected grant program.

State Hazard Mitigation Officers

The SHMO plays a critical role in the FEMA hazard mitigation grant process. In some cases, they are responsible for selecting the recipients of funding from their state allocations, such as with the BRIC program. Most states have their own priority and selection criteria for most HMA programs and recommended subapplications for FEMA HMA funding. In these scenarios, understanding the role and goals of the state are important to being selected for a grant. For example the SHMO for the State of California is the California Office of Emergency Services. They manage funds and select sbapplications for the HMGP, BRIC, and FMA programs. The California State Hazard Mitigation Plan is the primary hazard mitigation document that guides these selections. More information can be found on the California Office of Emergency Services website.

Coordination with your SHMO is the first step to establishing this foundational knowledge. In some cases, the SHMO may not manage all of the FEMA mitigation grants, as not all states manage HMGP, FMA, and BRIC out of the same agency. A list of all SHMOs can be found on FEMA's website.

17 When You Apply for Building Resilient Infrastructure and Communities (BRIC) Funds – FEMA (fema.gov)
18 FEMA Ecosystem Service Value Updates – FEMA (fema.gov)

Table 1. FEMA HMA Grant Application Timelines

Grant Program	Application Timeline Defined By	Expected Release Timeframe	Estimated Time to Submit Application
FMA	Fiscal Year NOFO	NOFO typically released at beginning of Fiscal Year (September/October)	4 months
BRIC	Fiscal Year NOFO	NOFO typically released at beginning of Fiscal Year (September/October)	4 months
PDM	Fiscal Year NOFO*	Spring/early summer of Fiscal Year	1 month
HMGP	Presidential Major Disaster Declaration	~30 days after disaster	12 months
HMGP—Post Wildfire	Fire Management Assistance Grant (FMAG) Declaration	FEMA sends formal funding notification letter to eligible applicants	Defined in FEMA letter, but typically opens with first FMAG declaration of the Fiscal Year and closes on the last day of the 6th month of the next Fiscal Year (~18 months)

*NOFO for PDM grant program typically defines specific eligible applicants/projects

Paradise. (left) Bille Park with burnt trees visible behind. The park was one of the few areas in Paradise untouched by the Camp Fire and demonstrates how leveraging ecologically beneficial land uses can buffer forest communities from wildfire. © Laura Bliss/Bloomberg CityLab. (right) The remains of a house after the Camp Fire. © California National Guard Senior Airman Crystal Housman/Creative Commons

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3. Nature-Based Solutions in BCA

Mitigating hazard impacts has traditionally been accomplished by implementing "gray" infrastructure, or traditional solutions, that utilize concrete and steel to reduce risk. However, more projects are beginning to shift towards solutions that are motivated and supported by nature, including both green and natural infrastructure, to increase resilience and capture the abundant benefits provided by naturally functioning habitats. Projects incorporating NBS include a wide range of approaches such as restoration, management, conservation, and nature-based infrastructure that can be implemented to protect communities from a variety of hazards. Not only do these NBS present effective ways to mitigate hazard risk, they also provide a plethora of additional environmental, economic, and social benefits such as access to clean air and water, carbon sequestration, protection of important habitat, and additional public access or recreational opportunities.

While NBS may provide a more holistic approach to mitigating risk, a NBS project must still meet all HMA funding eligibility criteria to receive FEMA funding, including undergoing the BCA process to demonstrate cost-effectiveness by generating a BCR of 1.0 or greater. This reality may be more difficult to achieve when considering the justification necessary for valuing the costs and benefits of nature-based approaches, maintenance and monitoring over time, and mitigation benefits that can be accrued with NBS projects. On the other hand, NBS projects typically have lower upfront costs as a result of the reduced labor, machinery, and materials required, and their value appreciates as the habitat created or protected increases in functionality throughout the project lifetime.[19] For these reasons, it is worthwhile to consider all the benefits that are plausible as a result of an NBS project when calculating the BCR to achieve a ratio that is greater than 1.

Find out more about the tools and resources developed by TNC and FEMA on TNC's Science for Conservation website.

Although NBS are becoming more accepted within the hazard mitigation community, there is currently no universal definition and organizations often use different terminology that is specific to their sectors. Commonly used definitions include:

TNC: "project solutions that are motivated and supported by nature and that may also offer environmental, economic, and social benefits, while increasing resilience. Nature-based solutions include both green and natural infrastructure."

FEMA: "sustainable planning, design, environmental management, and engineering practices that weave natural features or processes into the built environment to build more resilient communities."

U.S. Army Corps of Engineers (Engineering with Nature): "the intentional alignment of natural and engineering processes to efficiently and sustainably deliver economic, environmental, and social benefits through collaboration."

At a state level, the California Natural Resources Agency defines NBS as actions that work with and enhance nature to build climate resilience and/or contribute to carbon neutrality.

19 Strategies for Operationalizing Nature-Based Solutions in the Private Sector – The Nature Conservancy (nature.org)

The benefits derived from an NBS project can be integrated into the FEMA BCA Toolkit through natural, economic, or social benefits provided by the project. However, as discussed previously, the project must accomplish one or more of the primary benefits described in Section 2.2 to be considered for HMA funding. Additional benefits provided by the project may include, but are not limited to, greenhouse gas sequestration, erosion control, groundwater recharge, appreciating property values, reduced stormwater treatment costs, and increased recreational opportunities.

Similar to traditional gray infrastructure projects, NBS project benefits should be evaluated quantitatively as often as possible. If it is not possible to quantify some of the identified benefits, then the subapplicant should include those as qualitative descriptions in the project narrative. While only quantitative values will be used to calculate the BCR, qualitative benefits may provide information to meet additional scoring criteria increasing the competitiveness of the proposal, especially for the national competitive BRIC program. Furthermore, it may be beneficial within the application to connect the qualitative benefits to one or more of FEMA's Community Lifelines regarding risk reduction and overall resiliency effectiveness.

FEMA's Community Lifelines were developed to reframe hazard incident information, understand and communicate impacts in a way that's more accessible, and promote united efforts throughout the community to prioritize stabilization of these essential lifelines during incident response. The Community Lifelines represent the most fundamental services within a community that enable all aspects of society to function. This includes Safety and Security, Food, Hydration, Shelter, Health and Medical, Energy, Communications, Transportation, Hazardous Materials, and Water Systems. FEMA developed these as a construct for objectives-based response to help decision makers prioritize the rapid stabilization of vital infrastructure following a disaster.

More information can be found on FEMA's Community Lifelines website.

3.1 Quantifying NBS Benefits

To capture the quantitative benefits of NBS hazard mitigation projects, the subapplicant must include the ecosystem service valuation in the BCA Toolkit. This is typically represented as the percentage of each land cover category that will be restored, created, enhanced, or protected during the project within the total footprint (i.e., percent of each category within the total project acreage). A PUL should be selected that represents the amount of time the selected mitigative action, once implemented, is expected to be effective. FEMA provides a list of standard PUL values for most project types but does not include values for NBS projects. For NBS projects, this metric is generally calculated as the amount of time over which the subapplicant can demonstrate that they will provide maintenance or protection to the identified land cover categories. In many cases, with appropriate documentation, this value can be used in place of FEMA's standard PUL values and is needed when claiming a PUL greater than the FEMA standard.

Landscape categories, described further in Section 5 of FEMA's 2022 "FEMA Ecosystem Service Value Updates," are used as inputs into the BCA Toolkit. The tool utilizes the acreage of each category within the project's footprint to calculate the annual and net present value of the associated natural, social, and economic benefits derived from each specific land cover category. The ecosystem service value associated with each land cover category will account for the broader "area of benefit." The subapplicant should then determine whether each land cover category identified within the project footprint meets the feasibility and effectiveness criteria and then select a PUL. The criteria and guidelines on selecting an appropriate PUL are also described within the 2022 FEMA "Ecosystem Service Value Updates" document.[20] The FEMA methodology for quantifying the ecosystem service benefits includes multiplying the number of acres in each of the land cover categories by the annual economic value associated with that category. This annual economic value (calculated separately for pre- and post-mitigation scenarios) then needs to be converted to a

20 FEMA Ecosystem Service Value Updates – FEMA (fema.gov)

FEMA's Ecosystem Service Valuations

FEMA currently recognizes the following land cover categories as providing additional ecosystem benefits to communities. The valuation of those benefits is included as well, represented as 2021 U.S. Dollars per acre per year. A breakdown of the ecosystem services included within the valuations is detailed in the 2022 Ecosystem Service Value Updates.

Land Cover Category	Value (2021 U.S. dollars per acre per year)
Forest	$12,589
Urban Green Open Space	$15,541
Rural Green Open Space	$10,632
Riparian	$37,199
Coastal Wetland	$8,955
Inland Wetland	$8,171
Coral Reefs	$7,120
Shellfish Reefs	$2,757
Beaches and Dunes	$300,649

While these benefit values are pre-defined by FEMA, they are NOT considered a 'pre-calculated benefit' in the traditional sense. The ecosystem services values are embedded into the BCA Toolkit and are not eligible to be used as a replacement for a new BCA through the completion of a streamlined BCA. For all project types that are eligible to utilize a streamlined BCA, discussed in Section 2.2.1 above, benefits have been pre-calculated by FEMA and may be used in place of a new BCA. However, subapplicants that utilize the pre-calculated benefits may not combine pre-calculated benefits with an output from the BCA Toolkit. The primary difference is that the ecosystem service values are only one benefit considered and subapplicants will still need to consider additional benefits provided by the project, while the pre-calculated benefits consider all benefits provided by the project.

present-day value based on a standard financial equation using the assumed discount rate and selected project PUL. If multiple land cover categories are included, the annual values are summed for all categories. In general, however, subapplicants should demonstrate that there is a significant level of restoration, creation, enhancement, or protection of any relevant land cover categories and ensure that FEMA's established principles, policies, and guidelines are followed to be considered feasible and effective.

For any ecosystem service benefits that are currently not included within the BCA Toolkit, subapplicants should perform a separate benefits analysis outside of the BCA Toolkit and include all supporting documentation with the application. All analyses performed outside of the BCA Toolkit must be based on credible sources such as academic studies, engineering reports, and published peer reviewed journal articles. Subapplicants should work with the BCA Toolkit helpline to determine whether the calculations are acceptable for inclusion.

FEMA uses the Net Present Value (NPV) to describe the value of a project's expected future benefits, in today's dollars, while accounting for the value of the costs that will be incurred in the future, in today's dollars. A positive NPV indicates that something is a good investment.

Future benefits (in today's dollars) - Costs (in today's dollars) = Net Present Value (NPV)

Benefits that are experienced sooner are worth more and to account for the reduced value of future benefits, the federally mandated discount rate must be applied to calculate total future benefits (i.e., 3% decline in annual benefit value over the PUL for FMA and BRIC applications).

Example: A mitigation project with $100 in benefits in Year 1 and a discount rate of 3%, the annual benefits would be as follows:

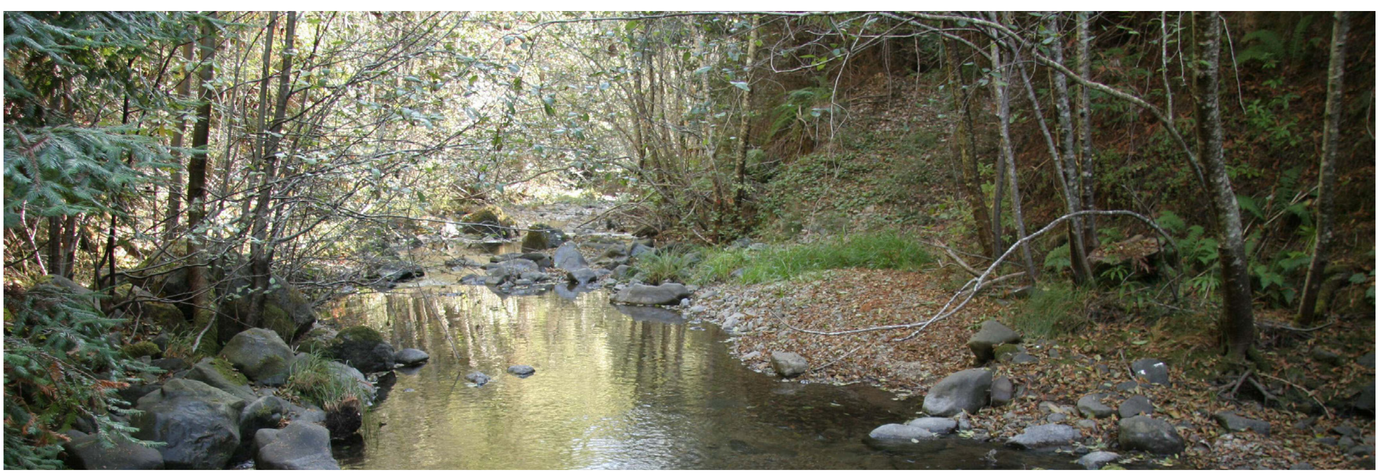
Year 1: $100
Year 2: $97
Year 3: $94
Year 4: $91
Year 5: $89

Source: FEMA's Basic Concepts in Benefit-Cost Analysis (BCA), Unit 1

3.2 Qualitative NBS Benefits

When benefits cannot be assigned a monetized value or a monetary value would be too difficult to determine, they can be discussed qualitatively in the project narrative. While qualitative benefits will not impact the BCR, they are often used by grant application review teams to compare projects for competitive funding. A discussion of qualitative benefits is especially important under the BRIC program, which utilizes evaluation scoring criteria.[21] For NBS projects, qualitative benefits are dependent on the hazard being mitigated and may include anticipated ecological and biodiversity enhancements; preservation of habitat or open space; improvements in evacuation and supply access routes; soil and bank stabilization; and mitigating for climate change, sea level rise, or other future conditions.

Within the qualitative assessment, the subapplicant should describe how the project and associated benefits align with and support any existing FEMA-approved Hazard Mitigation Plans (HMPs) at the state or local level, including any Tribal HMPs. Furthermore, the subapplicant should review additional local plans to understand the full breadth of potential benefits to be provided by the project. Examples of local plans include capital improvement plans, economic development or recovery plans, emergency management plans, transportation plans, recreation or open space plans, stormwater management plans, and state-wide resiliency plans. Although geared primarily toward BRIC applications, subapplicants may also describe how benefits align with or support FEMA's Community Lifelines.



Healthy Forest. Signal Creek runs through the Garcia River Forest in Mendocino County. © John Birchard

21 BRIC Qualitative Evaluation Criteria – FEMA (fema.gov)

4. California's Climate Hazards

© Lara Weatherly

California's diverse landscape gives rise to numerous natural hazards that are exacerbated by climate change. This document focuses specifically on nature-based mitigation actions and benefits associated with drought, flooding, and wildfire projects. However, the guidance and rationale included herein can be applied to other hazards that are projected to occur, including but not limited to, urban flooding, extreme temperatures, earthquakes, landslides, and erosion. For a comprehensive list of hazards in California, refer to the 2023 California Hazard Mitigation Plan.[22] Many hazards are interrelated—for example, landslides may result after a wildfire has impacted a particular region and extreme precipitation follows. Coastal flooding is another concern for California due to the compounding effects from riverine flooding, relative sea level rise, warming temperatures, storm surges, and high tide events. Furthermore, climate hazards tend to have disproportionate impacts on frontline communities. This creates an immense need to provide communities with appropriate guidance and tools to implement impactful NBS projects that reduce overall risk, address pre-disaster mitigation, and increase resilience.

> To provide additional context and connect this guidance document with a parallel case study effort, TNC and AECOM developed "Capturing the Flow of FEMA Funds: Mitigating Drought with Nature in the San Joaquin Valley." The case study explores nature-based drought mitigation actions and co-benefits for a region in California that is comprised of socially vulnerable communities, has been transformed into an agriculturally intensive and critically water restricted region, and is suitable for landscape-scale habitat restoration, protection, and connectivity.

The hazards described below set the stage for the remainder of the document and include how NBS projects may be leveraged to achieve more substantial benefits for social, environmental, and economic systems and outcomes.

4.1 Drought

Drought and increasing aridity, exacerbated by climate change, have reduced the availability of surface and groundwater in California and are projected to further threaten water resources over time.[23] Drought, coupled with increased pumping of groundwater and warming temperatures, has caused negative and disproportionate impacts to communities throughout California due to sustained imbalances between water supply and demand. Increased groundwater use due to more frequent and prolonged periods of drought is one contributing factor to the intensification of drought risk within California, particularly in the Central Valley, where the agriculture industry relies heavily on groundwater resources to sustain operations.

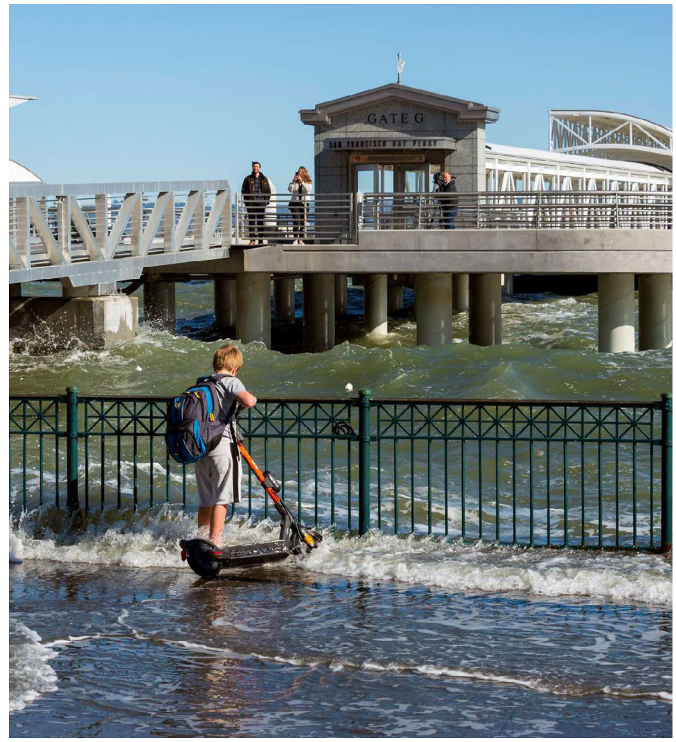
22 California State Hazard Mitigation Plan: Volume 1 – California Governor's Office of Emergency Services (caloes.ca.gov)
23 The Fifth National Climate Assessment – US Global Change Research Program (nca2023.globalchange.gov)

4.2 Flooding

In California, two major flood hazard archetypes are projected to impact communities, natural systems, and the economy—coastal flooding and riverine flooding. Coastal flooding, primarily caused by higher than average tides exacerbated by heavy rainfall and wind, is already evident throughout the state and is projected to worsen through time with warming temperatures, rising sea levels, and more frequent and extreme storm events and subsequent storm surges.[24] Coastal flooding and saltwater intrusion will have acute and disproportionate impacts on communities, infrastructure, and natural systems. Inland, riverine flooding occurs from a culmination of events that cause the overtopping of river banks, such as early snowpack melt caused by increasing temperatures, increasing intensity and frequency of extreme precipitation events, cascading, downstream effects from major wildfire events, and alteration of the natural landscape through human development and expansion.[25] Prolonged periods of drought causing soil compaction may compound both impacts and damages from riverine flooding, illustrating how climate change can have interacting effects.

4.3 Wildfire

The frequency and devastation of wildfires in California has been amplified by climate change, which has magnified warming temperatures, swings between extreme precipitation and prolonged drought years, and the spread of invasive plant species. Additionally, California's history of fire suppression and mismanagement of forests and grasslands has increased susceptible fuels and the spread/intensity of wildfires, while population growth and movement into wildland-adjacent areas has increased ignition risk across the state. Wildfires threaten communities through loss of structures, fatalities, and impacts from smoke inhalation/poor air quality; natural systems through the loss of biodiversity and degradation of forest health and resilience due to high-intensity burns; and the economy through the generation of substantial costs incurred from losses of homes and businesses.



Climate Hazards. (top) Waters of the San Francisco Bay surge onto the sidewalk at Ferry Gate G on the Embarcadero in San Francisco. © California King Tides Project. (bottom) A wildfire encroaches on homes in Solano County. © Robert Couse-Baker/Creative Commons

24 Severe Weather 101: Flood Types – NSSL (nssl.noaa.gov)
25 Severe Weather 101: Flood Types – NSSL (nssl.noaa.gov)


© Erika Nortemann/TNC

5. Drought Mitigation Actions

Drought is a relatively new topic under FEMA's purview of climate hazards — drought mitigation was introduced into the BCA Toolkit in 2016.[26] As the threat from drought continues to increase and intensify, implementation of mitigation actions becomes increasingly important to reducing risk, particularly NBS actions that can provide additional benefits to the surrounding communities. The FEMA *Hazard Mitigation Assistance Program and Policy Guide*[27] details the eligibility and requirements of various climate hazard mitigation actions under each of the HMA funding programs.

Drought mitigation actions eligible for FEMA HMA funding include:

- Early Warning Systems
- Stabilization
- Floodplain and Stream Restoration
- Flood Diversion and Storage
- Aquifer Storage and Recovery

Aquifer Storage and Recovery (ASR) is currently the only drought-focused action included within FEMA's BCA Toolkit and will be the focus of this template for the drought hazard mitigation. While this is currently the only action that can be used within the BCA Toolkit, other drought mitigation actions, like those listed above, may be eligible to receive FEMA HMA funding. However, justifying the cost-effectiveness may be more difficult.

AQUIFER STORAGE AND RECOVERY

ASR projects aim to capture and store excess water supplies during periods of abundant waterflow, such as during rainy seasons or spring/summer snow melts, which are then used to increase total freshwater supply. Storing captured water supplies in underground reservoirs protects the resource from pollutants, evaporation, and weather events and helps maintain stream flow during low flow periods. The stored freshwater supplies can then be recovered for use during sustained drought events.

ASR projects can take on many forms, some of which include NBS. One example is the creation of a wildlife-friendly recharge basin (WFRB) to capture surface water supplies and replenish and recharge nearby aquifers through natural infiltration. While WFRBs directly address low groundwater supplies and provide additional water sources for surrounding communities to use during periods of drought, enhancing the natural landscape as part of the project also provides habitat for shorebirds, waterfowl, and pollinators that utilize the surface water resources and/or associated plant communities.

5.1 Benefits of Drought Mitigation NBS Strategies

WFRB projects offer a plethora of benefits to the surrounding area; however, to be eligible as a benefit within FEMA's BCA Toolkit, the water source or aquifer being targeted for recharge must be used primarily for providing water services to the community (i.e., domestic or industrial uses that are needed to sustain life and property). This satisfies the primary purpose of FEMA's hazard mitigation programs, which is to protect life, buildings, and infrastructure. In many cases, this connection can easily be made, as the primary benefit provided by WFRB projects is typically that it enhances or increases water supply to reduce the risk of potentially life-threatening impacts during drought events. Many communities use groundwater aquifers as a source of raw water, which when treated can be used as potable water

26 Benefit-Cost Analysis Tools for Drought, Ecosystem Services, and Post-Wildfire Mitigation for Hazard Mitigation Assistance – FEMA (fema.gov)
27 Hazard Mitigation Assistance Program and Policy Guide – FEMA (fema.gov)

for residents and businesses. Extraction from the aquifer can be used as a primary water source or a secondary water source as part of a longer-term management strategy to alleviate needs during extreme drought events. For example, communities may allow a certain percentage of the stored water to be used during high demand times, while leaving a majority of the aquifer untouched for more significant periods of drought. WFRB projects offer flexibility to capture water from a variety of sources to meet the needs of communities with differentiated access to available water resources.

Although WFRB projects are primarily targeted toward drought mitigation, they may also provide flood mitigation benefits. When projects focus on capture of the initial several inches of rainfall, they can provide water quality benefits and reduce overall runoff volume and peak runoff levels. Increasing or enhancing natural floodways through the creation of flood-tolerant habitats, such as wetlands, may reduce the risk to surrounding communities by storing excess floodwaters that would subsequently be captured for aquifer recharge. When possible, subapplicants should demonstrate a reduction in subsidence and structural damage to homes and properties in the vicinity of the project. If this benefit can be shown with sufficient justification, it can be included as part of the overall project benefits within the BCA Toolkit.

WFRB projects may also provide additional benefits to the project area, not only contributing to reducing the risk of drought, but also providing additional social, natural, and economic benefits. Specific benefits that WFRB projects target may include but are not limited to:

- Increased social equity,*
- Providing additional native habitat,
- Increasing biodiversity,*
- Increasing pollination,*
- Reducing erosion and stabilizing stream banks,
- Increasing aesthetic value of project area,
- Increasing nutrient cycling,*
- Increasing climate regulation services,
- Increasing carbon capture,
- Increasing water filtration and water supply,
- Increasing soil quality and formation,*
- Reducing saltwater intrusion,*
- Reducing risk associated with flood and storm hazards, and
- Increasing water storage capacity.*

Benefits with an asterisk indicate qualitative benefits that may not be quantifiable at this time.

Groundwater. Groundwater used to flood rice fields in an agriculture region east of Marysville, California in Yuba County. © Dale Kolke/California Department of Water Resources

5.2 Incorporating NBS Benefits into FEMA BCAs

When trying to understand the cost-effectiveness of a nature-based drought mitigation project through FEMA's BCA Toolkit, it's important to understand the information that will be needed as part of the process. The two scenarios compared in a BCA are current conditions (pre-mitigation) versus after project implementation conditions (post-mitigation). All benefit calculations need to show that avoided damages and associated economic impacts will change from pre-mitigation to post-mitigation. For drought mitigation projects, the subapplicant should show the expected increase in water supply capacity that the WFRB project would provide in relation to the total population that is supported by the water supply during periods of drought and throughout the project's useful life. As part of this calculation, the BCA Toolkit will require hazard parameters such as a drought recurrence interval, the pre- and post-mitigation system supply yield, and the pre- and post-mitigation duration of impact. Although these parameters may be difficult to calculate due to historical data gaps and variance in drought conditions, publicly-available studies and associated modeling can often provide source data to derive parameters used for the BCA.[28-30] Other possible parameters used for a drought BCA include general project location, total project acreage, and cost to maintain project per year.

As discussed previously, benefits derived from NBS projects are primarily quantified through the ecosystem services provided by the land cover categories that are created, protected, or enhanced by the project. For most hazards, the BCA Toolkit calculates these benefits using the percentage of each land cover category represented within the total project footprint and the economic value applied to each of the land cover types. However, for drought mitigation, the BCA Toolkit does not currently include these land cover categories as an input. As such, subapplicants should perform these calculations outside of the BCA Toolkit and include the methodology used as part of the BCA narrative. In addition, if the subapplicant can provide evidence of additional ecosystem services provided by the land cover categories that are not currently included as part of FEMA's methodology, they are encouraged to include these within the narrative as well, along with the source of that determination and all supporting documentation. Any additional ecosystem service calculation approaches beyond FEMA-accepted approaches should be submitted to the FEMA BCA Helpline for review. Even if these additional benefits can only be described, but not calculated, these should be included in the BCA narrative presenting a strong case for the benefits provided by the project.

The land cover categories potentially associated with WFRB projects in California are dependent upon the location of the project and the habitat created or enhanced as part of the project design. Table 2 provides a list of the ecosystem services included in the valuation of the land cover categories with potential to be included as part of a benefits analysis for WFRB projects. A full list of all ecosystem services considered for each land cover category and a description of the quantification method for each is included in FEMA's "Ecosystem Service Value Updates" document.[31]

Table 2. Ecosystem services provided by potential land cover categories for Wildlife Friendly Recharge Basin Projects

Ecosystem Services Provided	Land Cover Category		
	Coastal Wetland	Inland Wetland	Riparian
Aesthetic Value	X	X	X
Air Quality			X
Biological Control			X
Climate Regulation	X	X	X
Erosion Control			X
Food Provisioning			X
Habitat	X	X	X
Hazard Risk Reduction	X	X	X
Recreation/Tourism	X	X	X
Water Filtration	X	X	X
Water Supply	X	X	X

28 Introduction to Benefit-Cost Analysis: BCAs for Drought Mitigation, Generators, and Other Types of Projects – FEMA (fema.gov)
29 National Integrated Drought Information System – FEMA, NIDIS (drought.gov)
30 National Drought Mitigation Center – University of Nebraska (drought.unl.edu)

Groundwater Use. Groundwater used to flood a vineyard in Lodi, California. © Sustainable Conservation

For benefits where a FEMA-approved economic value has not been currently determined, subapplicants should qualitatively describe these within the BCA narrative. Subapplicants should also consider the project's capacity to increase economic opportunities within the surrounding communities, reduce social vulnerability if the project benefits frontline communities, and provide cultural resources. When describing these benefits, subapplicants should indicate how these benefits meet local or statewide resource management goals or HMPs, such as California's Sustainable Groundwater Management Act, the California Water Plan, the California State Hazard Mitigation Plan, the California Climate Adaptation Strategy, or the California Department of Conservation's Multibenefit Land Repurposing Program.

In addition, subapplicants should review any additional criteria outlined for the HMA funding program for which they are applying. For example, the BRIC program provides guidelines on additional qualitative criteria that are also scored and considered during project review. For a WFRB project, this may include describing any benefits that reduce or mitigate impacts from climate change or other future conditions that were not captured under the quantitative benefits, such as changes in precipitation, increased inland flooding, and potentially changes in sea level.[32–35] However, if the project design directly uses future condition assumptions rather than present-day design assumptions, then the subapplicant should submit a FEMA BCA Helpline request for guidance on benefit calculations and documentation needs. Furthermore, connecting benefits to FEMA's Community Lifelines provides additional support for qualitative benefits. For example, WFRB projects could support the "Food, Hydration, Shelter" lifeline by increasing biodiversity and pollination, thereby supporting agriculture and food production industries. The "Water Systems" lifeline, similarly, may also be supported by the benefit of increased water storage.[36]

31 FEMA Ecosystem Service Value Updates – FEMA (fema.gov)
32 Fourth National Climate Assessment, Volume II: Impacts, Risks, and Adaptation in the United States – US Global Change Research Program (nca2018.globalchange.gov)
33 Climate Explorer – US Global Change Research Program (toolkit.climate.gov)
34 AASC Home Page – American Association of State Climatologists (stateclimate.org)
35 2022 Sea Level Rise Technical Report – US Global Change Research Program (sealevel.globalchange.gov)
36 Community Lifelines – FEMA (fema.gov)

© California King Tides Project

6. Flood Risk Reduction Actions

Flood risk reduction actions eligible for FEMA HMA funding include both localized and non-localized flood risk reduction measures. These actions would be applicable in both inland, riverine setting or for coastal flooding hazards. Per the *Hazard Mitigation Assistance Program and Policy Guide*, localized measures are "actions or projects taken to lessen the frequency or severity of flooding and decrease predicted flood damage within an isolated or confined drainage or catchment area that is not hydraulically linked or connected to a larger basin that is regional in scale," and non-localized measures consist of "actions or projects that lessen the frequency or severity of flooding and decrease predicted flood damage within an area that is hydraulically linked or connected to a drainage basin that is regional in scale." Risk reduction project examples for each category are outlined below.

- Localized:
  - Stormwater management
  - Flood diversion and storage measures
  - Slope stabilization
  - Flood protection for utility systems
  - Vegetation management for shoreline stabilization (coastal, riverine, riparian, and other littoral zones).
  - Flood protection and stabilization for roads/ bridges
- Non-Localized:
  - Construction, demolition, or rehabilitation of dams and weirs
  - Construction or modification of dikes, levees, floodwalls, seawalls, groins, jetties, breakwaters, and stabilized sand dunes
  - Large-scale channelization of waterways

Localized and non-localized flood risk reduction projects are eligible for funding assistance under HMGP, HMGP Post Fire, and BRIC. For FMA funding, localized projects are eligible, but non-localized projects would not eligible unless such activities are considered the most cost-effective mitigation activities per the National Flood Mitigation Fund.

Per the BCA Toolkit, there are numerous flood risk reduction project types that fall under the eligible actions listed above (localized vs. non-localized) included for the BCR. These project types include floodplain and stream restoration, acquisition, elevation, floodproofing measures, drainage improvement, and flood diversion and storage. Floodplain and stream restoration projects exemplify a nature-based approach to alleviate both riverine and coastal flood risk, while enhancing climate resilience and will be the focus for the remainder of this section.

FLOODPLAIN AND STREAM RESTORATION

Floodplain and stream restoration projects can easily translate into nature-based approaches to reduce flood risk for communities. Examples of nature-based flood risk reduction projects that maximize ecosystem services and restore natural ecosystem function, help mitigate drought impacts and extreme heat, and enhance climate resiliency include:

- Floodplain setbacks aiming to remove structures and restore the historical floodplain,
- Multistage channels that reduce flows and provide flood conveyance while enhancing habitat and improving sediment transport,
- Relief channels which can help divert high-flows and create wetland or lowland habitat and possible recreational benefits,
- In-stream structures that divert flows and reduce bank erosion, and
- Enhance riparian corridors with native vegetation to support habitat creation, bank stabilization, channel shading, aesthetic benefits, and maintenance of ecosystem functionality.

6.1 Benefits of Flood Risk Reduction NBS Strategies

Floodplain and stream restoration projects offer a suite of quantitative and qualitative benefits and may simultaneously act to alleviate both drought and extreme heat impacts, creating a more robust pathway to reduce climate hazard risk for communities in California watersheds. This mitigation action type can be scalable to meet a community's need, can be used to recharge baseflows, augment water supplies, provide floodwater storage solutions, enhance biodiversity and ecosystem services, restore ecosystem functionality, create recreational opportunities, reduce risk for communities, and can have cascading benefits for downstream regions within the watershed.

Primary benefits that can be calculated from the implementation of this project type are dependent on multiple factors since watershed planning and restoration is complex, especially when considering the nexus of flood impacts at the land-sea interface (refer to Section 4 for more information on the compounding effects of coastal and riverine flooding). Considerations may include: the type of restoration taking place, the existing conditions of the project area, the scale of the project (a critical component when estimating direct and indirect benefits within the watershed), the current and projected hazard risk for the project location, the location in the watershed where the project will take place, and surrounding communities (i.e., Tribes, various landowners, protected areas, etc.), among others.

Specific benefits that floodplain and stream restoration projects may target include:

- Reducing peak water velocities,
- Decreasing stream bank erosion,
- Reducing peak flood stages,
- Protecting critical infrastructure,
- Protecting valuable land and property,
- Increasing and improving both water supply and capacity within a watershed,
- Restoring ecological plant and wildlife communities and overall ecosystem functionality,
- Maximizing ecosystem services in, and adjacent to, the project area, and
- Improving water quality.

Additional co-benefits that could be realized by floodplain and stream restoration projects may span a wide range of qualitative benefits including community-wide benefits such as outreach and education, partnerships created to meet community needs and make community voices heard, benefits to frontline communities, input from a wider range of stakeholders, increased public access and recreational opportunities to restored areas, and many more.

Road Flooding. A car drives along a flooded North San Pedro Road in China Camp State Park. © California King Tides Project

6.2 Incorporating NBS Benefits into FEMA BCAs

Section 5.2 above highlights key information that project subapplicants will need to consider before quantifying benefits of NBS projects based on the land cover categories anticipated to be restored and associated ecosystem services provided, qualitative benefits, additional criteria required by specific FEMA funding programs, and Community Lifelines that may be applicable for certain hazard risk reduction projects. Guidance outlined in Section 5.2 can be leveraged for flood risk reduction projects.

Cost-effectiveness of flood risk reduction projects should follow HMA guidance but may need to also consider

- The Office of Management and Budget *Circular A-94, Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*[37]
- The White House Council on Environmental Quality's *Updated Principles, Requirements and Guidelines for Water and Land Related Resources Implementation Studies.*[38]

Cost-effectiveness for benefits resulting from the implementation of floodplain and stream restoration projects can typically be calculated using the BCA Toolkit. It may be the case that drought mitigation benefits can also be realized as a secondary benefit—if so, the application must identify how the proposed project increases water supply capacity as well as the population supported. Habitat creation (e.g., inland wetlands), can also be included in the BCA Toolkit by quantifying the total area restored by land cover category.

Examples of BCA Toolkit inputs that will be required for floodplain and stream restoration projects include the project location, PUL, mitigation project cost, years of maintenance and associated annual maintenance costs, structure types and identifying features, total project area, percentages of land cover types,[39] the flood recurrence interval, water surface and discharge elevations before and after mitigation, and pertinent critical facility information. As noted in Section 5.2, if the project design directly uses future climate change parameters, such as projected precipitation or modeled flood flows from major

Table 3. Ecosystem services provided by potential land cover categories for Floodplain and Stream Restoration Projects

Ecosystem Services Provided	Land Cover Category			
	Forest	Riparian	Urban Green Open Space	Rural Green Open Space
Aesthetic Value	X	X	X	X
Air Quality	X	X	X	
Biological Control		X		
Climate Regulation	X	X	X	X
Erosion Control	X	X	X	X
Existence Value	X			
Food Provisioning		X		
Habitat		X	X	X
Hazard Risk Reduction	X	X	X	
Pollination			X	X
Recreation/Tourism	X	X	X	X
Water Filtration	X	X		
Water Supply	X	X		

37 Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs – US White House (whitehouse.gov)
38 Updated Principles, Requirements and Guidelines for Water and Land Related Resources Implementation Studies – US White House Archives (obamawhitehouse.archives.gov)
39 FEMA Ecosystem Service Value Updates – FEMA (fema.gov)

rivers, then the subapplicant should submit a FEMA BCA Helpline request for guidance on benefit calculations and documentation needs. For example, if a project is expected to have a 50-year PUL, the request should inquire if conditions for 2070-2080 are acceptable as a design basis.

Land cover categories associated with floodplain and stream restoration projects in California may include but are not limited to, forest, riparian, urban green open space, and rural open space. Ecosystem services that may be provided by implementing a floodplain and stream restoration projects are listed in Table 3. Note that watersheds throughout California are highly variable, and Table 3 provides a list of possible land cover categories that could be present where floodplain and stream restoration projects could be implemented. A full list of land cover categories and associated ecosystem services can be found in FEMA's "Ecosystem Service Value Updates" document.[40]

Additional resources that may be useful to project subapplicants include:

- American Society of Civil Engineers (ASCE), Flood Resistant Design and Construction criteria should be consulted for costs to design and construct HMA flood risk reduction projects.[41]
- FEMA's authority to assist certain non-localized flood risk reduction projects may overlap with the USACE/Natural Resources Conservation Service's (NRCS) authority to fund similar projects—caution must be exercised as duplication of the programs are evaluated at project and site levels. Local USACE/NRCS offices should be contacted.

Urban Life. (left) Fair Oaks Park in Orangevale. © ray_explores/Creative Commons. (right) Ferry Point picnic area, Martinez Regional Shoreline Park. © California King Tides Project

40 FEMA Ecosystem Service Value Updates – FEMA (fema.gov)
41 Highlights of ASCE 24-14 Flood Resistant Design and Construction – FEMA (fema.gov)

© Ben Jiang / TNC Photo Contest 2019

7. Wildfire Management Actions

Wildfire management actions are eligible for HMGP, HMGP Post-Fire, and BRIC funding programs. Note: in the *Hazard Mitigation Assistance Program and Policy Guide*, wildfire mitigation techniques are referred to as "management activities," but they will be referred herein as "management actions" to keep consistent with drought and flood hazards.

FEMA funding assistance will only be considered for projects that clearly define wildfire mitigation and risk reduction for vulnerable buildings and structures (e.g., residential and non-residential buildings/structures, public and commercial facilities, and those located in the Wildland Urban Interface [WUI]). Projects must demonstrate both protection to life and to the built environment in the face of future wildfire disasters. Wildfires have proven to be extremely destructive and costly for post-disaster mitigation in recent years, with conditions exacerbated by climate change only worsening the situation for California. The cost of living and availability of housing in cities has also become a huge hurdle for California residents, pushing many to move further into the WUI, which poses greater community risk to wildfires.[42] FEMA will only provide funding assistance for wildfire projects that are not duplicative of projects that are funded by other federal agencies or departments that have wildland fire management responsibilities (e.g., Forest Service, NRCS, Fish and Wildlife Service, National Park Service, Bureau of Land Management and the Bureau of Indian Affairs).

Not all wildfire management actions are nature-based in design; therefore, the options to create a NBS-specific project that mitigates wildfire risk and is eligible for FEMA funding may be more restrictive when compared to flood risk reduction projects. In addition, many management actions target post-disaster relief for communities, whereas the focus for this document is to highlight management actions that emphasize nature-based approaches which target pre-disaster risk reduction.

Specific FEMA-approved mitigation action types are outlined below.

- Defensible Space
- Ignition-Resistant Building Materials and Infrastructure
- Fire Suppression Systems
- Fuel Reduction / Vegetation Management
- Post-Wildfire Flooding Prevention and Sediment Reduction Measures:
  - Reforestation, restoration and/or soil stabilization
  - Ground cover vegetation re-establishment (e.g., seeding and mulching)
  - Erosion prevention measures on slopes
  - Flash flooding prevention measures resulting from runoff (e.g., drainage dips and debris traps)
- Installing Warning Equipment and Systems

Several of the aforementioned wildfire mitigation actions are eligible project types covered in the BCA Toolkit. These include defensible space, hazardous fuels reduction, ignition-resistant construction, and projects that combine all three. Of these, hazardous fuels reduction is an example of a NBS that can be implemented to reduce wildfire risk and is well-documented in scientific literature. Hazardous fuel reduction, in combination with creation of defensible space, can be an effective way to mitigate future wildfire hazards while integrating nature-based components and increasing protection of communities across the landscape. Hazardous fuel reduction mitigation actions, based on the BCA Toolkit, will be used for the remainder of this section.

42 Americans are Moving Closer to Nature, and to Fire Danger – The New York Times (nytimes.com)

Fire-Resilient Community Design — A Holistic Nature-Based Approach

In 2019, The Nature Conservancy of California began working with the Paradise Recreation and Parks District to reimagine the rebuilding of the Town of Paradise in the wake of the 2018 Camp Fire as a fire-resilient community. Along with the Conservation Biology Institute, and the insurance firm Marsh McLennan, the team studied how fire risk in Paradise would change over time — specifically, how much would urban ignition risk from wildfire change — if, instead of building back on every parcel of land, the community used wildland-adjacent parcels to construct wildfire risk reduction buffers. The community design models that were developed take a popular tool currently used for reducing fire risk — fuel breaks — and reimagines them as a linked system of fire-resistant land uses such as orchards, agricultural plots, and recreational trails and fields that serve as a fire buffer surrounding a community. This networked fuel break not only reduces the risk of fire, but also provides a staging ground for firefighters, an evacuation point for residents, protection of biodiversity and ecosystem services, and the provision of critical habitat.

© Jessica Paterson/Creative Commons

To learn more about TNC's work in Paradise, read Learning to Live with Fire in Forest Communities.

HAZARDOUS FUELS REDUCTION

Hazardous fuels reduction, used in combination with the creation of defensible space, allows for increased protection and more resilient communities and natural systems to future wildfire events. Hazardous fuels reduction may include vegetation thinning, removal of ladder fuels (i.e., tall grasses, shrubs, and branches that allow fires to transition into overstory tree crowns), removal of flammable vegetation, and replacing flammable vegetation with fire-resistant vegetation (using proper plant palettes [generally native and pollinator-friendly species] that are well-maintained and spaced appropriately) to moderate fire behavior and reduce risk. Certain FEMA funding streams will also provide assistance for sheep and goat grazing as a mode to mitigate wildfire via vegetation removal.[43,44]

FEMA eligible hazardous fuel reduction projects aimed to reduce threats to human life and structures include:

- Community-level vegetation management,
- Vegetation removal,
- Vegetation clearing and/or thinning,
- Slash removal, and
- Vertical and horizontal clearance of tree branches.

While the above fuel reduction actions are eligible for FEMA funding assistance, not all are inherently nature-based. Some project types may be more destructive to the environment and surrounding communities and not all hazardous fuel reduction projects will be appropriate based on the local vegetation communities that are present. Wildfire management and risk reduction projects employing nature-based features is site-specific and may include a combination of actions.

43 Laguna Beach Goat Vegetation Management Project – FEMA (fema.gov)
44 Reno Fire, NV Energy, Nevada Division of Forestry Using Goats to Reduce Wildfire Risk – City of Reno (reno.gov)

Wildfire Management in Chaparral and Coastal Sage Scrub Ecosystems

Fuels reduction approaches such as thinning and burning may not be appropriate in chaparral and sage scrub ecosystems. Depending on the local context — including dominant vegetation, burn history, topography, and development pressures — such approaches can in fact lead to increased fire risk and further biodiversity and habitat loss. It is important to consult with local land stewards and experts to ensure that appropriate land management strategies are applied to reduce fire risk in these sensitive ecosystems.

Ecological Forest Management: Hazardous Fuels Reduction for Nature

Extensive vegetation thinning and removal can have destructive consequences in forests, from habitat destruction and biodiversity loss to the introduction of invasive species and loss of carbon capture potential. A nature-based approach such as Ecological Forest Management has two primary objectives: *the careful and targeted removal of forest fuels—thinning of smaller trees and shrubs in strategic, accessible areas where it is needed most and will have the least negative impact on sensitive species—plus implementation of prescribed fire and managed wildfire as a natural process where it is safe to do so.* Furthermore, the purpose of ecological forestry is to restore natural processes which, when done correctly, can restore natural processes such as low-intensity fire in the forest, which can significantly reduce the need for ongoing treatment and the costs associated with that. Hazardous fuels reduction is typically seen as a recurring cost as vegetation grows back into the areas that have been cleared.

To learn more about Ecological Forest Management, read Wildfires and Forest Resilience: the case for ecological forestry in the Sierra Nevada

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7.1 Benefits of Wildfire Management NBS Strategies

Nature-based management actions aimed to mitigate wildfires have associated benefits that can translate to communities, natural systems, and the economy. Mitigating pre-disaster wildfire hazards can help alleviate cascading effects such as landslides and mudslides.

Benefits that could be realized (both quantitative and qualitative) from wildfire mitigation may include, but are not limited to:

- Ecosystem enhancements (for instance, reduction of invasive species through vegetation management practices),
- Pest management,
- Reduced intensity of wildfires should they still occur,
- Reduced flood, erosion, and landslide/mudslide risk,
- Reduced loss of service for utility systems, public infrastructure, etc.,
- Reduced economic burden to rebuild communities, utility systems, and transportation networks, and
- Co-benefits for the surrounding communities.

Post-wildfire flood risk reduction projects have pre-calculated benefits (benefits of $5,250 per acre) for soil stabilization, flood diversion, and reforestation activities. The realized benefits are based on risk reduction and ecosystem services provided. A BCA Toolkit analysis may not be necessary for these project types, but FEMA-specific resources corresponding to the fiscal year application period should be referred to for further information.[45] In addition, there are a multitude of ineligible wildfire mitigation activities that are not eligible for FEMA assistance, some project activities include: prescribed burning, clear-cutting, and creating/maintaining fire breaks, among others.

7.2 Incorporating NBS Benefits into FEMA BCAs

Refer to Section 5.2 above for detailed information that is required for quantifying benefits for input into the BCA Toolkit to evaluate wildfire hazard mitigation projects. Guidance outlined in Section 5.2 can be leveraged for wildfire mitigation projects.

For wildfire mitigation projects to qualify for ecosystem services benefits using the BCA Toolkit, existing natural areas must be protected from future wildfire activity (at least one contiguous acre). The application and quantification of benefits are both project- and site-specific. In general, defensible space and ignition-resistant construction projects are not likely to qualify for ecosystem service benefits, whereas hazardous fuel reduction projects would qualify.[46] Per the BCA Toolkit analysis, numerous project metrics are required to obtain the BCR, including the PUL, mitigation project cost, years of maintenance and associated annual maintenance costs, burn recurrence, number of buildings, value of infrastructure vulnerable to fire, value of timber to be sold, number of volunteers, total project area, and percentages of land cover types.[47]

Land cover categories associated with wildfire mitigation projects, and more specifically, with hazardous fuel reduction projects in California, may include but are not limited to forest, riparian, and rural green open space. Ecosystem services that may be provided by implementing a hazardous fuel reduction project for each land cover category are listed in Table 4. A full list of land cover categories and associated ecosystem services can be found in FEMA's "Ecosystem Service Value Updates" document.[48]

45 Benefit-Cost Analysis – FEMA (fema.gov)

46 As mentioned above, hazardous fuel reduction projects are not all nature-based; it would be up to the project subapplicant to utilize the best available information depending on the environmental conditions and community needs.

47 FEMA Ecosystem Service Value Updates – FEMA (fema.gov)

48 FEMA Ecosystem Service Value Updates – FEMA (fema.gov)

Table 4. Ecosystem services provided by potential land cover categories for Hazardous Fuel Reduction Projects

Ecosystem Services Provided	Land Cover Category		
	Forest	Riparian	Rural Green Open Space
Aesthetic Value	X	X	X
Air Quality	X	X	
Biological Control		X	
Climate Regulation	X	X	X
Erosion Control	X	X	X
Existence Value	X		
Food Provisioning		X	
Habitat		X	X
Hazard Risk Reduction	X	X	
Pollination			X
Recreation/Tourism	X	X	X
Water Filtration	X	X	
Water Supply	X	X	

Additional resources that may be useful to project subapplicants include:

- Knowledge of local building codes.
- Design guidance in FEMA P-737, *Home Builder's Guide to Construction in Wildfire Zones,*[49] or FEMA P-754, *Wildfire Hazard Mitigation Handbook for Public Facilities,*[50] *and the International Wildland Urban Interface Code,* FEMA P-737 or FEMA P-754.[51]
- If hazardous fuels reduction projects are located in the WUI, subapplicants can check for duplication by contacting a local Department of Agriculture or Department of the Interior office for additional information.

49 Building Science Resource Library – FEMA (fema.gov)
50 Wildfire Hazard Mitigation Handbook for Public Facilities – FEMA (fema.gov)
51 2021 International Wildland-Urban Interface Code (IWUIC) – International Code Council (codes.iccsafe.org)


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8. Conclusions and Recommendations

Although recognition for NBS is continuing to grow in the hazard mitigation field, there are still many obstacles that project proponents face when applying for funding. This is particularly true when calculating cost-effectiveness as part of the FEMA HMA application process. As FEMA continues to expand the role of NBS projects within the BCA process, there are several improvements that could be made. These include expanding the types of drought mitigation and pre-wildfire mitigation actions identified within the BCA Toolkit (ASR and hazardous fuel reduction projects are currently the only actions included, respectively), including the quantification of land cover categories within the toolkit for drought mitigation as is currently done for other hazard types, and expanding available pre-calculated benefits for NBS projects, which currently only include post-wildfire flood reduction ecosystem service values.


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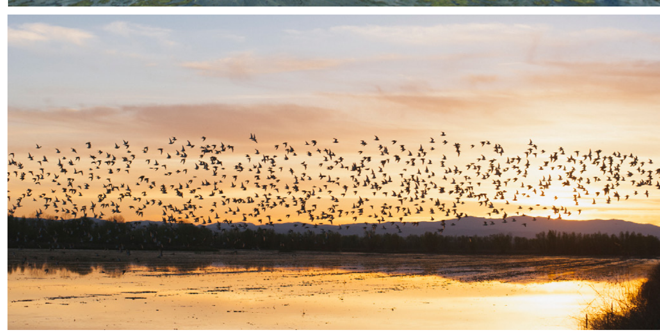
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