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# Nature-Based Mitigation Goals and Actions in State and Tribal Hazard Mitigation Plans

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## Executive Summary

Historically, hazard mitigation strategies have primarily focused on hard infrastructure, such as dams, seawalls, and levees, and designing and applying building construction practices for residential, commercial, and industrial structures. Recently, increased emphasis has been placed on non-structural and nature-based hazard mitigation solutions, such as the restoration of wetlands and floodplains, as cost-effective alternatives for hazard mitigation that also help achieve conservation goals like maintaining biodiversity and addressing climate impacts.

Much of the needed investment in identifying and implementing nature-based projects for hazard mitigation may be accomplished by leveraging and integrating existing institutions and programs. FEMA's Hazard Mitigation Assistance (HMA) grants can be one potential funding opportunity to pay for the restoration and protection of critical natural infrastructure and to improve outcomes and reduce costs from the next disaster. These grants provide funding for hazard mitigation planning as well as for cost-effective hazard mitigation activities. While Hazard Mitigation Grant Program (HMGP) funding is only available after a federal disaster declaration, the Building Resilient Infrastructure and Communities (BRIC) and Flood Mitigation Assistance (FMA) programs are available nationwide on an annual basis. FEMA's new BRIC program, for example, made $500 million dollars available to states, U.S territories, Indian tribal governments, and local communities for *pre-disaster* mitigation activities in 2020.[1] The FY2020 program priorities included incentivizing projects that incorporate nature-based solutions.

Nature-based solutions have been demonstrated as cost-effective hazard mitigation solutions. Coastal wetlands, for example, are one of the natural features that provide valuable protection from natural hazards. According to one study, existing wetlands prevented $625 million in property damage in areas affected by Hurricane Sandy.[2] Nature-based strategies also contribute important co-benefits like achieving conservation goals through improving biodiversity, increased carbon sequestration, water quality improvement, erosion reduction, habitat provision, support for recreation and tourism industries, and providing community green space.

Despite being eligible for federal funding to mitigate hazards identified in state, tribal, and local plans, relatively few nature-based solutions have been funded through FEMA hazard mitigation grant programs. Mitigation activities funded through FEMA's Hazard Mitigation Assistance Grants, including all nature-based projects, must be identified and implemented in accordance with priorities set out in state, tribal, or local hazard mitigation plans. Hazard mitigation plans identify the potential risks to the state, tribal, or local community, assess the capabilities of the government entity to address the risks, and develop goals and actions to reduce risk from the hazards across the plan area.

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[1] FEMA's BRIC grant program was created as part of Disaster Recovery Reform Act of 2018 and replaces the Pre-Disaster Mitigation program. The BRIC program is funded by a six percent set-aside from federal post-disaster grant expenditures. The 2020 FEMA Mitigation Action Portfolio highlights a wide range of innovative hazard mitigation projects that are possible to fund under the new BRIC program. FEMA, *Hazard Mitigation Assistance Mitigation Action Portfolio* (Aug. 2020), *available at* https://www.fema.gov/sites/default/files/2020-08/fema_mitigation-action-portfolio-support-document_08-01-2020_0.pdf.

[2] Beck et al., *Coastal Wetlands and Flood Damage Reduction: Using Risk Industry-based Models to Assess Natural Defenses in the Northeastern USA*, Lloyd's Tercentenary Research Foundation, London (2016) https://conservationgateway.org//ConservationPractices/Marine/crr/library/Documents/CoastalWetlandsandFloodDamageReductionReport.pdf.

It is not clear how well hazard mitigation plans are integrating nature-based goals and strategies. To address this knowledge gap, we reviewed 50 state hazard mitigation plans to better understand the extent they are incorporating nature-based strategies. In this review, we focused on the mitigation strategy – specifically looking at the goals and objectives of the strategy and the actions identified to address risk. We aimed to identify the range of practices as well as model examples of plan language that could be used by other states and tribes.

## *Results*

We found that thirty-eight of the 50 state plans had goals and objectives that were relevant to the natural systems protection. We identified three categories of mitigation goals: 1) broad goals that mention protecting the environment in addition to protecting other state aspects (24 plans), 2) goals that specifically focus on the environment (7 plans), and 3) goals that specifically focus on nature infrastructure/nature-based solutions (14 plans). Seven plans had more than one relevant goal type (e.g., New York had a broad goal that mentions the environment as well as a goal that specifically focuses on nature-based solutions).

### Mitigation Goals and Objectives Categories

| Goal Category | States |
|---|---|
| No Relevant Goal | AK, AZ, DE, GA, IL, IN, KY, NV, OH, TN, WA, WY |
| Broad goal that mentions protecting the environment in addition to protecting other state aspects | AL, FL, HI, ID, IA, KS, LA, ME, MA, MN, MS, NH, NM, NY, NC, ND, PA, RI, SD, TX, VT, VA, WV, WI |
| Goal specifically focuses on the environment | CA, MD, MO, OK, OR, SD, UT |
| Goal specifically focuses on natural infrastructure/nature-based solutions | AR, CA, CO, CT, FL, MI, MS, MT, NE, NJ, NY, PA, SC, VT |

We identified a total of 177 nature-based actions across thirty-nine state plans. Four states had more than 10 actions listed. The documented actions were sorted into categories to better understand the range of strategies included in state plans across the country. The categories identified included:

- **Conservation/Preservation/Management**: actions that are explicitly focused on protection or management of ecosystems or natural resources (e.g., protect wetlands, maintain creek banks, ecosystem preservation).
- **Restoration**: actions focused on restoration of natural habitats, usually wetlands, streambanks, floodplains, beaches, etc. These actions include dam removals, dune restoration, and restoration of native vegetation.
- **Green Infrastructure**: actions that call on the use of parcel-scale green infrastructure projects to address urban stormwater management.
- **Land Use**: actions that seek to address risks to communities through land use, including planning and zoning guidelines or policy and managing development in hazard-prone areas.
- **Funding and Programmatic**: actions that seek to create or expand preservation, restoration, or green infrastructure programs; develop or enhance funding programs; or develop implementation plans related to nature-based strategies.

- **Policy and Law**: actions that call upon different agencies to develop and implement policies and regulations that would encourage or facilitate conservation and/or nature-based mitigation actions.
- **Technical and Information**: actions related to studies, modeling, and development of tools (e.g., decision support tools).
- **Education and Awareness**: actions focused on development of guidance, conducting community outreach, and creating technical bulletins and training programs aimed at enhancing understanding of ecosystem services and non-structural mitigation measures.
- **Agency Coordination**: actions that encourage or promote coordination among state agencies or state and local agencies.
- **Partnerships**: actions that encourage partnerships with non-profits, utilities, or other organizations to conduct mitigation strategies.

We found the most actions in the state hazard mitigation plans were related to the Funding and Programmatic (37), Restoration (39), and Technical and Information (37) categories. Many of the action categories were distributed across a number of states. Fifteen states had one or more funding and programmatic actions, 19 states had one or more restoration actions, and 11 states had one or more technical and information actions. Many of the other action categories were also distributed across a number of states.

### Mitigation Actions in Reviewed State Plans by Action Category

| Action Category | Number of Actions* | Number of States |
|---|---|---|
| Agency Coordination | 3 | **3 states** (CA, MA, MN) |
| Conservation/ Preservation/ Management | 21 | **17 states** (CO, DE, KY, MD, MA, MN, MS, MT, NV, NY, RI, SC, TX, VT, WA, WI, WY) |
| Education and Awareness | 9 | **7 states** (AL, CO, IN, MI, NY, NC, MD) |
| Funding and Programmatic | 38 | **16 states** (AL, CA, CT, MA, NE, NV, NH, NJ, NC, OH, OR, PA, SC, VT, WA, WI) |
| Green Infrastructure | 13 | **12 states** (AR, HI, IN, IA, KY, MD, MA, MN, NY, OH, RI, UT) |
| Land Use | 8 | **8 states** (AK, AL, DE, GA, IA, MT, NH, TX) |
| Partnerships | 8 | **8 states** (HI, MA, MI, MT, TN, TX, VT, WA) |
| Policy and Law | 12 | **9 states** (AK, AL, DE, GA, MA, MN, MT, WA, WI) |
| Restoration | 39 | **19 states** (AK, CO, CT, IA, KY, MD, MA, MN, MS, MT, NV, NM, NY, SC, TX, UT, WA, WI, WY) |
| Technical and Information | 37 | **11 states** (CT, GA, HI, IL, KS, MA, NH, NY, RI, VT, WA) |
| No Actions Included | -- | **11 states** (AZ, FL, ID, LA**, ME, MO, ND, OK, SD, VA, WV) |

*Notes: * 11 actions were included in more than 1 category; ** The Louisiana plan does not include actions like other states, but has a technical appendix with possible mitigation actions*

The companion spreadsheet for the report could serve as a resource for reviewing examples of actions from other state plans.[3]

In recognition of tribal sovereignty and the unique needs of Indian Tribal governments, FEMA established requirements for Tribal Hazard Mitigation Plans separate from State and Local Mitigation Plans.[4] Tribal mitigation strategy requirements are similar to state hazard mitigation plans. However, the land within the Tribe's planning area may contain natural and cultural resources and sacred sites or other land of importance to the Tribe's culture, history, and values that must be taken into account when developing mitigation goals and strategies. Further, Tribal plans may include goals and objectives that have a particular focus on the wellbeing of the Tribal community. In a review of a small set of tribal mitigation plans, we found hazard mitigation goals and strategies that were similar to the kinds of goals and actions we found in state hazard mitigation plans. There is a need for more in-depth study of tribal hazard mitigation plans.

Through our review of state and tribal plans, we identified a number of conditions and opportunities that may influence the integration of nature-based strategies in the planning process. For example, in addition to the mitigation strategy component of the hazard mitigation plan, other parts of plan can inform the design of nature-based goals and actions that may most effectively mitigate risk. For example, better understanding of the role natural systems play in risk and vulnerability could aid planners in identifying and selecting nature-based projects that can provide effective mitigation. The capability section of the plan is another real opportunity for states to identify the natural resource programs and capacity that could be tapped to aid in the identification and implementation of nature-based projects. Equally important is the identification of possible funding sources for these projects.

Leveraging existing natural resource plans and facilitating key partnerships with natural resource experts are key enabling conditions that can increase the integration of natural system protection and nature-based strategies in hazard mitigation planning. Other state- or local-level plans, programs, and partners, if brought into the planning process, can provide a wealth of information that can inform the risk and vulnerability assessments and identify actions that could help the state achieve its hazard mitigation goals. For example, some states may have legal drivers that influence the integration of nature-based mitigation strategies in the hazard mitigation plan (e.g., state natural resource laws, state hazard mitigation laws, etc.). Further, involving technical experts in the planning and implementation process can help fill information gaps, aiding in identifying risks and identifying and prioritizing viable nature-based mitigation actions. These other analyses and programs may serve as opportunities to stimulate the inclusion of nature-based strategies for states that have not yet tapped into these opportunities, or that have only begun to do so.

## *Conclusions and Recommendations*

Based on the results of our review, we identified the following conclusions:

- There are many opportunities to integrate nature-based goals and actions into hazard mitigation plans. Many states have done this to some degree, but there are still opportunities to improve, including more comprehensive evaluation of the value of natural systems in the assessment of

[3] The spreadsheet is available at https://www.eli.org/land-biodiversity/hazard-mitigation-planning.
[4] Mitigation Planning 44 C.F.R § 201 at 72 Fed. Reg. 61720 (interim rule in October 2007 established the tribal mitigation plan, and 2009 final rule clarified tribal planning requirements).

risk and vulnerability, systematic inclusion of well thought out and specific nature-based hazard mitigation actions, and realistic prioritization and implementation of nature-based strategies.

- Most states had nature-based goals. However, plans with well-developed nature-based goals and objectives were not necessarily the same states that included higher numbers of nature-based actions, and vice versa.
- We identified very few geographically specific projects defined in mitigation plans. Although state plans are linked to local strategies, more specific activities may be found in local hazard mitigation plans. Local plans are more directly tied to community needs and goals and thus may provide an important opportunity for integrating nature-based actions.
- Identifying and integrating nature-based hazard mitigation actions in hazard mitigation plans is an important first step toward advancing and expanding the use of these techniques to address risk associated with natural hazards. Funding, implementing, and monitoring these projects are important next steps. More demonstration projects are needed to show the multiple benefits of nature-based projects.
- It is important to understand some of the other challenges in getting nature-based hazard mitigation strategies in the ground. For example, the Benefit-Cost Analysis (BCA) methods (all projects funded by FEMA Hazard Mitigation Assistance grants must pass a benefit cost analysis) may present challenges for showing the cost-effectiveness of nature-based strategies. FEMA could make updates to the BCA Toolkit and invest in more guidance and decision support tools that help communities consider nature-based project types. Further, FEMA or state governments could assist in the collection of more data to inform benefit-cost analyses.

We have identified a series of steps states and tribes can take to improve integration of nature-based goals and actions into their plans.

1. Identify and include natural resource protection and restoration experts as key members of the planning team (such experts could include state agency staff, NGOs, watershed groups, academics, etc.).
2. Conduct an explicit review of legal barriers or opportunities to integrating nature-based strategies in hazard mitigation planning.
3. Systematically evaluate the risk to natural systems and how the loss and degradation of natural habitats contributes to increased risk from hazards in the risk and vulnerability assessment.
4. Develop and include goals that not only focus on how to protect the environment from natural hazards, but also reflect the state's priority and commitment to use nature-based strategies to mitigate the state's risk. The companion spreadsheet for this report could serve as a resource for reviewing examples of goals and objectives from other state plans.[5]
5. Develop and integrate nature-based actions in the mitigation strategy. Both broad and specific actions could be useful. The companion spreadsheet for this report could serve as a resource for reviewing examples of actions from other state plans.[6] The action categories that we suggest here could be used as a guide for formulating, organizing, and reviewing actions. This framing might help states identify gaps in the types of actions they have and/or spur new ideas.
6. Invest in monitoring and assessment of nature-based hazard mitigation projects. Performance data will help planners communicate the success and value of nature-based projects to the public.

[5] The companion spreadsheet is available at https://www.eli.org/land-biodiversity/hazard-mitigation-planning.
[6] The companion spreadsheet is available at https://www.eli.org/land-biodiversity/hazard-mitigation-planning.

Finally, we have identified recommendations for FEMA to improve integration of nature-based goals and actions into hazard mitigation plans.

1. Examine FEMA's Hazard Mitigation Planning guidance documents to find ways to promote partnerships with nature resource experts and provide more detail on how to identify and integrate appropriate nature-based actions.
2. Examine the Benefit-Cost Analysis. FEMA could make additional changes that would result in further improvement. For example, FEMA could make changes to the BCA Toolkit in order to further reduce barriers to nature-based solutions, such as creation of additional "pre-calculated benefits" for certain project types. FEMA could also aid in data collection on project benefits, such as lost revenue avoided and environmental benefits associated with nature-based projects.
3. Invest in more "case studies" of nature-based projects that have been successfully funded by FEMA that could help to demonstrate to other applicants that such projects are possible and can result in multiple benefits.
4. Invest in partnerships with natural resource agencies and organizations. Partnerships with natural-resource experts are crucial for identifying projects, completing grant applications, and implementing nature-based hazard mitigation strategies.

## Introduction

Historically, hazard mitigation strategies have primarily focused on hard infrastructure, such as dams, seawalls, and levees, and designing and applying building construction practices for residential, commercial, and industrial structures. Recently, increased emphasis has been placed on non-structural and nature-based hazard mitigation solutions, such as the restoration of wetlands and floodplains, as cost-effective alternatives for hazard mitigation that also help achieve conservation goals like maintaining biodiversity and addressing climate impacts.

Much of the needed investment in identifying and implementing nature-based projects for hazard mitigation may be accomplished by leveraging and integrating existing institutions and programs. FEMA's Hazard Mitigation Assistance (HMA) grants can be one potential funding opportunity to pay for the restoration and protection of critical natural infrastructure and to improve outcomes and reduce costs from the next disaster. These grants provide funding for hazard mitigation planning as well as for cost-effective hazard mitigation activities (See Box 1). In its recent resources, FEMA has placed some emphasis on nature-based hazard mitigation, identifying natural systems protection actions for reducing risk to natural hazards and disasters in resources for planners[7] and communities.[8] In 2015, FEMA announced the eligibility of a suite of new activities, including floodplain and stream restoration, for its hazard mitigation funding.[9] FEMA has also made a series of changes to its Benefit-Cost Analysis Toolkit and supporting policies, most recently in 2020, to allow "for easier inclusion of nature-based solutions into risk-based mitigation projects."[10] Additionally, FEMA's new Building Resilient Infrastructure and Communities (BRIC) program made $500 million dollars available to states, U.S territories, Indian tribal governments, and local communities for *pre-disaster* mitigation activities in 2020.[11] The FY2020 program priorities included incentivizing projects that incorporate nature-based solutions.[12] Although nature-based methods are eligible for FEMA funding to mitigate almost any hazard identified by state and local

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[7] FEMA, *Mitigation Ideas - A Resource for Reducing Risk to Natural Hazards* (2013), *available at* https://www.fema.gov/sites/default/files/2020-06/fema-mitigation-ideas_02-13-2013.pdf.

[8] FEMA, *Building Community Resilience with Nature-Based Solutions- A Guide for Local Communities* (2020), *available at* https://www.fema.gov/sites/default/files/2020-08/fema_riskmap_nature-based-solutions-guide_2020.pdf.

[9] FEMA, *Floodplain and Stream Restoration Fact Sheet* (2015), *available at* https://www.epa.gov/sites/production/files/2016-04/documents/fema_floodplain_stream_restoration_fact_sheet-sept_2015.pdf

[10] FEMA*, Ecosystem Service Benefits in Benefit-Cost Analysis for FEMA's Mitigation Programs Policy* FEMA Policy FP-108-024-02 (All projects funded by FEMA Hazard Mitigation Assistance grants must pass a benefit cost analysis using FEMA software), *available at* https://www.fema.gov/sites/default/files/2020-09/fema_ecosystem-service-benefits_policy_september-2020.pdf (last visited March 31, 2021); Thomas Frank, *FEMA ends policy favoring flood walls over green protection,* E&E News Reporter (Oct. 15, 2020) https://www.eenews.net/stories/1063716253/print.

[11] FEMA's BRIC grant program was created as part of Disaster Recovery Reform Act of 2018 and replaces the Pre-Disaster Mitigation program. The BRIC program is funded by a six percent set-aside from federal post-disaster grant expenditures. The 2020 FEMA Mitigation Action Portfolio highlights a wide range of innovative hazard mitigation projects that are possible to fund under the new BRIC program. https://www.fema.gov/sites/default/files/2020-08/fema_mitigation-action-portfolio-support-document_08-01-2020_0.pdf

[12] FEMA, *Building Resilient Infrastructure and Communities Notice of Funding Opportunity (NOFO) FY 2020,* (2020), *available at* https://www.fema.gov/sites/default/files/2020-08/fema_fy20-bric-notice-of-funding-opportunity_federal-register_August-2020.pdf

**Box 1: Hazard Mitigation Assistance Grants**

Much of the needed investment in natural protection projects may be accomplished by leveraging and integrating existing institutions and programs. FEMA's Hazard Mitigation Assistance (HMA) grants provide potential funding that could pay for the restoration and protection of critical natural infrastructure, like wetlands and natural floodplains, and improve outcomes and reduce costs from the next disaster. These grants provide funding for hazard mitigation planning as well as for cost-effective hazard mitigation activities (see Table below). While Hazard Mitigation Grant Program (HMGP) funding is only available after a federal disaster declaration, the Building Resilient Infrastructure and Communities (BRIC) and Flood Mitigation Assistance (FMA) programs are available nationwide on an annual basis.

| Description of Hazard Mitigation Assistance Program Grants | | |
|---|---|---|
| | **Description** | **Mitigation Projects Allowed** |
| Hazard Mitigation Grant Program | HMGP helps states, tribes, and local communities reduce the loss of life and property from natural disasters and enables the implementation of mitigation measures following a Presidential disaster declaration. The HMGP funds voluntary actions that protect either public or private property in accordance with priorities set out in state, tribal, or local hazard mitigation plans. | Property acquisition, structure elevation, mitigation reconstruction, dry floodproofing, generators, localized and non-localized flood risk reduction projects, structural and non-structural retrofitting, safe room construction, wind retrofit, infrastructure retrofit, soil stabilization, wildfire mitigation, code enforcement, advance assistance, aquifer and storage recovery, flood diversion and storage, floodplain and stream restoration, green infrastructure, other |
| Building Resilient Infrastructure and Communities (BRIC) | BRIC assists states, local communities, tribes, and territories with hazard mitigation projects to minimize risk from disasters and natural hazards. BRIC replaces the existing Pre-Disaster Mitigation (PDM) program.<br><br>The FY2020 priorities include incentivizing public infrastructure projects; projects that mitigate risk to one or more lifelines; projects that incorporate nature-based solutions; and projects that facilitate the adoption and enforcement of the latest published editions of building codes. | Provides funding for projects falling under these categories:<br>(1) Capability- and Capacity-Building, including building codes activities, partnerships, project scoping, mitigation planning and planning-related activities, and other activities<br>(2) Mitigation Projects<br>(3) Management Costs |
| Flood Mitigation Assistance Program | The FMA program funds projects that reduce or eliminate the risk of flood damage to buildings insured under NFIP. FMA funds two types of activities: planning and projects." | Property acquisition, structure elevation, mitigation reconstruction, dry floodproofing, localized flood risk reduction projects, structural and non-structural retrofitting, infrastructure retrofit, aquifer and storage recovery, flood diversion and storage, floodplain and stream restoration, green infrastructure, other |

plans, relatively few of these projects have been funded through FEMA hazard mitigation grant programs so far.[13]

Mitigation activities funded through FEMA's Hazard Mitigation Assistance Grants, including all nature-based projects, must be consistent with priorities set out in state, tribal, or local hazard mitigation plans.[14] Hazard mitigation plans identify potential risks the state, tribal, or local community faces from hazards, assess the capabilities of the government entity to address the risks, and develop goals and actions to reduce risk from the hazards across the plan area.

## *Purpose of this Study*

Despite nature-based mitigation actions providing multiple benefits, it is not clear how well state and tribal hazard mitigation plans are integrating nature-based goals and strategies. We reviewed 50 state hazard mitigation plans to better understand to what extent they are incorporating nature-based strategies, such as the conservation and restoration of wetlands and floodplains and the use of green infrastructure, looking particularly at plan goals and explicit hazard reduction strategies. We also reviewed a small set of tribal plans. Over 200 tribal governments across the country have current tribal hazard mitigation plans.[15] We aimed to identify the range of practice as well as model examples of plan language that could be used by states in future iterations of their plans. We conclude with some observations on the state hazard mitigation plan development process and how planning elements can serve as opportunities to stimulate states and tribes to identify and use nature-based strategies.[16]

### Hazard Mitigation Plans

Hazard mitigation attempts to break the cycle of disaster damage, reconstruction, and repeated damage from the next disaster. From 2007 to 2016, FEMA provided $8.3 billion (adjusted for inflation) in mitigation grants to help communities rebuild and improve resilience.[17] This investment has repeatedly been shown to be cost-effective. According to a 2019 study conducted by the National Institute of Building Sciences, the impacts of federal mitigation grants resulted "in a national benefit of $6 for every $1 invested."[18]

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[13] Although there may be relatively few FEMA-funded grants for projects that are primarily nature-based, there are some examples of these kinds of projects. Examples of some nature-based projects that were funding primarily or in part by FEMA grants can be found on the Naturally Resilient Communities website. http://nrcsolutions.org/. We also have prepared two case studies of FEMA-funded nature-based projects (See https://www.eli.org/land-biodiversity/hazard-mitigation-planning). There are likely a greater number of FEMA grant funded projects that have nature-based components.

[14] FEMA, *State Mitigation Plan Review Guide,* at p. 47 (2015) https://www.fema.gov/sites/default/files/2020-06/fema-state-mitigation-plan-review-guide_03-09-2015.pdf

[15] FEMA, *Hazard Mitigation Plan Status* (2021), *available at* https://www.fema.gov/emergency-managers/risk-management/hazard-mitigation-planning/status.

[16] We also produced an accompanying report on local hazard mitigation plans, *available at* https://www.eli.org/land-biodiversity/hazard-mitigation-planning

[17] The Pew Charitable Trusts, *Natural Disaster Mitigation Spending Not Comprehensively Tracked* (2018) *available at* https://www.pewtrusts.org/en/research-and-analysis/issue-briefs/2018/09/natural-disaster-mitigation-spending--not-comprehensively-tracked.

[18] National Institute of Building Sciences, *Natural Hazard Mitigation Saves* (2019), *available at* https://cdn.ymaws.com/www.nibs.org/resource/resmgr/reports/mitigation_saves_2019/mitigationsaves2019report.pdf.

**Box 2: State Hazard Mitigation Plan Requirements**

States must have FEMA-approved Standard Mitigation Plans that comply with certain requirements in order to be considered eligible for non-emergency Stafford Act assistance and FEMA mitigation grants. These plans must be developed through a **planning process** that coordinates with other state and federal agencies, interested groups, and other ongoing state planning and mitigation efforts. The planning process must also include processes for reviewing and updating the plan every 5 years.

Beyond this, plans must include the following elements:

- A description of the planning process
- A **Risk Assessment**, providing the factual basis for activities, that characterizes and analyzes natural hazards and risks throughout the state, enabling comparison of potential losses and determining priorities for mitigation, including overviews of:
    - Type and location of natural hazards, including previous occurrences and future probabilities, and maps as needed;
    - State vulnerability to relevant hazards, based on local risk assessments;
    - Losses to vulnerable structures, including estimations of dollar losses to state-owned and operated facilities.
- A **Mitigation Strategy** for reducing losses from hazards identified in the risk assessment, including a discussion of:
    - State goals to guide activity selection;
    - State capabilities to mitigate hazards, including state and local policies and funding capacities;
    - Prioritization of cost-effective, environmentally sound, and technically feasible mitigation activities and description of linkages to overall strategy and local plans;
    - Sources of funding to implement activities;
    - Severe and repetitive loss activities and strategy.
- A section discussing **Coordination of Local Mitigation Planning**, including:
    - State processes to support local plans;
    - State process to coordinate, review, and link local plans to state plan;
    - Process of prioritizing community and local jurisdictions for support.
- A **Plan Maintenance Process** including:
    - Monitoring and evaluation for updates;
    - Monitoring and implementation of mitigation measures;
    - Review of progress towards mitigation goals
- A **Plan Adoption Process**
- **Assurances** of compliance with relevant State and Federal statutes and regulations of that period.

44 CFR § 201.4

States may also develop Enhanced State Plans, which make them eligible to receive additional HGMP funds,

FEMA requires every state to have a state hazard mitigation plan in order to be eligible for certain types of FEMA funding (e.g., Public Assistance, Hazard Mitigation Grant Program, Building Resilient Infrastructure and Communities program). The plans must meet certain requirements (Box 2) and be updated every five years. The purpose of a state hazard mitigation plan is to reduce or eliminate the risk to human life and property from hazards experienced by the state. To do this, state hazard mitigation plans identify potential risks and hazards the state faces, assess the capabilities of the state to address

the hazards, and identify goals and actions to reduce risk from the hazards. Hazard mitigation plans are developed by a variety of actors, often involving committees that include members from federal, state, and local agencies, but generally led by a state or local emergency management agency (or a consultant hired by that agency).

FEMA recommends incorporating agencies and stakeholders with mitigation capabilities from the following sectors:

- Hazard data
- Climate projections and data
- Emergency management
- Economic development
- Land use and development
- Housing
- Health and social services
- Infrastructure, and
- Natural and cultural resources[19]

These groups also can help with the implementation of actions, or actions can be delegated to or worked on with other organizations with expertise.

The state hazard mitigation plan "must describe the current process used to update the plan, including how the plan was prepared, the schedule or timeframe, specific milestones and activities, the agencies and stakeholders who were involved in the process, and if the mitigation planning process was integrated to the extent possible with other state planning efforts."[20] The plan must include a description of the other state and federal agencies and other stakeholders involved in the process, including emergency management; economic development; land use and development; housing; health and social services; infrastructure; and natural and cultural resources.[21] Where coordination with agencies and stakeholders representing these sectors is not practicable, the plan must describe the limitations. Once the hazard mitigation plan has been completed, it must be formally adopted by the state and approved by FEMA. The plan then must be implemented and consistently reviewed and updated.[22]

This report focuses primarily on the *mitigation strategy* section of the state plans. The mitigation strategy includes "a description of State goals to guide the selection of activities to mitigate and reduce

[19] FEMA, *State Mitigation Plan Review Guide,* at p. 11 (2015) https://www.fema.gov/sites/default/files/2020-06/fema-state-mitigation-plan-review-guide_03-09-2015.pdf (States report that a number of different agencies are involved in disaster mitigation, preparedness, response, and recovery activities, including conservation/natural resources/forestry and environmental protection agencies); *See* The Pew Charitable Trusts, *What We Don't Know About State Spending on Natural Disasters Could Cost Us - Data limitations, their implications for policymaking, and strategies for improvement* (2018), *available at* https://www.pewtrusts.org/-/media/assets/2018/06/statespendingnaturaldisasters_v4.pdf.

[20] FEMA, *State Mitigation Plan Review Guide,* at p. 12 (2015) https://www.fema.gov/sites/default/files/2020-06/fema-state-mitigation-plan-review-guide_03-09-2015.pdf.

[21] *Id.*

[22] Standard State Mitigation Plans 44 C.F.R. § 201.4.

potential losses."[23] FEMA defines mitigation goals as "broad, long-term policy and vision statements that explain what is to be achieved by implementing the mitigation strategy."[24] These should be directly tied to the risks, vulnerabilities, and capacities identified in the Risk Assessment and State Capability sections. The Mitigation Strategy section must also include "an identification, evaluation, and prioritization of cost-effective, environmentally sound, and technically feasible mitigation actions and activities the State is considering and an explanation of how each activity contributes to the overall mitigation strategy."[25] Actions identified in the hazard mitigation plans must be linked directly to the state's risks, capabilities, and objectives.[26] They should also be linked to local plans, where specific local actions and projects are identified.

Finally, the mitigation strategy includes an analysis of state capabilities to mitigate hazards (e.g., state programs) and funding opportunities. The state capability assessment should not only address the ways the state's existing capabilities can aid the mitigation effort, but also address areas in which the state needs to strengthen its capabilities. The capabilities section is "an assessment based on existing capabilities that demonstrates the state's commitment to mitigation, [that] identifies a wide range of resources from which to implement mitigation activities, and reveals areas to target improvements."[27]

The specific actions included in the mitigation strategy provide the basis for proposing and applying for funding for specific mitigation projects (see Box 1 for information on FEMA's Hazard Mitigation Assistance Grants). As such, the more the Mitigation Strategy is able to frontload cost and risk assessments for nature-based projects, the easier the application process will likely be for those projects. In fact, a recent Government Accountability Office (GAO) report highlighted the challenges state and local officials face when applying to hazard mitigation grant programs, "including challenges with the required benefit-cost analysis, the complexity of the application processes, the timeliness of grant awards, and the technical capacity required to successfully apply."[28] State and local officials described the application process as complex and lengthy and cited challenges with applicants' technical capacity to successfully apply for grants. These challenges apply to any type of project, including nature-based strategies.

## Nature-Based Hazard Mitigation Strategies

Nature-based strategies (also called natural infrastructure, green infrastructure or nature-based solutions) are actions that use the conservation or restoration of nature, such as ecosystems like

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[23] *Id.*

[24] FEMA, *State Mitigation Planning Key Topis Bulletin: Mitigation Strategy* (Oct. 2016), *available at* https://www.fema.gov/sites/default/files/2020-06/fema-state-mitigation-strategy-planning-bulletin_10-26-2016_0.pdf.

[25] Standard State Mitigation Plans 44 C.F.R. § 201.4. FEMA has characterized suggested mitigation actions into four types: (1) Local Planning and Regulations, (2) Structure and Infrastructure Projects, (3) Natural Systems Protection, and (4) Education and Awareness Programs. FEMA, *Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards* (2013) https://www.fema.gov/sites/default/files/2020-06/fema-mitigation-ideas_02-13-2013.pdf.

[26] FEMA, *Flood Mitigation Assistance (FMA) Grant* https://www.fema.gov/flood-mitigation-assistance-grant-program (last visited Mar. 31, 2021).

[27] FEMA, *State Mitigation Plan Review Guide,* at p. 19 (2015) https://www.fema.gov/sites/default/files/2020-06/fema-state-mitigation-plan-review-guide_03-09-2015.pdf.

[28] United States Government Accountability Office. Disaster Resilience: *FEMA Should Take Additional Steps to Streamline Hazard Mitigation Grants and Assess Program Effects* (Feb. 2021), *available at* https://www.gao.gov/assets/720/712172.pdf.

wetlands, or green infrastructure projects like green (vegetated) roofs, to address hazards (See Box 1).[29] Nature-based *mitigation* strategies can help reduce the likelihood of future hazards occurring and minimize negative impacts when they do occur. These strategies also provide environmental and social co-benefits, such as increasing habitat and biodiversity, and creating recreational spaces for communities.

Coastal wetlands, for example, are one of the natural features that provide valuable protection from natural hazards. According to one study, existing wetlands prevented $625 million in property damage in areas affected by Hurricane Sandy.[30] The study showed a "correlation between wetland cover and avoided property damages: the greater the extent of the wetland, the more protection it provides. Even relatively degraded wetlands in highly urban areas like New York City provided hundreds of millions of dollars in flood protection."

Nature-based mitigation strategies can also be more cost-effective than traditional "gray" solutions in many contexts, achieving the same hazard mitigation benefits while requiring lower upfront (capital) and ongoing (operation and maintenance and repair) costs.31 For example, installing living shorelines in the South Atlantic is estimated to cost, on average, $361/linear foot, which is approximately a third of the estimated cost to install concrete bulkheads.32 Similarly, investment in natural infrastructure up-

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[29] There are no universal definitions for nature-based solutions. Nature-based Solutions (NbS) are defined by IUCN as "actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits." Commission on Ecosystem Management, *Nature-based Solutions* https://www.iucn.org/commissions/commission-ecosystem-management/our-work/nature-based-solutions#:~:text=Nature%2Dbased%20Solutions%20(NbS),%2Dbeing%20and%20biodiversity%20benefits%E2%80%9D; CA law defines natural infrastructure as "the preservation or restoration of ecological systems, or utilization of engineered systems that use ecological processes, to increase resiliency to climate change, manage other environmental hazards, or both. This may include, but is not limited to, floodplain and wetlands restoration or preservation, combining levees with restored natural systems to reduce flood risk, and urban tree planting to mitigate high heat days." CA Assembly Bill No. 1482 Chapter 603 https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201520160AB1482; The Nature Conservancy added the concept of natural processes providing services. NBS—sometimes called natural infrastructure and green infrastructure—incorporate the natural environment that mimic or work in concert with natural processes to provide clean water, clean air, flood, fire and drought risk reduction, and other benefits. Unlike many forms of grey infrastructure, NBS also offer an array of economic, social, and environmental co-benefits. *Strategies for Operationalizing Nature-Based Solutions in the Private Sector* (2018), https://www.nature.org/content/dam/tnc/nature/en/documents/NBSWhitePaper.pdf.

[30] Beck et al., *Coastal Wetlands and Flood Damage Reduction: Using Risk Industry-based Models to Assess Natural Defenses in the Northeastern USA*, Lloyd's Tercentenary Research Foundation, London (2016) https://conservationgateway.org//ConservationPractices/Marine/crr/library/Documents/CoastalWetlandsandFloodDamageReductionReport.pdf.

[31] Environmental and Energy Study Institute, *Fact Sheet: Nature as Resilient Infrastructure – An Overview of Nature-Based Solutions* (Oct. 16, 2019), *available at* https://www.eesi.org/papers/view/fact-sheet-nature-as-resilient-infrastructure-an-overview-of-nature-based-solutions. Glick, P., E. Powell, S. Schlesinger, J. Ritter, B.A. Stein, and A. Fuller. *The Protective Value of Nature: A Review of the Effectiveness of Natural Infrastructure for Hazard Risk Reduction.* (2020) Washington, DC: National Wildlife Federation, *available at https://www.nwf.org/-/media/Documents/PDFs/NWF-Reports/2020/The-Protective-Value-of-Nature.ashx?la=en&hash=A75F59611475502BEE58723F8B3C58423417E579*

[32] Anne N. Connor, *Why you want oysters and a salt marsh between you and a hurricane*, Vox (June 3, 2019). *available at* https://www.vox.com/2019/6/3/18262182/hurricane-season-2019-storm-protection

front can save communities money down the road. For example, for every $1 spent on wetland and reef restoration in the Gulf of Mexico, communities have saved up to $7 in "flood-reduction benefits."[33]

**Box 3: Nature-Based Hazard Mitigation Actions**

There is a wide variety of types of nature-based hazard mitigation strategies,[a] from land conservation and restoration to green infrastructure to land use policy. These projects can address a range of hazards while also providing other environmental and community benefits.

Types of projects include:

- **Land conservation** – Identifying and protecting land for hazard mitigation and ecosystem benefits.
- **Wetland, floodplain, habitat restoration** –Restoring functions and habitat areas that have been lost or degraded for hazard mitigation benefits.
- **Green infrastructure** – Parcel-scale land conservation and storm water management projects (e.g., bioswales, rain gardens, green roofs) that provide flood and drought mitigation benefits, generally in urban areas.
- **Land use projects** – Land use policy and regulatory actions such as zoning, greenways, and growth management in high hazard areas.
- **Dune restoration, living shorelines, coastal wetland restoration** – Coastal protection and restoration projects that provide protection from flooding and storm surge.

Nature-based projects provide mitigation benefits for a variety of hazards, including:

- Riverine flooding
- Urban flooding
- Coastal flooding and storm surge
- Drought
- Wildfire

Nature-based projects provide additional co-benefits, including:

- Habitat protection
- Wildlife protection
- Other ecosystem services (e.g., improved water quality)
- Increased property values for neighboring properties
- Green jobs
- Recreation space for the surrounding community
- Public health benefits
- Carbon sequestration

a - FEMA, *Mitigation Ideas - A Resource for Reducing Risk to Natural Hazards* (2013), *available at* https://www.fema.gov/sites/default/files/2020-06/fema-mitigation-ideas_02-13-2013.pdf; FEMA, *Building Community Resilience with Nature-Based Solutions - A Guide for Local Communities* (2020), *available at* https://www.fema.gov/sites/default/files/2020-08/fema_riskmap_nature-based-solutions-guide_2020.pdf.

[33] NOAA Office for Coastal Management, Fast Facts – Natural Infrastructure, *at* https://coast.noaa.gov/states/fast-facts/natural-infrastructure.html

Natural infrastructure may also require fewer post-disaster repairs. For example, after Hurricane Matthew (2016), a study found living shorelines reduced erosion just as effectively as bulkheads, but required no repairs post-disaster, while ¾ of the bulkheads required repairs.[34]

## *Methods*

### Plan Identification

We compiled the most recently available and approved state hazard mitigation plans from 50 states from state web pages and/or by contacting the State Hazard Mitigation Officers. Plan links, approval years, and lead planning agencies can be seen in Appendix 1.

### Plan Review

A key word search approach was used as an initial screen to identify natural and nature-based goals, objectives, strategies and actions. The key words used included: wetland; environment; natur- (e.g., natural and nature-based); green (e.g., green infrastructure); conserv- (e.g., conserve, conservation); preserv- (e.g., preserve, preservation); restor- (e.g., restore, restoration); stream; and living shore. We searched the entire plan for the key words, including the Risk Assessment, Mitigation Strategy, and Planning Process sections. We documented all identified mentions including relevant goals, objectives, and mitigation actions.

The key word search was followed by a more detailed review of the risk assessment and mitigation strategy sections of the plan to ensure all relevant mentions and actions were included in the data. Each plan's mitigation goals/objectives and actions were reviewed to better understand the context of each action and determine if it was relevant to inclusion in the study. Some of the plans include a description of each action, others just list actions without additional information.

### Data Collected

#### *State Plan Summaries*

We created summary documents for each plan reviewed that include all of the information collected from the plan review, including:

- Year
- Planning Timeframe
- Date of Next Planned Revision
- Responsible Planning Agency (including the Planning Team and Identified Stakeholders)
- Relevant Goals and Objectives
- Relevant Actions

[34] Smith et al., *Living shorelines enhanced the resilience of saltmarshes to Hurricane Matthew*, Ecological Applications, 28(4), (2016), *available at* https://esajournals.onlinelibrary.wiley.com/doi/full/10.1002/eap.1722?sid=nlm%3Apubmed

### *Goals and Objectives*

We identified goals and objectives that address the environment, natural resource protection, or nature-based strategies. These ranged from broad goals that mentioned the environment to more specific goals focused on minimizing harm to the environment or identifying ways to integrate nature-based solutions.

We categorized plans as including:

- No relevant goals: The plan did not have any goals or objectives that mention the environment, natural resources, or habitat.

- Broad goal that mentions protecting the environment in addition to protecting other state assets: The plan includes a broad goal that includes the environment or natural resources in addition to other state assets (e.g., reduce state's "vulnerability and increase resilience to hazards to protect people, property, and natural resources")[35]

- Goal specifically focuses on the environment: The plan includes a goal(s) or objective(s) that specifically identifies reducing risk to natural resources or the environment.

- Goal specifically focuses on natural infrastructure/nature-based solutions: The plan includes a goal(s) or objective(s) that explicitly identifies protecting or restoring natural infrastructure as a hazard mitigation strategy.

### *Mitigation Actions*

We documented plan actions that were explicitly related to the environment, natural infrastructure, or nature-based solutions. Some plans included explanatory text for their actions, providing an opportunity for planners to be more specific in the approaches or tactics to be employed for that action. Many plans, on the other hand, only included the title or a brief description of their actions, making it difficult to interpret what the action might entail. We therefore took a conservative view of relevant actions to include in our analysis. We included only actions that explicitly discussed natural infrastructure or nature-based strategies (e.g., habitat conservation or restoration projects, green infrastructure projects, protection policies, etc.). We did not include the following types of actions:

- references to buyouts or acquisitions that just focused on the purchase of structures (unless they explicitly talked about converting the land to open or green space),
- stormwater projects (e.g., detention ponds or construction/clearing of drainage structures or creation of drainage management plans) that did not mention habitat restoration,
- drought-tolerant landscaping plans or ordinances (or vegetation management for drought that did not mention habitat conservation or restoration),
- beach re-nourishment (that did not talk about dune restoration),

[35] Alabama Emergency Management Agency, *Alabama State Hazard Mitigation Plan,* p 5 (July 18, 2019), *available at* https://alabamaema.files.wordpress.com/2018/11/state-of-alabama_state-hazard-mitigation-plan-2018-update_final_07182018.pdf [hereinafter Alabama Plan].

- erosion control plans/programs (or projects) that did not mention habitat,
- tree management, when focused only on pruning, and
- fire vegetation management (that did not mention habitat conservation or restoration).

We included actions where it was reasonable to interpret the action as primarily (or in large part) a nature-based activity. It is possible that in practice some of the actions or programs focus on other non-nature-based programmatic components to varying degrees. It is also possible that we screened out some actions that are in practice relevant nature-based strategies.

The documented actions were sorted into categories to better understand the range of strategies included in state plans across the country. The categories identified included:

- **Conservation/Preservation/Management**: Conservation/Preservation/Management actions are those that explicitly focus on protection or management of ecosystems or natural resources (e.g., protect wetlands, maintain creek banks, ecosystem preservation).

- **Restoration**: Restoration actions are those focused on restoration of natural habitats, usually wetlands, streambanks, floodplains, beaches, etc. These actions include dam removals, dune restoration, and restoration of native vegetation.

- **Green Infrastructure**: These actions call on the use of green infrastructure projects to address stormwater management.[36] Green infrastructure is generally implemented at the parcel-scale and is primarily conducted in urban areas. Many of the actions identified in this study broadly mention promoting or investing in green infrastructure projects, others describe more specific green infrastructure projects such as bioswales, rain gardens, or green roofs.

- **Land Use**: Land Use actions seek to address risks to communities through land use, including acquiring properties and converting to open space, planning and zoning guidelines or policy, and managing development in hazard-prone areas.

- **Funding and Programmatic**: Funding and Programmatic actions seek to create or expand preservation, restoration, or green infrastructure programs; develop or enhance funding programs; or develop implementation plans related to nature-based strategies.

- **Policy and Law**: Policy and Law actions call upon different agencies to develop and implement policies and regulations that would encourage or facilitate conservation and/or nature-based mitigation actions. These include promulgating wetland regulations, ensuring enforcement of policies, and integrating protection policies into existing plans.

- **Technical and Information**: Technical and Information actions include those related to studies, modeling, and development of tools (e.g., decision support tools). Sometimes these actions are related to better understanding risk and other times they include actions to identify future projects that will address identified risk.

[36] Green infrastructure refers to a way to collect and clean rainwater where it falls. Using plants and soil, green infrastructure projects reduce the amount of rainwater entering 'gray' water infrastructure (e.g., storm sewers, pipes). This can help reduce flooding. Green infrastructure projects can also help to clean and conserve water and provide recreational and other benefits to the community.

- **Education and Awareness**: Education and Awareness actions include those focused on development of guidance, conducting community outreach, and creating technical bulletins and training programs aimed at enhancing understanding of ecosystem services and non-structural mitigation measures.

- **Agency Coordination**: Agency Coordination actions encourage or promote coordination among state agencies or state and local agencies.

- **Partnerships**: Partnership actions encourage partnerships with non-profits, utilities, or other organizations to conduct mitigation strategies.

We also recorded which hazard the actions addressed and the plan goal/objective with which the actions were correlated. We were able to record these data for many, but not all, of the actions.

## Findings

Overall, plans varied widely in the extent to which they incorporated nature-based mitigation goals and objectives and actions.

### *Goals and Objectives*

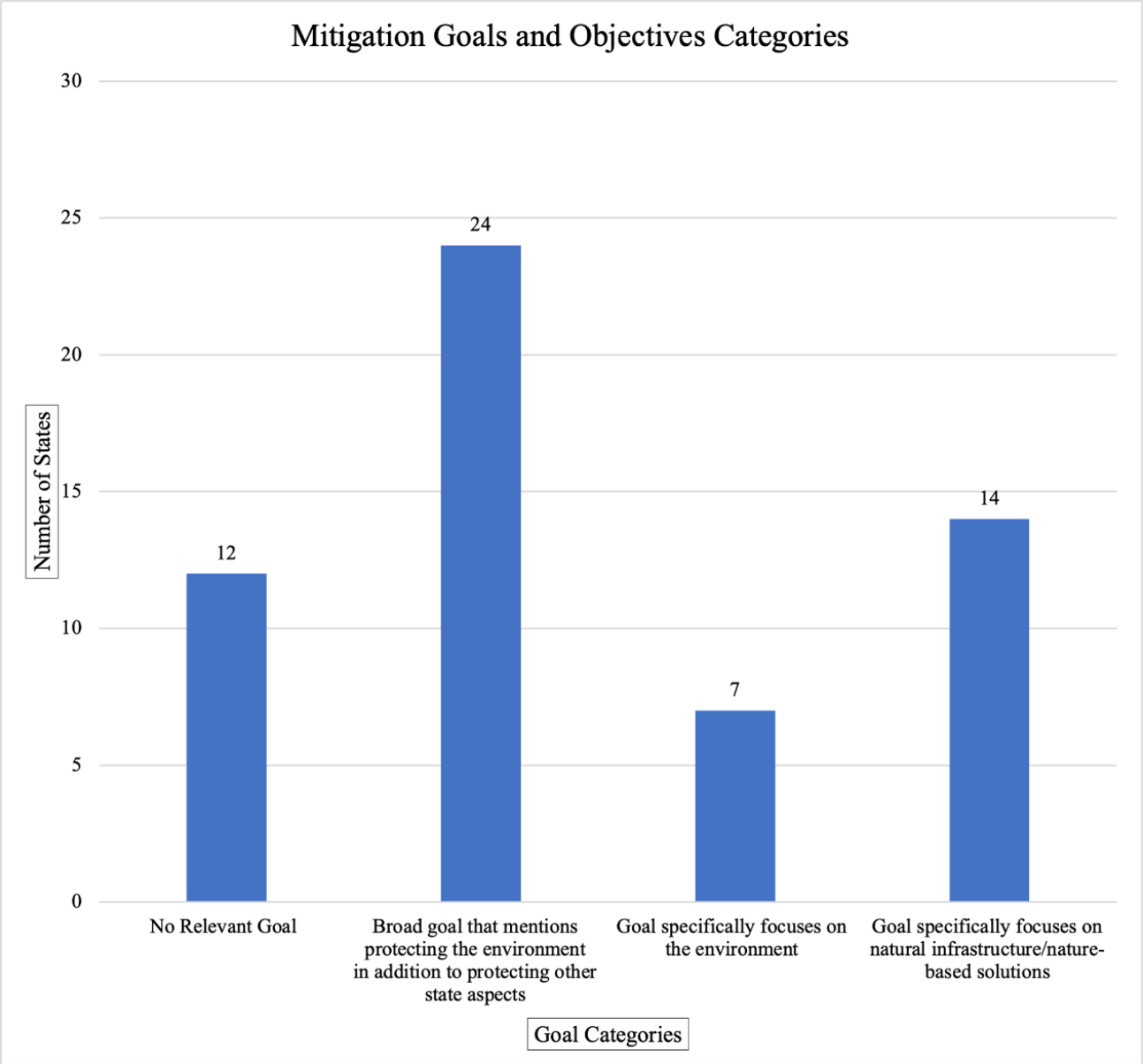
Mitigation goals are meant to guide the mitigation strategy and actions selection. As described by the state of Washington, plan goals are meant "to be general policy statements that reflect the state's priorities and commitment to risk reduction."[37] We identified 38 plans that had goals and objectives that were relevant to the environment (Table 1, and Appendix 2). Twelve plans did not include goals or objectives that explicitly mentioned the environment or natural resources. We identified three categories of plan goals, 1) broad goals that mention protecting the environment in addition to protecting other state aspects, 2) goals that specifically focus on the environment, and 3) goals that specifically focus on nature infrastructure/nature-based solutions (Table 1, Figure 1). Seven plans had more than one relevant goal type (e.g., New York had a broad goal that mentions the environment as well as a goal that specifically focuses on nature-based solutions).

**Table 1: Mitigation Goals and Objectives Categories**

| Goal Category | States Including Goal Category |
|---|---|
| No Relevant Goal | AK, AZ, DE, GA, IL, IN, KY, NV, OH, TN, WA, WY |
| Broad goal that mentions protecting the environment in addition to protecting other state aspects | AL, FL, HI, ID, IA, KS, LA, ME, MA, MN, MS, NH, NM, NY, NC, ND, PA, RI, SD, TX, VT, VA, WV, WI |
| Goal specifically focuses on the environment | CA, MD, MO, OK, OR, SD, UT |
| Goal specifically focuses on natural infrastructure/nature-based solutions | AR, CA, CO, CT, FL, MI, MS, MT, NE, NJ, NY, PA, SC, VT |

[37] Washington Emergency Management Division, *Washington State Enhanced Hazard Mitigation Plan,* p 168 (2018), *available at* https://mil.wa.gov/asset/5d1626c2229c8 [hereinafter Washington Plan].

**Figure 1: Mitigation Goals and Objectives**




*Note: 38 plans that had goals and objectives that were relevant to the environment. We identified three categories of goals: 1) broad goals that mention protecting the environment in addition to protecting other state aspect; 2) goals that specifically focus on the environment; and 3) goals that specifically focus on nature infrastructure/nature-based solutions.*

Almost half of the state plans (24) included broad goals that listed the environment or natural resources in a list of other state assets. For example, Idaho had a stated goal of reducing "the adverse economic and environmental impacts of natural, technological, and human-caused hazard events."[38] Similarly,

[38] Idaho Office of Emergency Managment, *State Hazard Mitigation Plan*, p 1-27 (2018), *available at* https://ioem.idaho.gov/preparedness-and-protection/mitigation/state-hazard-mitigation-plan/ [hereinafter Idaho Plan].

Alabama had a goal to "reduce the State of Alabama's vulnerability and increase resilience to hazards to protect people, property, and natural resources," and a sub-point objective to "promote hazard mitigation policies that reduce risk to people and property and protect the environment."[39]

Several plans (7) incorporated a goal specifically focused on the environment. For example, Maryland's goal: "Maryland Hazard Mitigation Plan Goal - To protect life, property, and the environment from hazard events through: Promote actions that protect natural resources, while enhancing hazard mitigation and community resiliency."[40] Oregon included a goal to "minimize the impact of natural hazards while protecting, restoring, and sustaining environmental processes,"[41] and Missouri included an objective to "consider sustainability issues (ecologically sound, economically viable, socially just, and humane) when developing or reviewing mitigation projects and plans."[42]

Other plans (14) sought to have the environment considered more specifically in the identification and implementation of mitigation strategies. Colorado, for instance, included a goal to "Support mitigation initiatives and policies that promote disaster resiliency, nature-based solutions, cultural resources and historic preservation, and climate adaptation strategies."[43] South Carolina's Goal 7 was to "enhance and encourage the use of natural resource protection measures as a means to reduce the impacts of hazards on people and property."[44] Similarly, Goal 3 in the California Plan recognized the importance of mitigating impacts to natural systems, while also addressing the connection between protecting the environment and improving disaster resilience:

> "Goal 3: Protecting the environment . . .
>
> > Objective 2: Encourage hazard mitigation measures that promote and enhance nature-based solutions, natural processes, and ecosystem benefits while minimizing adverse impacts to the environment.
> >
> > Objective 3: Encourage mitigation planning programs at all levels of government to protect the environment and promote enforcement of sustainable mitigation actions.

[39] Alabama Plan, p 313.
[40] Maryland Emergency Management Agency, *State of Maryland 2016 Hazard Mitigation Plan,* p 5-2 (Aug. 2016), *available at* https://mema.maryland.gov/community/Documents/2016_Maryland_Hazard_Mitigation_Plan_final_2.pdf [hereinafter Maryland Plan].
[41] Oregon Office of Emergency Management, *Oregon Natural Hazards Mitigation Plan,* p 21 (2015), *available at* https://www.oregon.gov/LCD/NH/Documents/Approved_2015ORNHMP.pdf [hereinafter Oregon Plan].
[42] Missouri State Emergency Management Agency, *Missouri Hazard Mitigation Plan,* p 4.4 (2018), *available at* https://sema.dps.mo.gov/docs/programs/LRMF/mitigation/MO_Hazard_Mitigation_Plan2018.pdf [hereinafter Missouri Plan].
[43] Colorado Department of Public Safety, *2018-2023 Colorado Hazard Mitigation Plan*, p 5-4 (2018) *available at https://drive.google.com/file/d/1bp0qDZTfOTO6bQa6TA8hv7_FLZZqSwxp/view* [hereinafter Colorado Plan].
[44] South Carolina Emergency Management Division, *South Carolina Hazard Mitigation* Plan, p 248 (Oct. 2018), *available at* https://www.scemd.org/media/1391/sc-hazard-mitigation-plan-2018-update.pdf [hereinafter South Carolina Plan].

> Objective 4: Coordinate and implement integrated and adaptive hazard mitigation, and watershed and habitat protection strategies, through public and private partnerships."[45]

The New York Plan also provides a useful example in which the mitigation goals more specifically include green infrastructure and nature-based solutions:

> "Goal 4: Encourage the development and implementation of long-term, cost effective, and resilient mitigation projects to preserve or restore the functions of natural systems.
>
> 4.1: Encourage the use of green and natural infrastructure.
>
> 4.2: Provide technical assistance to communities and stakeholders in the application and implementation of mitigation projects that preserve or restore natural systems.; Build stronger by promoting mitigation actions that emphasize sustainable construction and design measures to reduce or eliminate the impacts of natural hazards now and in the future."[46]

In addition to including these specific objectives under the environmentally-focused Goal 4, the New York Plan mentioned natural infrastructure under Goal 2, which was to "Protect existing property including public, historic, private structures, state-owned/operated buildings, and critical facilities and infrastructure."[47] The relevant objectives under that goal were to:

> "2.3: Encourage resilient and sustainable structural practices that reduce vulnerabilities and encourage the use of green and natural infrastructure.
>
> 2.4: Promote the continued use of natural systems and features, open space preservation, and land use development planning with local jurisdictions."[48]

### Other Approaches

In addition to the mitigation goals and objectives, some plans indicated their prioritization of nature-based strategies and environmental protections in other ways and in other components of their plans. The Massachusetts Plan included a broad goal that includes protecting the environment, but also included a section in its Hazard Mitigation and Climate Adaptation Strategy entitled "Importance of Nature-Based Solutions in Hazard Mitigation and Climate Adaption," which appeared after their Goals & Objectives.[49] The section defines Nature-Based Solutions (NBS) and gives specific examples of co-benefits from NBS projects for specific hazards (e.g. flooding), other initiatives (e.g. carbon

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[45] California Governor's Office of Emergency Services (Cal OES), *2018 California State Hazard Mitigation Plan,* p 70 (2018), *available at* https://www.caloes.ca.gov/HazardMitigationSite/Documents/002-2018%20SHMP_FINAL_ENTIRE%20PLAN.pdf [hereinafter California Plan].

[46] New York State Division of Homeland Security and Emergency Services, *2019 New York State Hazard Mitigation Plan, Mitigation Strategy* (2019), *available at* https://mitigateny.availabs.org/strategies/actions [hereinafter New York Plan].

[47] *Id.*

[48] *Id*.

[49] Massachusetts Emergency Management Agency, *Massachusetts State Hazard Mitigation and Climate Adaptation Plan,* p 7-3 (2018), *available at* https://www.mass.gov/files/documents/2018/10/26/SHMCAP-September2018-Full-Plan-web.pdf [hereinafter Massachusetts Plan].

sequestration), and measures of well-being (e.g. air and water quality).[50] It explicitly states that the co-benefits should be considered in decision-making and that "NBS should receive strong consideration over 'hard' infrastructure solutions, where feasible."[51] In addition, the plan noted that the prioritization framework the planners "used to rank the action items . . . includes nature-based approaches specifically designed to conserve and/or employ natural resources as the highest-priority ranking."[52] As we describe below, the Massachusetts plan had the most relevant actions of any of the plans reviewed for this study.

## *Mitigation Actions*

Thirty-nine of the 50 plans that we reviewed had relevant nature-based actions, such as the conservation and restoration of wetlands and floodplains and green infrastructure (Table 2, and Appendix 3). We identified 177 actions over the reviewed plans. With 30 relevant actions, Massachusetts was the state with the most actions. Three other plans had more than 10 relevant actions (New York, Vermont, Washington). The remaining states had fewer than 10 actions, most with five or fewer actions. Eleven states had no relevant actions.

As we described above, we identified a series of categories to organize the identified actions. We found the most actions were related to the Funding and Programmatic (37), Restoration (39), and Technical and Information (37) categories (Table 3, Figure 2). Many of the action categories were distributed across a number of states. Fifteen states had one or more funding and programmatic actions, 19 states had one or more restoration actions, and 11 states had one or more technical and information actions (Table 3, Figure 3).

**Table 2: Number of Mitigation Actions Per State**

| State | Number of Mitigation Actions per Hazard Mitigation Plan |
|---|---|
| Alaska | 3 |
| Alabama | 5 |
| Arizona | 0 |
| Arkansas | 1 |
| California | 2 |
| Colorado | 3 |
| Connecticut | 6 |
| Delaware | 3 |
| Florida | 0 |
| Georgia | 3 |

[50] Nature-based solutions (NBS) are defined as: The conservation, enhancement, and restoration of nature to reduce emissions, adaptation, and enhance resiliency. These types of solutions use natural systems, mimic natural processes, or work in tandem with traditional engineering approaches to address natural hazards like flooding, erosion, drought, and heat islands. Massachusetts Plan.
[51] Massachusetts Plan, p 7-3.
[52] Massachusetts Plan, p 7-4.

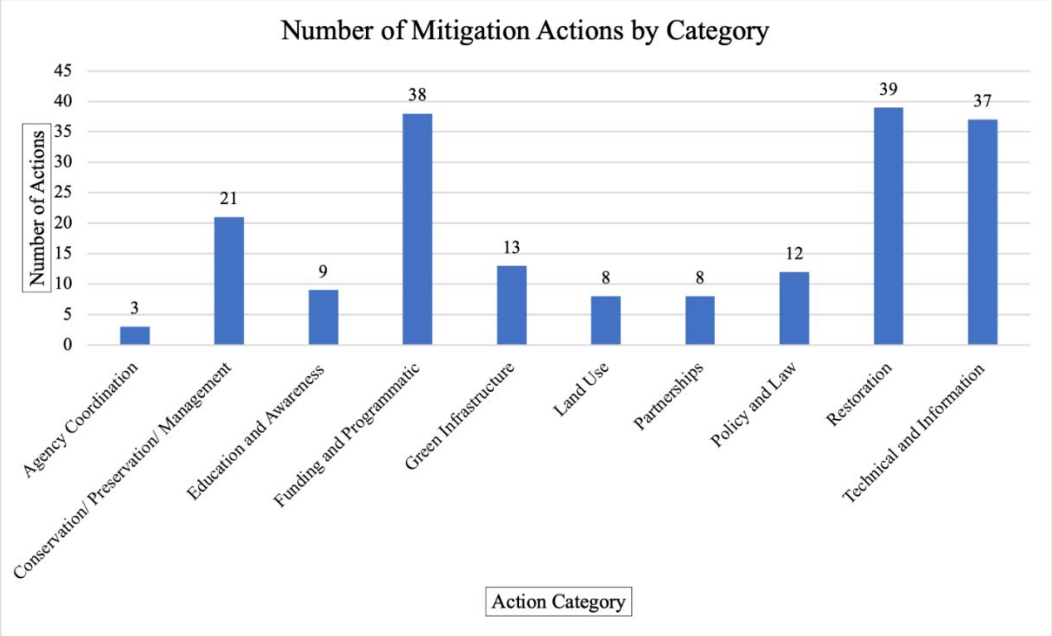
| State | Number of Mitigation Actions per Hazard Mitigation Plan |
|---|---|
| Hawaii | 5 |
| Idaho | 0 |
| Illinois | 1 |
| Indiana | 2 |
| Iowa | 6 |
| Kansas | 1 |
| Kentucky | 5 |
| Louisiana | 0 |
| Maine | 0 |
| Maryland | 3 |
| Massachusetts | 30 |
| Michigan | 2 |
| Minnesota | 4 |
| Mississippi | 1 |
| Missouri | 0 |
| Montana | 9 |
| Nebraska | 1 |
| Nevada | 3 |
| New Hampshire | 4 |
| New Jersey | 1 |
| New Mexico | 1 |
| New York | 17 |
| North Carolina | 2 |
| North Dakota | 0 |
| Ohio | 1 |
| Oklahoma | 0 |
| Oregon | 2 |
| Pennsylvania | 1 |
| Rhode Island | 3 |
| South Carolina | 3 |
| South Dakota | 0 |
| Tennessee | 1 |
| Texas | 4 |
| Utah | 3 |
| Vermont | 13 |
| Virginia | 0 |
| Washington | 13 |
| West Virginia | 0 |
| Wisconsin | 8 |
| Wyoming | 1 |

## Table 3: Mitigation Actions in Reviewed State Plans by Action Category

| Action Category | Number of Actions* | Number of States |
|---|---|---|
| Agency Coordination | 3 | **3 states** (CA, MA, MN) |
| Conservation/ Preservation/ Management | 21 | **17 states** (CO, DE, KY, MD, MA, MN, MS, MT, NV, NY, RI, SC, TX, VT, WA, WI, WY) |
| Education and Awareness | 9 | **7 states** (AL, CO, IN, MI, NY, NC, MD) |
| Funding and Programmatic | 38 | **16 states** (AL, CA, CT, MA, NE, NV, NH, NJ, NC, OH, OR, PA, SC, VT, WA, WI) |
| Green Infrastructure | 13 | **12 states** (AR, HI, IN, IA, KY, MD, MA, MN, NY, OH, RI, UT) |
| Land Use | 8 | **8 states** (AK, AL, DE, GA, IA, MT, NH, TX) |
| Partnerships | 8 | **8 states** (HI, MA, MI, MT, TN, TX, VT, WA) |
| Policy and Law | 12 | **9 states** (AK, AL, DE, GA, MA, MN, MT, WA, WI) |
| Restoration | 39 | **19 states** (AK, CO, CT, IA, KY, MD, MA, MN, MS, MT, NV, NM, NY, SC, TX, UT, WA, WI, WY) |
| Technical and Information | 37 | **11 states** (CT, GA, HI, IL, KS, MA, NH, NY, RI, VT, WA) |
| No Actions Included | -- | **11 states** (AZ, FL, ID, LA**, ME, MO, ND, OK, SD, VA, WV) |

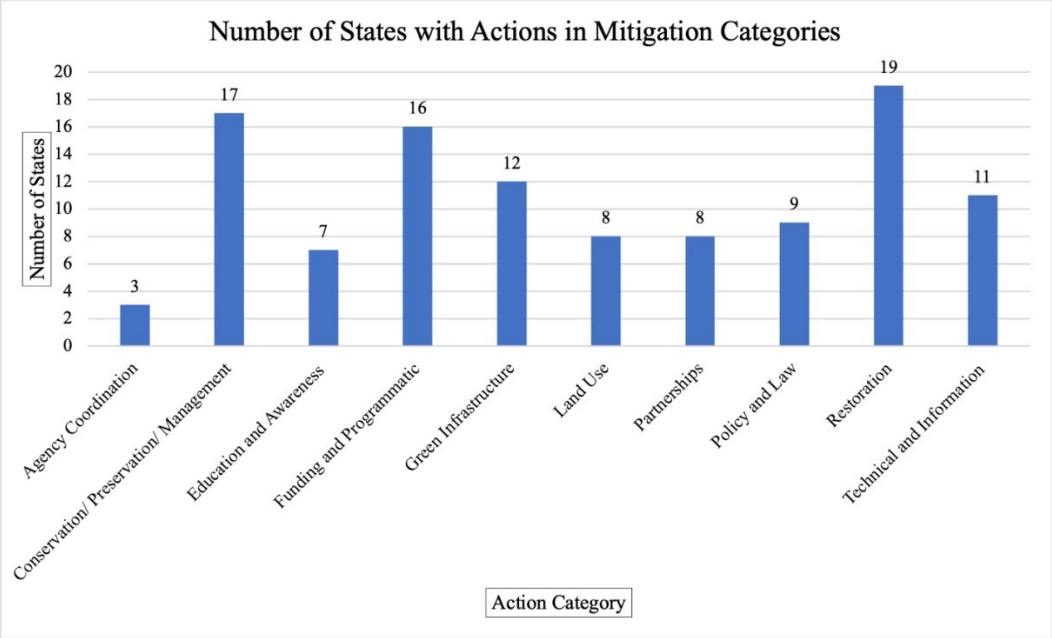
*Notes: * 11 actions were included in more than 1 category. ** The Louisiana plan does not include actions like other states, but has a technical appendix with possible mitigation actions.*

## Figure 2: Number of Mitigation Actions by Category




*Note: We identified a series of categories to organize the identified actions. The number of actions in each category varied by category; 11 actions were included in more than 1 category. We found the Restoration, Funding and Programmatic, and Technical and Information categories contained the most actions.*

## Figure 3: Mitigation Action Categories




*Note: We identified a series of categories to organize the identified actions. The number of states including a given category of action in their plan varied by the category. We found the most states had actions related to Restoration, Conservation/Preservation/Management, and Funding and Programmatic.*

Some plans identified the specific hazard that the action was meant to address (see Appendix 3). Many actions addressed a single hazard (e.g., flood); however, a number of actions were meant to address a range of identified hazards. Other plans did not identify a specific hazard for the identified action. We did not specifically focus on flood-related actions, but many of the nature-based actions were developed to address flood hazards.

Plans included varying levels of detail regarding each mitigation action proposed in their Mitigation Strategy. Some, such as the Kentucky Plan, only included what is suggested by FEMA regulations: the action itself, the hazards addressed, responsible agencies, and a funding option.[53] Others, such as the Alabama Plan, clearly delineated how each action contributed to the Mitigation Goals and Objectives, as well as information about priority levels and implementation planning. Other plans incorporated more narrative information, which can include anything ranging from rationale for the action, potential project approaches, connections with other ongoing programs, or more. The Wisconsin Plan, for example, included the action, supporting agencies, implementation status, background, and 2011 and 2016 update status for each action.

The following section elaborates on the different types of nature-based actions that were included in the plans.

[53] Kentucky Emergency Management, *2018 Kentucky Hazard Mitigation Plan* (2018), *available at* https://kyem.ky.gov/recovery/Pages/2018-Kentucky-Hazard-Mitigation-Plan-.aspx [hereinafter Kentucky Plan].

## Conservation/Preservation/Management

Conservation and preservation actions were those that were oriented towards protecting or managing natural areas or the mitigation and ecosystem services provided by a given ecosystem.

Many of these actions were directed towards a particular natural feature. The Kentucky Plan, for example, has an action to "Maintain Creek Banks."[54] Another example is Rhode Island's "Beach Ecosystem Preservation"[55] action, which aims to "preserve the dynamic nature of beaches and barriers in future management of these critical natural systems."[56] The Texas Plan included an action to "Restore and protect coastal wetlands and marshes. Coastal wetlands are transitional areas of vegetation and soils located between uplands and open marine water environments that are typically saturated or periodically inundated by tidal waters."[57]

Some plans explicitly tied the conservation of a habitat type to the ecosystem/mitigation services it provides. For example, a Minnesota action stated "[s]tream corridor protection projects and restoration and soil erosion control projects will be used to prevent or reduce risks and increase the protection of natural resources from flooding."[58]

Others, however, focused on the ecosystem services provided by a given feature and the importance of protecting those features from the impacts hazards pose, including Washington's action to "[r]educe the Conversion of Ecologically Important Lands for Development."[59] Other actions explicitly noted that the intention of the nature-based action was to reduce hazards and improve ecological outcomes. For example, one of Wyoming's actions was "[p]romote utilizing natural systems protections to protect and restore natural floodplain functions, such as stream restoration, forest management, conservation easements, and wetland preservation."[60]

## Restoration

A number of mitigation actions were oriented towards restoring the natural mitigation functions served by an ecosystem feature, usually wetlands, streambanks, floodplains, beaches, etc. Some of these, such as Texas's action to "[r]estore and protect coastal wetlands and marshes"[61] were brief and directed

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[54] Kentucky Plan, p Ms38.
[55] Rhode Island Emergency Management Agency, *State of Rhode Island State Hazard Mitigation Plan,* p 6-8 (2018), *available at* http://www.riema.ri.gov/forms-additional-resources/documents/Rhode%20Island%202019%20State%20Hazard%20Mitigation%20Plan-COMBINED_DRAFT.pdf [hereinafter Rhode Island Plan].
[56] Rhode Island Plan, p F-19.
[57] Texas Division of Emergency Management, *State of Texas Hazard Mitigation Plan,* p 304 (2018) *available at* http://tdem.wpengine.com/wp-content/uploads/2019/08/01-Texas-SHMP-FINAL-Adopted-10.17.2018.pdf [hereinafter Texas Plan].
[58] Minnesota Department of Public Safety & Division of Homeland Security and Emergency Management, *Minnesotta Hazard Mitigation* Plan, p 227 (2019), available *at* https://dps.mn.gov/divisions/hsem/hazard-mitigation/Documents/2019-mn-hmp-only.pdf [hereinafter Minnesota Plan].
[59] Washington Plan, p 236.
[60] Wyoming Office of Homeland Secutiry, *Wyoming State Mitigation Plan*, p 301 (2016), *available at* https://www.wsspc.org/wp-content/uploads/2019/07/Final_Wyoming-State-Mitigation-plan_012516.pdf [hereinafter Wyoming Plan].
[61] Texas Plan, p 304.

towards an ecosystem feature. Other similar actions include Maryland's "[c]oastal Restoration to Mitigate Hazards for Vulnerable Communities,"[62] and Mississippi's "[p]reserve, create, and restore natural systems to serve as natural mitigation functions."[63]

Others, such as Wisconsin's action to "[e]ncourage restoration of natural wetland functions,"[64] explicitly recognized the hazard mitigation potential of wetlands. In the background section on the action, the Wisconsin Plan stated "[w]etlands provide natural flood storage areas. Restoring the natural function of these areas can reduce the flooding potential of other areas in the watershed."[65] Iowa's action to "[i]mplement floodplain and streambank restoration/channel improvement projects that reduce peak flow during flood events,"[66] was explicit about the hazard mitigation value of restoration efforts. A similar Iowa action sought to "[m]inimize damage and also preserve/restore the functions of natural systems by establishing vegetated buffers and strategically-placed wetlands that capture runoff and drainage waters before they can negatively impact the surrounding environment."[67]

Other plans encouraged nature-based restoration using specific techniques. For example, Montana proposed to "[e]ncourage Natural Channel Design (NCD) techniques for stream restoration and bank restoration/stabilization projects to increase flood resiliency" and "projects that will increase stream length to regain natural function and reduce impact of flooding."[68] Restoration projects that explicitly encouraging hydrologic restoration or projects that highlight specific ecological outcomes where natural infrastructure is optimized are especially valuable.

### Green Infrastructure

Twelve state plans sought to incorporate green infrastructure[69] into urban spaces to address stormwater and flood (and other) hazards. Often, these actions called on the use of green infrastructure techniques to address certain challenges, such as using "[g]reen stormwater infrastructure"[70] to expand the capacity of traditional stormwater systems in the Rhode Island Plan or "[p]romote, develop Green

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[62] Maryland Plan, p 5-21.

[63] Mississippi Emergency Management Agency, *State of Mississippi Standard Mitigation Plan*, p 2-15 (2018), *available at* https://www.msema.org/wp-content/uploads/2020/10/State-of-Mississippi-2018-plan-update-with-Dam-Safety-FEMA-revisions-2020-07-15.pdf [hereinafter Mississippi Plan].

[64] Wisconsin Emergency Management, *2016 State of Wisconson Hazard Mitigation Plan*, p 3-34 (2016), *available at* https://dma.wi.gov/DMA/wem/mitigation/2016-hazard-mitigation-plan [hereinafter Wisconsin Plan].

[65] *Id.*

[66] Iowa Department of Homeland Security and Emergency Management, *2018 Iowa Hazard Mitigation Plan,* p 5-54 (2018), *available at* https://homelandsecurity.iowa.gov/disasters/hazard-mitigation/ [hereinafter Iowa Plan].

[67] Iowa Plan, 5-55.

[68] Montana Department of Military Affairs Disaster and Emergency Services, *2018 Update State of Montana Multi-Hazard Mitigation Plan Statewide Hazard Assessment,* p 5-13 (2018), *available at* https://drought.unl.edu/archive/Plans/GeneralHazard/State/MT_2018.pdf [hereinafter Montana Plan].

[69] As defined by FEMA, "[g]reen infrastructure is a sustainable approach to natural landscape preservation and storm water management that can be used for hazard mitigation activities as well as provide additional ecosystem benefits. Green infrastructure provides a framework and methodology for implementing flood risk reduction and drought mitigation actions in a manner that also incorporates ecosystem benefits and helps build a community's resilience to the impacts of climate change." https://www.fema.gov/media-library-data/1487161212568-3b313a4502545a8cf6846f36d53e1367/GI_Fact_Sheet_Feb2017_COMPLIANT.pdf

[70] Rhode Island Plan, p F-16.

Infrastructure/Low-Impact Development Projects"[71] to address flooding and landslides in the Kentucky Plan. The Arkansas Plan's action to "[u]se green mitigation techniques such as bio swales, rain gardens, and permeable pavers,"[72] provided examples of specific green infrastructure actions that could be employed.

The Iowa Plan provided specific green infrastructure techniques and their hazard mitigation benefits:

> Encourage and implement green infrastructure practices to create healthier urban environments and manage storm water in cities. Practices include mechanisms that prevent soil erosion or provide flood protection, habitat, and cleaner air and water (riparian forest buffers, infiltration including bioswales, wet detention systems, storm water wetlands, vegetated swales, permeable pavement, and green roofs).[73]

In addition to addressing the mitigation benefits of green infrastructure strategies, some actions included the broader ecosystem benefits they confer. The Minnesota Plan, for example, sought to use green infrastructure to mitigate the environmental drivers of natural hazards they experience: "Reduce Urban Heat Island Effect. Increase tree plantings around buildings to shade parking lots and along public rights-of-way. Encourage installation of green roofs and cool roofing products that reflect sunlight and heat away from a building."[74]

Finally, some plans proposed actions that incorporated both green and gray infrastructure. The Utah Plan included an action to "[c]onstruct debris basins, flood retention ponds, bioswales & energy flow dissipaters in an effort to control the flow and release of flood waters."[75] Other actions mention green infrastructure as an example of a strategy that could be used to implement a particular action. The Indiana Plan, for example, includes an action to "[r]etrofit state facilities to provide adequate capabilities in the event of disasters … [and] include green infrastructure to reduce unnecessary strain on water resources."[76]

Some states have proposed actions that seek to determine how green infrastructure might best be implemented in their state. Maryland, for example, has proposed to "[i]ncrease opportunities for communication about adaptation planning in Maryland, facilitate the exchange of ideas between Chesapeake Bay watershed partners, and pilot green/grey infrastructure to prepare for and respond to climate impacts to vulnerable populations."[77] Additional actions that seek to increase technical capacity around green infrastructure will be further discussed in the section on Technical and Information actions.

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[71] Kentucky Plan, p MS 37.
[72] Arkansas Division of Emergency Management, *State of Arkansas All-Hazards Mitigation Plan*, p 6-5 (2018), *available at* https://www.dps.arkansas.gov/emergency-management/adem/plan-prepare/hazard-mitigation/ [hereinafter Arkansas Plan].
[73] Iowa Plan, p 5-54.
[74] Minnesota Plan, p 231.
[75] Utah Division of Emergency Management, *State of Utah Hazard Mitigation Plan*, p 380 (2019), *available at* https://hazards.utah.gov/state-of-utah-hazard-mitigation-plan/ [hereinafter Utah Plan].
[76] Indiana Department of Homeland Security, *2019 State of Indiana Standard Multi-Hazard Mitigation Plan,* p 250 (2019), *available at* https://www.in.gov/dhs/files/Indiana-State-Mitigation-Plan-2019-Optimized.pdf [hereinafter Indiana Plan].
[77] Maryland Plan, p 5-25.

## Land Use

Various plans sought to address risks to communities through land use plans or through zoning, growth management guidelines, or other land use regulations.

Various regulatory actions sought to improve or establish new zoning requirements that would encourage conservation and nature-based actions. Some of these targeted development in vulnerable areas, such as New Hampshire's action that recommended "a comprehensive planning and zoning policy such as development setbacks and limits on density and infrastructure in coastal and transitional zones to consider vulnerability to sea level rise and saltwater intrusion."[78] Others, such as Delaware's action to "[e]ncourage greenways 'zoning' along river corridors"[79] to address flooding, referred more directly to nature-based strategies. Georgia included an action seeking to improve implementation of such ordinances: "Minimize damage to natural resources through the use of and compliance with greenspace, stream buffers, zoning ordinances as actions to protect Georgia communities."[80]

Most plans included at least one acquisition-related action.[81] While these may be helpful in preserving open space, we only included actions in our analysis that were explicit about converting the land to open space. For example, the Iowa plan proposed to "[a]cquire more flood prone properties (with priority for repetitive loss and SRL [Severe Repetitive Loss] properties) and convert to open space/green space; or elevate to or at least one foot above base flood elevation."[82]

## Funding and Programmatic Actions

Funding and Programmatic actions are those that seek to create or expand state or local preservation, restoration, or green infrastructure programs; develop or enhance of state or local funding programs; or develop implementation plans related to nature-based strategies.

Some actions proposed to improve initiatives through existing programs that would encourage green infrastructure or nature-based strategies include Washington's Voluntary Stewardship Program, which "provides an alternative approach for counties to address [the] state's Growth Management Act requirements through ecological protection like wetlands/other areas deemed critical,"[83] and

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[78] New Hampshire Homeland Security Emergency Management, *State of New Hampshire Multi-Hazard Mitigation Plan,* p 244 (2018), *available at* https://prd.blogs.nh.gov/dos/hsem/wp-content/uploads/2015/11/State-of-New-Hampshire-Multi-Hazard-Mitigation-Plan-Update-2018_FINAL.pdf [hereinafter New Hampshire Plan].

[79] Delaware Emergency Management Agency, *State of Delaware All-Hazard Mitigation Plan,* p 6.2-7 (2018), *available at* https://www.dema.delaware.gov/contentFolder/pdfs/HazardMitigationPlan.pdf [hereinafter Delaware Plan].

[80] Georgia Emergency Management and Homeland Security Agency (GEMA/HS), *Georgia Hazard Mitigation Strategy*, p 137 (2019), *available at* https://gema.georgia.gov/document/publication/2019-georgia-hazard-mitigation-strategypdf/download [hereinafter Georgia Plan].

[81] Floodplain buyouts, or the voluntary acquisition of flood-damaged property, are intended to mitigate flood damage by moving people and structures out of harm's way. Buyouts can be completed under federal, state, and sometimes local programs, but the largest source of funding is FEMA's Hazard Mitigation Grant Program (HMGP). Once structures are removed and the land is graded, acquired properties must be dedicated to "open space." Deed restrictions that effectively mitigate future risk of structural damage must be attached to the property title.

[82] Iowa Plan, p. 5-49.

[83] Washington Plan, p 236; Washington Plan, p 11 (The Growth Management Act (GMA) of 1990 requires all cities, towns and counties to identify and protect critical areas, such as frequently flooded areas and geologically

Wisconsin's proposal to "give extra points to communities applying for DNR Stewardship programs if their proposal includes mitigation elements (including removing floodplain from development)."[84] Similarly, the New Hampshire Plan included an action to "[c]ontinue the development of local and regional river corridor stewardship programs such as the Rivers Management and Protection Program."[85]

A number of actions were centered around funding programs. Some sought to facilitate funding opportunities, such as Pennsylvania's action to "[i]dentify cooperative funding opportunities for natural system protection projects."[86] Others endorsed implementation of nature-oriented projects, such as Wisconsin's action to "[i]mplement the Municipal Flood Control and Riparian Restoration (MFC) grant program."[87] Some of these actions simply described providing funding for specific actions. For example, California's action to "[p]rovide funding to local agencies in the Sacramento San Joaquin for levee maintenance and improvement and for habitat mitigation and enhancement."[88]

The Vermont Plan provides examples of actions that also describe how the state will support such efforts and ensure that they are environmentally sound. Its plan included actions to "[e]stablish a statewide conservation and buyout program" and to "[c]reate a dedicated State fund to support the purchase or local match of hazard-prone properties and the purchase of easements to conserve river corridors, floodplains, and wetlands identified as key flood attenuation areas."[89] Similarly, one of Vermont's actions tied the nature-based action to a particular hazard and its impacts: "Expand use of USDA conservation programs to plant riparian buffers and flood chute grassed waterways to reduce future flood damage to farm fields, attenuate flood-borne sediment and debris, and reduce downstream flooding."[90]

Some plans include actions related to climate change. New Hampshire's action to "[p]romote funding and resources for land acquisition, conservation planning, land management programs, and land stewardship in areas at risk of loss or degradation due to sea level rise" focused on the impacts associated with sea-level rise.[91] Wisconsin included an action to "[i]ncorporate Climate Resilient Mitigation Activities (CRMAs) as defined by FEMA (including Aquifer Storage and Recovery; Floodplain and Stream Restoration; Flood Diversion and Storage; and Green Infrastructure) into WEM's scoring

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hazardous areas, and for the fastest-growing counties (and their cities) to develop comprehensive land use plans to limit growth to identified urban growth areas (RCW 36.70A)).

[84] Wisconsin Plan, pp 3-32, 135.

[85] New Hampshire Plan, p 246.

[86] Pennsylvania Emergency Management Agency, *Commonwealth of Pennsylvania 2018 State Hazard Mitigation Plan,* p 735 (Oct. 2018), *available at* https://pahmp.com/wp-content/uploads/2018/10/PA-2018-Approved-HMP.pdf [hereinafter Pennsylvania Plan].

[87] According to the Background for this action, "Grants are available biennially, typically in the spring of even years, for projects that reduce flood risk. Projects shall minimize harm to existing beneficial functions of water bodies and wetlands, maintain natural aquatic and riparian environments, use stormwater detention and retention structures and natural storage to the greatest extent possible, and provide opportunities for public access to water bodies and to the floodplain." Currently the main focus of the program is supporting the non-federal match needed for FEMA buyouts. Wisconsin Plan.

[88] California Plan, Appendix C-23.

[89] Vermont Division of Emergency Management, *2018 State Hazard Mitigation Plan,* p 149 (Nov. 2018), *available at* https://vem.vermont.gov/plans/SHMP [hereinafter Vermont Plan].

[90] *Id.*

[91] New Hampshire Plan, p 241.

system for preapplications,"[92] noting in the action background that "[c]limate resilience is a state and national priority. FEMA has identified several new project types (CRMAs) that are eligible for funding under the HMA grant programs.[93] BCA guidance for these new project types has also been released. To show the importance of these types of projects, WEM [Wisconsin Emergency Management] will adjust the scoring for the pre-applications for the HMA grant programs to include points for CRMAs."

### Policy and Law Strategies

These actions mainly call upon different agencies to make changes to policies and regulations that would encourage or facilitate conservation or nature-based actions. These include promulgating wetland regulations, ensuring enforcement of policies, and integrating protection policies into existing plans.

Some actions addressed developing or modifying state or local regulations. The Alabama Plan included an action to "[d]evelop regulations that preserve and rehabilitate natural systems to serve natural hazard mitigation functions (i.e., floodplains, wetlands, watersheds, and urban interface areas)."[94] Massachusetts had an action to "[p]romulgate wetlands regulations to establish performance standards for work in land subject to coastal storm flowage."[95]

A different type of policy and law action aimed to integrate policies into other planning efforts. The Minnesota Plan, for example, had an action to "[r]equire incorporation of water-sensitive infrastructure – such as protection of natural areas, development of green infrastructure, and minimization of impervious areas to treat both water quality and quantity – in all comprehensive plans and watershed plans."[96] A couple of plans included actions related to enforcement. For example, the Wisconsin Plan stated, "[p]rovide workshops and distribute informational materials to improve understanding and enforcement of floodplain, coastal, shoreline, and wetland regulations, including mitigation techniques."[97]

### Technical and Information Actions

An important set of actions can orient states towards achieving higher technical capacity and know-how with respect to conservation and nature-based solutions. Technical and information actions include those related to studies, modeling, and development of tools (e.g., decision support tools). Sometimes these actions were related to better understanding risk and other times they included actions to identify future projects that would address identified risk.

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[92] Wisconsin Plan, p 3-68.
[93] "Climate Resilient Mitigation Activities including green infrastructure methods, expanded ecosystem service benefits, and three flood reduction and drought mitigation activities: Aquifer Storage and Recovery (ASR), Floodplain and Stream Restoration (FSR), and Flood Diversion and Storage (FDS)." FEMA, *Floodplain and Stream Restoration Fact Sheet* (2015), *available at* https://www.epa.gov/sites/production/files/2016-04/documents/fema_floodplain_stream_restoration_fact_sheet-sept_2015.pdf
[94] Alabama Plan, p 339.
[95] Massachusetts Plan, p 7-26.
[96] Minnesota Plan, p 226.
[97] Wisconsin Plan, p 3-35.

A number of plans included actions related to conducting studies aimed at identifying future projects. For example, the Connecticut Plan included an action to "[i]dentify and map the locations of headwater, main stem and coastal dams, culverts, bridges, and other structures or land modifications that contribute to flood damage and act as barriers to habitat connectivity, and assess the feasibility of removal or modification of these structures."[98] The Illinois Plan included an action to "[w]ork in developing and maintaining a database on all protected lands, identifying possible partners in the acquisition and maintenance of hazard prone lands contiguous to protected lands."[99]

Two plans discussed the development of decision-support tools. New York called for "[i]ntegrating SLAMM [Sea Level Affecting Marshes Model] results and stakeholder priorities to define marsh adaptation strategies: Building on the previous SLAMM project, this project will better incorporate roads and infrastructure into the analysis, better visualize marsh migration pathways, and develop a decision-support tool that will assist decision makers in planning adaptation strategies for marsh conservation and coastal community resiliency."[100] The Massachusetts Plan included an action to "[u]pdate and share a dam removal decision support tool that directly incorporates new climate change projections, climate adaptation benefits and helps municipalities and others prioritize dams for removal."[101]

Massachusetts also had a number of species-related actions, including "valuation of climate change impacts on common species,"[102] "[u]pdates to BioMap2" (identifies areas where conservation efforts should be focused in order to protect plant and wildlife biodiversity in Massachusetts),[103] and "[i]dentification of areas with high native aquatic biodiversity to help prioritize aquatic adaptation actions as the climate changes."[104]

Other plans included actions related to gathering specific data or models. For example, the Massachusetts Plan included an action to "[u]pdate precipitation data used by wetlands program."[105] The Vermont Plan included an action to "[d]evelop hydraulic and stream power models for a range of flood frequencies to analyze and define valley areas supporting essential floodplains and river corridor functions that would increase the storage of flood flows, sediments, and nutrients."[106] Several plans mentioned mapping studies or development of GIS layers. For example, the New Hampshire Plan included the action to "[c]ontinue to develop and maintain GIS layers as a multi-agency collaborative effort to capture data."[107]

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[98] Connecticut State Division of Emergency Management and Homeland Security, *Connecticut Hazard Mitigation Plan*, p 470 (2019) https://portal.ct.gov/-/media/DEMHS/_docs/Plans-and-Publications/EHSP0023--NaturalHazardMitPlan.pdf [hereinafter Connecticut Plan].

[99] Illinois Emergency Management Agency, *2018 Illinois Natural Hazard Mitigation Plan*, p. IV-41 *(*2018), *available at* https://www2.illinois.gov/iema/Mitigation/documents/Plan_IllMitigationPlan.pdf [hereinafter Illinois Plan].

[100] New York Plan.

[101] Massachusetts Plan, p 7-18.

[102] Massachusetts Plan, p 7-31.

[103] *Id.*

[104] Massachusetts Plan, p 7-50.

[105] Massachusetts Plan, p 7-26.

[106] Vermont Plan, p 148.

[107] New Hampshire Plan, p 243.

## Education and Awareness

Education and awareness actions included those focused on development of guidance, conducting community outreach, and creating technical bulletins and training programs aimed at enhancing understanding of ecosystem services and non-structural mitigation measures.

An important type of capacity-building action sought to incorporate natural infrastructure or conservation into other strategies or to create new plans or policies. Some of these sought to provide more information for practitioners on natural infrastructure, such as Wisconsin's proposal to "[p]rovide workshops and distribute informational materials to improve understanding and enforcement of floodplain, shoreline, coastal, and wetland regulations."[108] Similarly, an Alabama action sought to "[c]reate technical bulletin that educates local floodplain managers to account for and incorporate wetland protection and mitigation sites into the planning process when preparing new studies for watercourses."[109] In another example, Colorado's Plan had an action to "[e]nhance the natural and beneficial functions of floodplains by promoting an increased awareness of stream ecosystem function and its benefits to flood hazard mitigation."[110]

Some of these actions were oriented towards increasing knowledge among residents and community members. The Indiana Plan included an action to ""[d]evelop an outreach program to educate communities on green infrastructure and provide opportunities for them to seek additional training."[111]

## Agency Coordination

We found a few actions that specifically encouraged or promoted coordination among state agencies or state and local agencies. For example, "coordinate the activities of state agencies to improve air and water quality; protect natural resources and agricultural lands"[112] in California and "promote collective action between state agencies to address the stability of natural systems in the built environment by providing sufficient water storage, reducing volume, slowing velocity, and promoting practices to stabilize soils and maintain the diversity of native plant communities" in Minnesota.[113] The Massachusetts Plan included an action to promote coordination to achieve climate change adaption—"review habitat management, land stewardship, coastal zone management, agricultural and invasive species programs and policies to develop strategies that promote coordination among agencies and support climate change adaptation and mitigation goals."[114]

## Partnerships

Some mitigation actions also supported synergies and opportunities for integration with other groups and/or plans. For example, several plans included actions to build partnerships for conservation, including "[r]ecruit conservancy agencies to purchase and maintain key undeveloped land in coastal

[108] Wisconsin Plan, p 3-35.
[109] Alabama Plan, p 327.
[110] Colorado Plan, 5-26.
[111] Indiana Plan, p 246.
[112] California Plan, Appendix C-8.
[113] Minnesota Plan, p 225.
[114] Massachusetts Plan, p 7-55.

areas"[115] in Texas, to "[w]ork with land conservation organizations to include river corridor and floodplain protection provisions, and/or headwater storage in conservation easements"[116] in Vermont, and "[s]upport the Hawai'i Association of Watershed Partnerships" in Hawai'i.[117]

The Tennessee Plan included an action to bring in non-profit organizations into the plan development itself: "Develop a strategy for empowering non-profit groups such as environment or watershed protection organizations to support local hazard mitigation planning by October 2021."[118] This is a good example of how states could support and build the capacity of natural resource organizations to participate in the planning process; thereby increasing the opportunities for informed nature-based strategies to be included in future plans.

### Including Detailed or Location-Specific Actions

There is some tension over the degree of specificity plans should use when detailing their proposed actions.[119] On one hand, greater detail may facilitate the process of getting grant funding for projects that closely match the action in question, and signals that more thought and preparation has gone into the development of the idea. On the other hand, more general actions provide some flexibility to take advantage of project opportunities as they arise (especially for state plans). The majority of the state plans did not include any geographically specific actions. However, we did identify a few plans that included some actions for specific projects. Further, as they are more directly tied to community needs and goals, local plans may provide a better opportunity for integrating more specificity in projects and thus may provide an important opportunity for integrating restoration goals and actions.[120]

The New York Plan provided an interesting example as to how the mitigation strategy could incorporate actions that were highly geographically specific while still allowing for flexibility. The Plan added some geographic-specific actions in addition to some related broader actions. For example, it had both an action on "Wetlands restoration: Include wetlands restoration as part of waterfront development

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[115] Texas Plan, p 296.

[116] Vermont Plan, p 147.

[117] Hawai'i Emergency Management Agency, *State of Hawai'i 2018 Hazard Mitigation Plan*, p. 6-8 (2018), *available at* https://dod.hawaii.gov/hiema/files/2018/11/State-of-Hawaii-2018-Mitigation-Plan.pdf [hereinafter Hawai'i Plan].

[118] Tennessee Emergency Management Agency, *State of Tennessee Hazard Mitigation Plan*, p.13 (2018), *available at* https://www.tn.gov/content/dam/tn/tema/documents/hazard-mitigation-plan/Tennessee%20Hazard%20Mitigation%20Plan%202018%20FINAL.pdf [hereinafter Tennessee Plan].

[119] In California, for example, local mitigation plans include only broad descriptions of potential mitigation actions that are not yet fully flushed out projects due to the possibility of triggering a California Environmental Quality Act (CEQA) environmental review on the plan. The CEQA review can occur during the adoption process of a final local hazard mitigation plan if the local jurisdiction governing board feels there is anything "actionable" in the plan, specifically mitigation actions. A CEQA review could hold up the LHMP approval. Personal communication with California Governor's Office of Emergency Services.

[120] For example, the Nebraska state plan focuses primarily on reducing risk from all hazards through supporting implementation of mitigation actions identified in Local Hazard Mitigation Plans. The 2021 plan included only 5 state level mitigation actions that address the 2019 flooding event. Nebraska Emergency Management Agency, *2021 Nebraska State Hazard Mitigation Plan* (2021), *available at* https://nema.nebraska.gov/sites/nema.nebraska.gov/files/doc/hazmitplan2021.pdf. ELI examined 119 local hazard mitigation plans to identify examples of how states are including natural infrastructure or natural resource protection or restoration as mitigation goals and actions. We found over 275 relevant actions. See our report at https://www.eli.org/land-biodiversity/hazard-mitigation-planning

projects to comply with aesthetic permitting or stormwater management requirements," and an action on "Flushing Airport Wetlands Restoration: Implement Flushing Airport Wetlands Mitigation Project in College Point, Queens."[121] The Plan is innovative and unique in that the state has published it in the form of a website rather than a document, so that it is more user-friendly and can be updated in between the 5-year validity intervals.[122]

## *Tribal Hazard Mitigation Plans*

In recognition of tribal sovereignty and the unique needs of Indian Tribal governments, FEMA established requirements for Tribal Hazard Mitigation Plans separate from State and Local Mitigation Plans.[123] Prior to the 2009 final rule, tribal governments could prepare a State-level Mitigation Plan (if they intended on applying directly for FEMA funds as a grantee), or a Local-level Mitigation Plan (if they intended on applying for FEMA funds through the State as a subgrantee). Final Tribal Mitigation Planning Guidelines became effective March 2010.[124] According to FEMA's website, 222 tribal governments across the country have current tribal hazard mitigation plans.[125]

Tribal planning requirements are similar to the state requirements, but with some differences.[126] Tribal plans must document the planning process, "including how it was prepared, who was involved in the process, and how the public was involved." This process must include an opportunity for public comment, **"**including a description of how the Indian tribal government defined 'public.'"[127] In addition, the planning process must provide an opportunity for "neighboring communities, tribal and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia, and other private and nonprofit interests to be involved in the planning process." The process must also review and incorporate "existing plans, studies, and reports," and "be integrated to the extent possible with other ongoing tribal planning efforts as well as other FEMA programs and initiatives."[128]

FEMA regulations recognize the need for Tribal governments to have opportunity to define "public" and determine how to best involve tribal members and stakeholders. The planning process, including how public meetings are announced and facilitated, may be different for Indian Tribal governments. A successful tribal planning process must be inclusive and work within the traditions, culture, and methods most appropriate for the Indian Tribal government. In the end, the process must ensure that

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[121] New York Plan.
[122] Colin Wood, *Why New York City spend a year converting its 500-page hazard plan into a website,* State Scoop (May 22, 2019) https://statescoop.com/why-new-york-city-spent-a-year-converting-its-500-page-hazard-plan-into-a-website/.
[123] Mitigation Planning 44 CFR 201 at 72 Fed. Reg. 61720 (interim rule in October 2007 established the tribal mitigation plan, and 2009 final rule clarified tribal planning requirements).
[124] FEMA, *Tribal Multi-Hazard Mitigation Planning Guidance* (March 2010), *available at* https://emilms.fema.gov/IS318/assets/tribal_planning_guidance_may2010.pdf.
[125] FEMA, *Hazard Mitigation Plan Status* (Feb. 24, 2021), *available at* https://www.fema.gov/emergency-managers/risk-management/hazard-mitigation-planning/status.
[126] Tribal Mitigation Plans 44 CFR § 201.7; FEMA, *Tribal Mitigation Planning Handbook* (May 2019), *available at* https://www.fema.gov/sites/default/files/2020-06/fema-tribal-planning-handbook_05-2019.pdf.
[127] FEMA, *Tribal Multi-Hazard Mitigation Planning Guidance* (March 2010), *available at* https://emilms.fema.gov/IS318/assets/tribal_planning_guidance_may2010.pdf.
[128] Tribal Mitigation Plans 44 CFR § 201.7.

participants understand the risks and vulnerabilities addressed in the plan and that goals, priorities, and mitigation actions reflect Tribal values.

Tribal governments may seek opportunities to honor traditional beliefs and cultural and natural resources in the planning process and in the plan itself, in a way state or local planners may not. The Lac du Flambeau Plan, for example, opens with a statement of the importance of natural resources to the people of Lac du Flambeau: "For the Lac du Flambeau Tribe, water is part of their daily existence. About half of their reservation is open water or wetlands and water nourishes both the people and the natural resources on the reservation. For the Ojibwe people, natural resources are cultural resources and water plays a vital role in ensuring that the community continues to thrive with a changing climate."[129] This introduction sets the tone for the rest of the plan and establishes resource stewardship as a critical principle guiding the rest of the plan development.

Tribal mitigation strategy requirements are similar to state hazard mitigation plans. Tribal plans must have a "description of mitigation goals," "a section that identifies and analyzes a comprehensive range of specific mitigation actions and projects," an action plan describing how the mitigation actions identified will be "prioritized, implemented, and administered," a discussion on tribal capabilities, and a section on "current and potential sources of Federal, tribal, or private funding to implement mitigation activities."[130] However, the land within the Tribe's planning area may contain natural and cultural resources and sacred sites or other land of importance to the Tribe's culture, history and values that must be taken into account when developing mitigation goals and strategies. Further, Tribal plans may include goals and objectives that have a particular focus on the wellbeing of the Tribal community.

In a review of a small set of tribal mitigation plans, we found hazard mitigation goals and strategies that were similar to the kinds of goals and actions we found in state hazard mitigation plans. For example, the Lac du Flambeau Tribe Hazard Mitigation Plan (Wisconsin) include a goal specifically focused on the environment, recognizing the wellbeing of the natural environment as well as the community.

- Goal 2: The goal of these hazard mitigations actions is to reduce the risk and extent of loss of critical natural resources (plant and animal species) and the spread of invasive species on individuals, families, and the community as a whole. Implementation of these actions will help ensure the health and wellness of the community, as well as decrease the incidence of other man-made hazards.
- Goal 9: The goal of these hazard mitigations actions is to protect people and the natural environment from adverse effects of hazardous materials incident.[131]

The Lac du Flambeau plan also listed twelve nature-based hazard mitigation strategies across a number of the categories we describe above. The actions include:

- Conservation/Preservation/Management: For example, "Work with Federal partners to preserve or restore wetlands ecosystems in buffer zones along rivers and lakes for flood control and

[129] Emergency Management Department for the Lac du Flambeau Tribe, *Lac du Flambeau Tribe Hazard Mitigation Plan,* p 9 (April 2019), *available at* https://ldftribe.com/files/Lac%20du%20Flambeau%20Tribe%20All%20Hazards%20Mitigation%20Plan%20Draft%20for%20Public%20Comment.pdf [hereinafter Lac du Flambeau Plan].
[130] Tribal Mitigation Plans 44 CFR § 201.7.
[131] Lac du Flambeau Plan. p. 79, 87.

water quality management. Re-assess buffer zone setbacks" and "Protect and mitigate existing impacts to the forests along the wetlands and riparian areas, and within the wetlands system."[132]

- Green Infrastructure: For example, "Invest in and utilize green infrastructure to help control runoff, capture stormwater, and reduce water demand. Some common green infrastructure practices include bioretention areas (rain gardens), low impact development methods, green roofs, swales (depressions to capture water) and the use of vegetation or pervious materials instead of impervious surfaces."[133]
- Policy and Law: For example, "Enhance existing ordinances which manage riparian buffers along rivers, streams, lakes and other water bodies,"[134] and "[i]ntegrate policies into existing plans that protect, maintain, and enhance tree canopy in urban settings to reduce heat."[135]
- Education and Awareness: For example, "Expand opportunities to engage the community in nature preservation projects and efforts."[136]
- Funding and Programmatic: For example, "Expand programs working to protect sensitive land from development using land acquisition through purchase."[137]
- Partnerships: For example, "Expand work with utility companies to reduce sediment and nutrient inputs into source water bodies, regulate runoff (construction site) and streamflow, buffer against flooding (e.g., wetlands)."[138]

The Oneida Nation Pre-Disaster Mitigation Plan (Wisconsin) includes a goal that mentions protecting the environment in addition to protecting other tribal aspects as well as a goal that specifically focuses on natural infrastructure/nature-based solutions:

- Goal 1: Minimize human, economic, and environmental disruption from natural hazards
- Goal 5: Promote and enhance the use of natural resource protection measures as a means to reduce the impact if natural hazards on people and property.[139]

The Oneida plan also includes one nature-based mitigation strategy.

- Green Infrastructure: "Maintain a stormwater management plan that includes such remediation techniques as surface detention basins, in-street detention units, and rain gardens."[140]

The Klamath Tribes Hazard Mitigation Plan (Washington) includes several relevant goals and objectives that recognizes the wellbeing of the natural environment as well as the community. The Plan includes a goal that mentions protecting the environment in addition to protecting other tribal aspects as well as a goal that specifically focuses on natural infrastructure/nature-based solutions.

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[132] Lac du Flambeau Plan. p. 81.
[133] *Id*.
[134] Lac du Flambeau Plan, p 84.
[135] Lac du Flambeau Plan, p 89.
[136] Lac du Flambeau Plan, p 79.
[137] Lac du Flambeau Plan, p 84.
[138] Lac du Flambeau Plan, p 81.
[139] Oneida Nation, *Oneida Nation 2015-2020 Pre-Disaster Mitigation Plan*, p 61 *(2015)*, *available at* https://baylakerpc.org/application/files/7915/2830/1159/oneida_nation_haz_plan_update_final.pdf [hereinafter Oneida Plan].
[140] Oneida Plan, Section 4.

- Goal 1—Reduce or prevent future hazard-related injuries and losses of life, property damage, and environmental impact.
- Goal 3—Encourage the development and implementation of long-term, cost-effective and environmentally sound mitigation projects.
- Objective 7 – Establish a partnership among the Tribal Government and Tribal business leaders with surrounding area government and business community to improve and implement methods to protect life, property, and the environment, while preserving the cultural integrity of the Klamath Tribes.
- Objective 12 - Encourage hazard mitigation measures that result in the least adverse effect on the natural environment and that use natural processes, while preserving and maintaining the cultural elements of the Klamath Tribes.[141]

The Plan also includes three nature-based actions.

- Policy and Law: "Consider planting standards in wildland buffer areas to require fire-resistant plants with loose branching habits, non-resinous woody material, high moisture content leaves and limited seasonal accumulation of dead vegetation."[142]
- Partnerships: "Continue working with Oregon Watershed Enhancement Board for various watershed improvement activities."[143]
- Funding and Programmatic: "Continue working on the Legacy Road Reconstruction program for projects such as: decommissioning/vacating of roadways of high negative impact to natural resources; road upgrades; surface drainage improvements; road stabilization, and culvert replacement for fish passage."[144]

A more thorough review of tribal plans would be valuable for Tribal planners, as well as state and local planners.

## *Enabling Conditions*

As we detail above, state hazard mitigation plans are incorporating natural systems protection and nature-based solutions as goals or explicit hazard reduction strategies in a wide range of ways. Most, but not all, plans include goals/objectives that are related to impacts to the environment from natural hazards or use nature-based strategies to address the state's risk. Some plans have gone much further and have identified a larger number of nature-based actions. Whether and how these strategies are implemented in practice and their effectiveness at mitigating risk were not a focus of this study but would be an important follow-up effort.

The state hazard mitigation plan development process and planning elements other than the goals, objectives, and actions (e.g., risk assessment and capability sections) can serve as opportunities to stimulate states to evaluate the role of natural systems in risk and to identify and use nature-based

[141] Klamath Tribal staff, planners, and members, *Klamath Tribes Hazard Mitigation Plan*, p 19-1-2 (2017), *available at* https://klamathtribes.org/wp-content/uploads/2019/10/HAZARD-MITIGATION-PLAN-Draft.pdf [hereinafter Klamath Plan].
[142] Klamath Plan, p 19-9.
[143] Klamath Plan, p 19-10.
[144] *Id.*

strategies. Other natural resource focused state- or local-level plans, programs, and partners, if brought into the planning process, can provide a wealth of information that can inform the risk and vulnerability assessments and can identify actions that could help the state achieve its hazard mitigation goals. These other analyses and programs may serve as opportunities to stimulate the inclusion of nature-based strategies for states that have not yet tapped into these opportunities, or that have only begun to do so. We discuss some of these enabling conditions and how they have played a role in various plans below.

### Risk assessment

The risk assessment section of the state hazard mitigation plan characterizes the type and location of hazards and the state's vulnerability to the hazards "based on estimates provided in local risk assessments as well as the State risk assessment."[145] The risk assessment includes an analysis of losses to vulnerable structures and estimations of dollar losses to state owned and operated facilities. Plans generally include a section or profile for each of the hazards that the state has identified for analysis. This analysis provides the factual basis for the activities that are then included in the hazard mitigation strategy.[146] A robust assessment of how natural hazards impact the environment or how loss of natural infrastructure influences risk could help planners to better understand the habitats and natural areas that are at risk and the services that might be lost if these habitats are lost. It can also identify the location or types of natural infrastructure projects that may help the state to address their risk.[147]

We reviewed the risk assessment sections of the state plans to determine how they address risk to natural environments/ecosystems and/or how the loss of these habitats contributes to increased risk from hazards (See Appendix 4). Many states (14) have no consistent discussion of natural systems or the environment in the risk assessment or vulnerability analysis.[148] 35 states have some more consistent discussion of the impacts to natural resources. For many of these plans, the discussion is limited to a summary table for each hazard that generally includes a very brief discussion of impacts of the hazard to the environment among a list of other components (e.g., health and safety public; health and safety of responders; continuity of operations; property, facilities, and infrastructure; economic condition; and public confidence in jurisdiction's governance).[149]

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[145] Standard State Mitigation Plans 44 CFR § 201.4.

[146] *Id.*

[147] It is important to remember that dynamic natural habitats rely on natural processes (including seal level rise and episodic storm events) to help them function and persist into the future. However, when development or other activities prevent habitats from migrating inland with sea level rise or otherwise disrupt the natural processes that make them function, then natural hazards can become a problem for nature. Natural systems need to be able to respond to rising sea level and even episodic storms in order to be viable for further climate changes yet to come. Risk assessments need to take into account this dynamism and ability of natural systems to respond or adapt to changing conditions.

[148] We were unable to obtain the 2018 risk assessment for the state of Iowa.

[149] The categories examined are often those (or are similar to those) included in the Emergency Management Accreditation Program's (EMAP) standards on Hazard Identification, Risk Assessment and Consequence Analysis standard. The EMAP Standards by the Emergency Management Accreditation Program (EMAP) is designed as a tool for continuous improvement as part of a voluntary accreditation process for emergency management programs (https://www.emap.org/index.php/root/about-emap/57-draft-2016-emergency-management-standard/file). The Hazard Identification, Risk Assessment and Consequence Analysis includes responsibilities and activities associated with the identification of hazards and assessment of risks to persons, public and private property and structures. This includes conducting a consequence analysis for the hazards to consider the impact on the public; responders; continuity of operations including continued delivery of services; property, facilities, and,

A few states go into some more depth. California has an entire section on the natural environment under the section on state assets at risk. This includes a short section on ecosystems at risk. There is also a more in-depth assessment of effects on the natural environment in the profile on wildfire. In the New Jersey Plan there is a section on environmental impacts in most hazard profiles (e.g., the profiles on coastal erosion, dam and levee failure, drought, earthquake, hurricane and coastal storm, etc.). The individual sections go into some depth on impacts. The drought profile has more information on impacts to the environment, including habitats.

The Hawai'i Plan includes an exposure analysis (in the hazard profiles on climate change and sea level rise, chronic coastal flood, dam failure, earthquake, event-based flood, hurricane, landslide and rockfall, tsunami, volcanic hazards, and wildfire) or qualitative analysis (in the hazard profiles on drought, hazardous materials, health risks, and high wind storms) for environmental resources in each hazard protocol. The exposure analysis tables show the total extent and percent of total area of certain environmental resources located in the hazard areas. The environmental assets included are critical habitat, wetlands, and parks and reserves (and reefs) (see Table 4). The plan discusses the importance of these habitats and the impacts of their loss. For example, the loss of wetlands "could reduce the coast's ability to buffer impacts from storms and flooding" and "wetlands and coral reefs provide protection from rising sea levels and damaging wave action."[150]

**Table 4. Exposure Analysis Table for Environmental Resources Located in Sea-Level Rise Hazard Areas in Hawaii**

| Environmental Asset | Total Square Miles of Asset | SLR-XA-3.2 Area | Percent (%) of Total Asset Area | 1%CFZ-3.2 Area | Percent (%) of Total Asset Area |
|---|---|---|---|---|---|
| Critical Habitat[a] | 915.2 | 1.6 | 0.2% | 2.2 | 0% |
| Wetlands | 260.0 | 15.7 | 6.1% | 31.1 | 12% |
| Parks and Reserves | 2,607.7 | 7.2 | 0.3% | 17.7 | 1% |
| **Total[b]** | **3,837.6** | **79.3** | **2.1%** | **105.7** | **2.8%** |

*Note: Hawai'i Emergency Management Agency, State of Hawai'i 2018 Hazard Mitigation Plan, Table 4.2-17, Environmental Resources Located in the Sea Level Rise Hazard Areas (2018), available at https://dod.hawaii.gov/hiema/files/2018/11/State-of-Hawaii-2018-Mitigation-Plan.pdf.*

The Massachusetts Plan includes Natural Resources and Environment as one the sectors assessed for each hazard in the risk assessment. The plan defines natural resources as "components of natural systems that exist without human involvement. For the purpose of this survey, key natural resource categories include forested ecosystems, aquatic ecosystems, coastal ecosystems, wetland ecosystems, and old field ecosystems."[151] Each hazard profile has a table that discusses each sector assessed, including natural resources and the environment. Each profile also has a more in-depth discussion of impacts to natural resources and the environment (some hazards have more discussion than others).

infrastructure; the environment; the economic condition of the jurisdiction and public confidence in the jurisdiction's governance. Thirty-six states are accredited programs, not all of these states included consistent discussion of impacts to the environment or natural resources.

[150] Hawai'i Plan, p. 4-52.

[151] Massachusetts Plan, p 3-13.

For example, some sections of the risk assessment (e.g., precipitation-related flood, coastal flooding, and hurricanes and tropical storms) include a table that measures the amount of land in key natural areas vulnerable to 1% annual chance and 0.2% annual chance flood events, respectively, by county (see Table 5).[152] These habitat areas include those designated as Areas of Critical Environmental Concern,[153] BioMap2[154] Core Habitat,[155] and BioMap2 Critical Natural Landscapes. Critical Natural Landscapes are "intact landscapes in the state that are better able to support ecological processes and disturbance regimes and a wide array of species and habitats over a long time frame," providing functions such as "buffering uplands around coastal, wetland, and aquatic core habitats, maintaining connectivity among habitats, and enhancing ecological resilience."[156] These measures account for the level of risk to ecosystems as well as the hazard mitigation benefits they provide.

The Massachusetts Plan has the most extensive treatment of risk to critical ecosystems of any of the state hazard mitigation plans. It also has, by far, the most nature-based mitigation actions identified. In general, however, the degree to which the environment is addressed in the risk assessment of state plans does not strongly correlate with the number of actions included in the plan. Hawai'i, New Jersey, Idaho all go into some depth on impacts to the environment in the risk assessment/vulnerability analysis but are not among the states with the most actions. Therefore, there is an opportunity to better understand how the risk assessment could better set up planners to identify the kinds of natural infrastructure projects that may be most effective at addressing risk, and the locations to which the state should pay the most attention when contemplating these types of projects.

[152] Massachusetts Plan, p 4-36.

[153] Places in Massachusetts that have been designated by the EOEEA and that receive special recognition because of the quality, uniqueness, and significance of their natural and cultural resources. Massachusetts Department of Conservation & Recreation Office of Natural Resources, ACEC Program Overview, *at* *https://www.mass.gov/service-details/acec-program-overview*.

[154] BioMap2 is a Massachusetts framework for classifying ecosystems in order to guide strategic biodiversity conservation in the state. Massachusetts Natural Heritage & Endangered Species Program, *BioMap2: Conserving the Biodiversity of Massachusetts in a Changing World*, *at* https://www.mass.gov/service-details/biomap2-conserving-the-biodiversity-of-massachusetts-in-a-changing-world

[155] BioMap 2 Core Habitat data identify the specific areas needed to promote long-term persistence of Species of Concern, including species listed under the Massachusetts Endangered Species Act, and additional species identified in the State Wildlife Action Plan; exemplary natural communities; and intact ecosystems. Massachusetts Natural Heritage & Endangered Species Program, *BioMap2: Conserving the Biodiversity of Massachusetts in a Changing World*, *at* https://www.mass.gov/service-details/biomap2-conserving-the-biodiversity-of-massachusetts-in-a-changing-world

[156] Massachusetts Plan, p 4-112.

## Table 5: Nature Resource Exposure Table From the Massachusetts Plan

| Name | County | Total Acreage | 1 Percent Annual Chance Flood Event A Zone | | 0.2 Percent Annual Chance Flood Event X500 Zone | |
|---|---|---|---|---|---|---|
| | | | Acres | % of Total | Acres | % of Total |
| Aquatic Buffer | Barnstable | 15,910.8 | 2,310.9 | 14.5 | 3,990.4 | 25.1 |
| Aquatic Buffer | Berkshire | 54,738.6 | 20,313.4 | 37.1 | 1,013.9 | 1.9 |
| Aquatic Buffer | Bristol | 20,468.8 | 9,902.8 | 48.4 | 366.5 | 1.8 |
| Aquatic Buffer | Essex | 32,046.2 | 8,515.8 | 26.6 | 942.0 | 2.9 |
| Aquatic Buffer | Franklin | 48,769.1 | 112.4 | 0.2 | 0.1 | 0.0 |
| Aquatic Buffer | Hampden | 23,192.8 | 10,360.7 | 44.7 | 793.5 | 3.4 |
| Aquatic Buffer | Hampshire | 30,948.9 | 13,229.6 | 42.7 | 767.9 | 2.5 |
| Aquatic Buffer | Middlesex | 16,657.9 | 11,585.3 | 69.5 | 620.2 | 3.7 |
| Aquatic Buffer | Nantucket | 1,578.7 | 197.4 | 12.5 | 64.5 | 4.1 |
| Aquatic Buffer | Norfolk | 10,263.4 | 6,722.3 | 65.5 | 479.9 | 4.7 |
| Aquatic Buffer | Plymouth | 41,381.2 | 18,680.9 | 45.1 | 1,745.0 | 4.2 |
| Aquatic Buffer | Suffolk | 626.3 | 453.2 | 72.4 | 9.0 | 1.4 |
| Aquatic Buffer | Worcester | 60,793.8 | 32,802.1 | 54.0 | 1,526.9 | 2.5 |
| Coastal Adaptation Analysis | Barnstable | 20,054.7 | 14.5 | 0.1 | 34.2 | 0.2 |
| Coastal Adaptation Analysis | Bristol | 8,612.7 | 481.4 | 5.6 | 60.0 | 0.7 |
| Coastal Adaptation Analysis | Essex | 22,326.2 | 377.3 | 1.7 | 28.7 | 0.1 |
| Coastal Adaptation Analysis | Nantucket | 4,365.8 | 279.1 | 6.4 | 227.4 | 5.2 |
| Coastal Adaptation Analysis | Norfolk | 787.1 | 10.8 | 1.4 | 0.6 | 0.1 |
| Coastal Adaptation Analysis | Plymouth | 12,732.9 | 89.6 | 0.7 | 6.5 | 0.1 |
| Landscape Blocks | Barnstable | 82,481.2 | 1,224.2 | 1.5 | 1,457.9 | 1.8 |
| Landscape Blocks | Berkshire | 345,685.3 | 12,986.9 | 3.8 | 1,241.8 | 0.4 |
| Landscape Blocks | Bristol | 85,667.1 | 16,744.0 | 19.5 | 2,665.8 | 3.1 |
| Landscape Blocks | Essex | 41,937.3 | 4,011.7 | 9.6 | 1,320.6 | 3.1 |
| Landscape Blocks | Franklin | 221,827.3 | 135.7 | 0.1 | 0.1 | 0.0 |
| Landscape Blocks | Hampden | 136,833.0 | 6,503.0 | 4.8 | 961.6 | 0.7 |
| Landscape Blocks | Hampshire | 124,440.4 | 11,335.3 | 9.1 | 822.5 | 0.7 |
| Landscape Blocks | Middlesex | 36,866.4 | 3,626.2 | 9.8 | 1,410.9 | 3.8 |
| Landscape Blocks | Nantucket | 11,571.2 | 494.6 | 4.3 | 458.4 | 4.0 |
| Landscape Blocks | Norfolk | 8,250.4 | 521.0 | 6.3 | 751.2 | 9.1 |
| Landscape Blocks | Plymouth | 124,678.0 | 28,414.8 | 22.8 | 2,356.9 | 1.9 |
| Landscape Blocks | Worcester | 204,731.2 | 31,668.0 | 15.5 | 4,630.1 | 2.3 |

*Notes: The table indicates the amount of land in key natural areas vulnerable to 1% annual chance and 0.2% annual chance flood events, respectively, by county. Massachusetts Emergency Management Agency, Massachusetts State Hazard Mitigation and Climate Adaptation Plan, Table 4-11, Natural Resources Exposure — BioMap2 Critical Natural Landscape (2018), available at https://www.mass.gov/files/documents/2018/10/26/SHMCAP-September2018-Full-Plan-web.pdf.*

## Legal

In some cases, state law imposes requirements that may influence the integration of nature-based goals and objectives and identification of natural infrastructure actions and strategies in the state hazard mitigation plan. For example, California SB 379 requires that local jurisdictions review and update their general plan safety elements to address "climate adaptation and resiliency strategies applicable to that city or county."[157] The law requires "the update to include a set of goals, policies, and objectives based on a vulnerability assessment, identifying the risks that climate change poses to the local jurisdiction and the geographic areas at risk from climate change impacts, and specified information from federal, state, regional, and local agencies." This includes the "identification of natural infrastructure that may be used in adaptation projects, where feasible."[158] The law defines natural infrastructure as "the preservation or restoration of ecological systems, or utilization of engineered systems that use ecological processes, to increase resiliency to climate change, manage other environmental hazards, or both. This may include, but is not limited to, floodplain and wetlands restoration or preservation, combining levees with restored natural systems to reduce flood risk, and urban tree planting to mitigate high heat days."[159] The introduction to the state's mitigation goal to "protect the environment" indicates that this law was the driving force behind the development of the goal.

The Massachusetts hazard mitigation plan fulfills FEMA's requirement for a hazard mitigation plan as well as the requirements of the state's Executive Order 569. The Order requires that the Executive Office of Energy and Environmental Affairs (EOEEA) and the Executive Office of Public Safety and Security (EOPSS) "coordinate on efforts to strengthen the resilience of communities, prepare for the impacts of climate change, and proactively plan for and mitigate damage from extreme weather events, including publishing a climate adaptation plan."[160] The Order directs natural hazard resilience planning to wherever possible "employ strategies that conserve and sustainably employ the natural resources of the Commonwealth to enhance climate adaptation, build resilience, and mitigate climate change."[161] Natural resources, open spaces, and nature-based solutions provide multiple services that include resilience benefits, public health services, and contribute to environmental and restoration economies. The mitigation strategy section on Importance of Nature-Based Solutions in Hazard Mitigation and Climate Adaption cites Massachusetts Executive Order 569 as a basis for strong consideration of nature-based solutions over hard infrastructure solutions.[162] In 2018, the state passed a $2.4 billion Environmental Bond Bill that codified key components of the Executive Order.[163] The law emphasizes nature-based strategies and provides funding for investments in environmental protection projects.

It is possible that other states have other legal drivers that influenced the integration of nature-based mitigation strategies in the hazard mitigation plan (e.g., state natural resource laws, state hazard

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[157] California Senate Bill 379, Land use: general plan: safety element (2015), *available at* https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201520160SB379.
[158] *Id.*
[159] *Id.*
[160] Massachusetts Executive Order 569, *Establishing an Integrated Climate Change Strategy for the Commonwealth,* Governor Charlie Baker (Sep. 16, 2016), *available at* https://www.mass.gov/executive-orders/no-569-establishing-an-integrated-climate-change-strategy-for-the-commonwealth.
[161] *Id.*
[162] Massachusetts Plan, p 7-4.
[163] Massachusetts House No. 4835 An Act promoting climate change adaptation, environmental and natural resource protection, and investment in recreational assets and opportunity, 190th Congress (2018), *available at* https://malegislature.gov/Bills/190/H4835.

mitigation laws, etc.). Both of the examples we cite here – the California law and the Massachusetts executive order – are explicitly related to climate change adaptation efforts in the state. Hazard mitigation and climate adaptation address overlapping impacts and often employ the same actions and strategies. Indeed, the Massachusetts Plan is both the state hazard mitigation and climate adaptation plan. The plan is the "fully integrated, innovative, and actionable State Hazard Mitigation and Climate Adaptation Plan."[164] Due to their interagency/collaborative nature, climate adaptation efforts may have led states more quickly to integrate nature-based strategies into hazard mitigation. Looking toward existing climate adaptation efforts may be one opportunity for expanding nature-based hazard mitigation strategies in state plans.

### State Capabilities and Funding

The mitigation strategy section includes an analysis of state capabilities and funding, including "an evaluation of state laws, regulations, policies, and programs related to hazard mitigation as well as to development in hazard-prone areas."[165] This analysis also includes a discussion of state funding capabilities for hazard mitigation projects, including: "1.) a general description of how the state has used its own funds for hazard mitigation projects; and 2.) a general discussion of how the state has used FEMA mitigation programs and funding sources . . ."[166] The capabilities section should demonstrate "the state's commitment to mitigation," identify "a wide range of resources from which to implement mitigation activities," and reveal "areas to target improvements."[167]

The capability section is a real opportunity for states to identify the kind of natural resource programs and capacity that could be tapped to aid in the identification and implementation of nature-based projects. Equally important is the identification of possible funding sources for these projects. We did not review in depth the capabilities sections of the state plans for this report, but we did identify a number of actions that reference other state programs/capabilities or funding sources or call for the state to partner with other state or local agencies or non-profit organizations. We found a number of examples where the funding mechanisms identified in the state capabilities section is reflected in mitigation actions. For example, New Jersey's Shore Protection Fund (2008 PSA 223) for shore protection projects, stabilization, restoration or maintenance of the shore, including monitoring studies and land acquisition,[168] Ohio's action to explore the possibility of using Alternative Stormwater Infrastructure Loan Program to target properties purchased with HMA grants as future green infrastructure project sites,[169] and Oregon's action to "Maintain the Riparian Lands Tax Incentive Program. This program helps reduce sediment and protect stream banks which helps reduce the filling of river and stream channels"[170] are all funding programs that are identified or discussed in the capabilities section. The funding programs provide opportunities to identify resources necessary to implement mitigation actions.

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[164] Massachusetts Plan, p 1-1.
[165] FEMA, *State Mitigation Plan Review Guide,* at p 20 (2015) https://www.fema.gov/sites/default/files/2020-06/fema-state-mitigation-plan-review-guide_03-09-2015.pdf.
[166] *Id.* at p 20.
[167] *Id.* at p 19.
[168] New Jersey Office of Emergency Management, *2019 New Jersey State Hazard Mitigation Plan*, p 6-100 (2019), *available at* http://ready.nj.gov/mitigation/2019-mitigation-plan.shtml [New Jersey Plan].
[169] Ohio Emergency Management Association, *2019 State of Ohio Hazard Mitigation Plan (SOHMP)*, p 3-15 (2019), *available at* https://www.ema.ohio.gov/mip/planning_sohmp.aspx [hereinafter Ohio Plan].
[170] Oregon Plan, p 1038.

The state programs identified in the capabilities section also provide an opportunity to leverage other state natural resource protection partners and programs for the identification and implementation of mitigation actions. Many of these programs are likely identified in the states capability section, even if not tapped for mitigation action. There could be a wealth of untapped resources. For examples, many states have invested significant resources in developing wetland and watershed assessment tools that could be leveraged by hazard planners to identify at-risk areas and possible projects to address the risk. If not happening already, other state agencies and partner organizations could provide valuable information during the planning process that might aid in identifying programs, policies, partners, and funding opportunities with the most promise to address the state's risk.

## Plan Integration

One particularly helpful state capability that could be leveraged by hazard mitigation planners may be the availability of existing conservation plans and initiatives.[171] Many states and local governments have developed tools to prioritize lands for acquisition or restoration for various unrelated conservation or resilience purposes. For example, the New York Department of Environmental Conservation's Open Space Conservation Plan details evaluation and selection criteria that are used to determine spending priorities for the state's open space program. Local comprehensive plans often also include natural resource protection goals that may identify priorities for habitat conservation and restoration. These policies and plans can be informative for the development of nature-based actions that could be integrated into the hazard mitigation plan.[172]

Some of the state hazard mitigation plans include actions that identify specific planning efforts that can be leveraged for hazard mitigation. For example, Maryland's action to "Target Restoration, Preservation, & Mitigation within Special Flood Hazard Areas using the Water Resource Registry,"[173] advocated for the use of existing data to improve targeting. Another action in Vermont tied in a separate conservation plan: "Promote the use of Vermont Fish and Wildlife's Conservation Design Plan to achieve and maintain habitat connectivity and havens for Vermont rare, threatened, and endangered species (aquatic and terrestrial)";[174] they linked the action objective to an existing state program.

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[171] Integration of other state and/or regional planning initiatives (e.g., comprehensive, growth management, economic development, capital improvement, land development, and/or emergency management plans) and FEMA mitigation programs and initiatives that provide guidance to State and regional agencies is required of states with enhanced state mitigation plans. As of September 24, 2020, 14 states earned FEMA approval for their enhanced state mitigation plan. A State with a FEMA approved Enhanced State Mitigation Plan at the time of a disaster declaration is eligible to receive increased funds under the HMGP. The Enhanced State Mitigation Plan must demonstrate that a State has developed a comprehensive mitigation program, that the State effectively uses available mitigation funding, and that it is capable of managing the increased funding. In order for the State to be eligible for the 20 percent HMGP funding, FEMA must have approved the plan within 5 years prior to the disaster declaration. Enhanced State Mitigation Plans 44 CFR § 201.5.

[172] Environmental Law Institute, *Developing Wetland Restoration Priorities for Climate Risk Reduction and Resilience in the MARCO Region* (2016), *available at* https://www.eli.org/sites/default/files/eli-pubs/developing-wetland-restoration-priorities-climate-risk-reduction-and-resilience-marco-region.pdf (ELI's report on priority setting outlines recommendations for policy and process improvements that could improve the ability of states to develop wetland restoration priorities for climate risk reduction and resilience).

[173] Maryland Plan, p 5-41.

[174] Vermont Plan, p 148.

## Partnerships

Involving technical experts in the planning and implementation process can help fill information gaps, aiding in identifying risks and identifying and prioritizing viable nature-based mitigation actions. The hazard mitigation plan must discuss how the state planning team coordinated with other agencies and stakeholders,[175] including from the natural and cultural resources sector, in the planning process. In addition, as discussed above, the capabilities section of the mitigation strategy describes other relevant state programs and efforts that could aid in hazard mitigation efforts.

The plans themselves describe a number of actions that explicitly cite the role of partners. Many of these actions call for the state to engage other organizations to aid in land conservation efforts or other kinds of mitigation actions. For example, "[r]ecruit conservancy agencies to purchase and maintain key undeveloped land in coastal areas"[176] in Texas, "[w]ork with land conservation organizations to include river corridor and floodplain protection provisions, and/or headwater storage in conservation easements"[177] in Vermont, and "[s]upport the Hawai'i Association of Watershed Partnerships" in Hawai'i. The Tennessee Plan sought to bring local non-profit organizations into the development of local plans.

The Wisconsin Plan included an action with background information that acknowledged the role of partners in informing the development of the action. The action was to "Encourage restoration of natural wetland functions."[178] The background of the section describes the participation of Wisconsin Emergency Management in the Wetlands, Wildlife Habitat, and Flood Hazards in the Rock River Basin workshop in May 2011. This workshop was "designed to facilitate greater collaboration between emergency managers and wetland and wildlife conservation managers to strengthen protection of vital wetlands and floodplains." Additionally, the workshop "explored how agencies and organizations can work effectively together to meet multiple goals and identify the information needed and funding sources available for joint projects." The participation of these partners informed the action. The Plan goes on to say "The DNR will use lessons learned from the Wetlands, Wildlife Habitat, and Flood Hazards in the Rock River Basin workshop to identify and restore converted wetland areas."[179]

Partnerships are key to achieving a state's mitigation goals and in advancing nature-based approaches. There are many ways for partners to be involved in the planning process, and in the identification and implementation of mitigation actions, including:

- Natural resource partners can participate with other experts (land use planners, stormwater managers, emergency mangers, etc.) on hazard planning teams to inform the development of the plan itself. FEMA's *Building Community Resilience with Nature-Based Solutions* guide for communities stresses the importance of bringing in partners in planning and implementation of nature-based mitigation actions.[180]

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[175] Standard State Mitigation Plans 44 CFR §§201.4(b) and (c)(1).
[176] Texas Plan, p 296.
[177] Vermont Plan, p 147.
[178] Wisconsin Plan, pp 3-35.
[179] Wisconsin Plan, p 3-35.
[180] FEMA, *Building Community Resilience with Nature-Based Solutions: A Guide for Local Communities* (2020), *available at* https://www.fema.gov/sites/default/files/2020-08/fema_riskmap_nature-based-solutions-guide_2020.pdf.

- Natural resource partners can aid in engaging with other community stakeholders. These groups could educate the public about the environmental, social, and economic co-benefits of nature-based projects and the effectiveness of these projects for addressing the impacts of natural hazards. Gaining community buy-in can be important in ensuring nature-based projects that address community wants and needs are included in the plan, are implemented on the ground, and are maintained over the long term.
- Hazard planners often do not have the experience with the analyses/studies necessary to determine the services provided by natural infrastructure actions. As mentioned above, the GAO's recent report cited lack of technical capacity and complexity of the grant application processes as significant challenges for hazard mitigation grant program applicants.[181] In fact, the challenges associated with the hazard mitigation grant application process was cited by as a reason that states have not spent 35% of the funds that FEMA has allocated under the Hazard Mitigation Assistance program from 1989 through early 2018.[182] Natural resource partners can provide data and expertise for identifying types of, and the geographic location for, natural infrastructure projects that will provide necessary mitigation that will be crucial for the hazard mitigation grant application process.
- Natural resource partners can participate in the planning, designing, and implementing of nature-based projects. Specifically, conservation groups or watershed planners can be instrumental in identifying other relevant plans that could be incorporated or that have identified specific projects that could provide hazard mitigation benefits.
- Natural resource partners can also provide crucial assistance by taking on the maintenance, management, or monitoring responsibilities for projects. An often-overlooked component of any natural infrastructure project is long-term maintenance and management. Partners may provide necessary expertise or willingness to take-on these efforts. Identifying the cost of this component in the mitigation plan so that it could be federally funded is key.

A big challenge in developing these partnerships is the absence of dedicated funding for coordination. It takes time to assemble the right mix of partners, to convene meetings, and push the partnership toward actionable items. A coordinator is also important to help states and municipalities to scope projects and develop funding proposals. State emergency management offices, or FEMA, should consider funding such coordinator positions.

## Conclusion and Recommendations

Most state hazard mitigation plans include at least one nature-based mitigation goal or action. A few states (e.g., Massachusetts, Washington, etc.) have more integrated plans advancing nature-based approaches. We identified many different types of actions across a number of different categories. We did not assess the implementation of these actions, but we were able to gauge the documented commitment to integrating nature-based goals and actions in hazard mitigation plans.

We identified these conclusions:

[181] United States Government Accountability Office, *Disaster Resilience: FEMA Should Take Additional Steps to Streamline Hazard Mitigation Grants and Assess Program Effects* (Feb. 2021), *available at* https://www.gao.gov/assets/720/712172.pdf.
[182] Thomas Frank, *States shun billion in federal aid as climate costs soar,* Climate Wire (Feb. 26, 2021), *available at* https://www.eenews.net/climatewire/stories/1063726077/search?keyword=hazard+mitigation.

- There are many opportunities to integrate nature-based goals and actions into hazard mitigation plans. Many states have done this to some degree, but there are still opportunities to improve, including more comprehensive evaluation of the value of natural systems in the assessment of risk and vulnerability, systematic inclusion of well thought out and specific nature-based hazard mitigation actions, and realistic prioritization and implementation of nature-based strategies.
- Most states had nature-based goals. However, plans with well-developed nature-based goals and objectives were not necessarily the same states that included higher numbers of nature-based actions, and vice versa. Massachusetts had the most actions, and although it did not have goals and objectives with explicit focus on using nature-based solutions, Massachusetts did have a separate section of the plan discussing the importance of nature-based strategies. The Massachusetts plan also extensively discussed the environment in its risk assessment section.
- We identified very few geographically specific projects defined in plans. Most discussions of activities describe general types of actions (such as "use green mitigation techniques such as bio swales, rain gardens, and permeable pavers" or "protect and restore natural floodplain functions"). Although the state plan is linked to local strategies, more specific activities may be found in local hazard mitigation plans. Local plans are more directly tied to community needs and goals and thus may provide an important opportunity for integrating restoration actions.[183] Where it makes sense, state hazard mitigation planners may choose to identify specific projects, and project locations, that can be shown to address a specific risk while continuing to coordinate with local governments to complement the strategies and actions identified in the local plans. Hazard mitigation grants may be available to conduct the studies necessary to identify and plan these kinds of projects. We identified more than 30 Technical and Information actions in the plans, many of which were related to studies that sought to identify future project sites.
- Identifying and integrating nature-based hazard mitigation actions in mitigation plans is an important first step toward advancing and expanding the use of these techniques to address risk associated with natural hazards. Funding, implementing, and monitoring these projects are important next steps. More demonstration projects are needed to show the multiple benefits of nature-based projects.

  We did not review the required sections in the plans that discuss progress on previous actions. However, these sections may provide some information about how well nature-based actions have helped to address risk. There are also other plan sections that could be reviewed to better understand how the state is prioritizing the implementation of nature-based actions versus other types of actions (e.g., the plan's methodology for prioritizing actions).[184]
- It is important to understand some of the challenges in implementing nature-based hazard mitigation strategies, even when they are identified in the hazard mitigation plan. For example, the Benefit-Cost Analysis (BCA) methods (projects must pass benefit-cost in order to be eligible for HMA funding) may present challenges for showing the cost-effectiveness of nature-based strategies. In their recent analysis, the GAO stated that officials in all of the jurisdictions in their study found the BCA for hazard mitigation grants was a challenge due, in part, to the amount of

[183] ELI examined 119 local hazard mitigation plans to identify examples of how states are including natural infrastructure or natural resource protection or restoration as mitigation goals and actions. We found 275 relevant actions. See our report at https://www.eli.org/land-biodiversity/hazard-mitigation-planning

[184] For example, as discussed above, the Massachusetts plan indicates that the prioritization framework the planners "used to rank the action items… includes nature-based approaches specifically designed to conserve and/or employ natural resources as the highest-priority ranking." *See* Massachusetts Plan. p. 7-4

resources and data needed.[185] Calculating "project benefits, such as lost revenue avoided and environmental benefits, can be difficult to calculate and may require hundreds of pages of data or technical project information to support."[186] Also, hiring contractors to conduct these studies can cost thousands of dollars. This may be especially true for nature-based projects as data on ecosystem service values may be less readily available.

Recently, FEMA has made moves to update its BCA Toolkit[187] to reduce barriers to nature-based hazard mitigation projects. For example, FEMA's 2020 policy "Ecosystem Service Benefits in Benefit-Cost Analysis for FEMA's Mitigation Programs Policy" means that nature-based hazard mitigation projects can now be considered cost-effective based on the value of their environmental and social benefits alone. This change will likely reduce the technical and monetary burden on applicants for BCA related to certain project types, especially when they reduce the need for complex modeling (e.g., hydrologic). While this has been an important policy update, challenges remain. FEMA could also make additional tweaks to its BCA Toolkit, for example, in order to further reduce barriers to nature-based solutions, such as creation of additional "pre-calculated benefits" for certain project types. FEMA or state governments could also assist in the collection of data to inform BCA (e.g., data needed to estimate the savings from other benefits such as avoided soil loss, mass wasting or landslides, and the role that healthy, intact floodplains and wetlands play in preventing those types of catastrophes). FEMA should also invest in more guidance and decision support tools that help communities consider nature-based project types, especially things like upper watershed projects and reach-scale schemes.

A related challenge is a dearth of nature-based project "case studies" that have been successfully funded by FEMA, which could help to demonstrate to other applicants that such projects are possible. This challenge is being partially addressed by FEMA's Mitigation Action Portfolio (and other efforts),[188] and the situation will presumably improve as more nature-based projects are approved through BRIC and HMGP over time.

We have identified a series of steps states can take to improve integration of nature-based goals and actions into their plans.

1. Identify and include natural resource protection and restoration experts as key members of the planning team (such experts could include state agency staff, NGOs, watershed groups,

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[185] United States Government Accountability Office, *Disaster Resilience: FEMA Should Take Additional Steps to Streamline Hazard Mitigation Grants and Assess Program Effects* (Feb. 2021), *available at* https://www.gao.gov/assets/720/712172.pdf.

[186] *Id.*

[187] FEMA, *Ecosystem Service Benefits in Benefit-Cost Analysis for FEMA's Mitigation Programs Policy*, FEMA Policy FP-108-024-02 (Sept. 2020), *available at* https://www.fema.gov/sites/default/files/2020-09/fema_ecosystem-service-benefits_policy_september-2020.pdf; Thomas Frank, *FEMA ends policy favoring flood walls over green protections,* Climate Wire (Oct. 15, 2020), *available at* https://www.eenews.net/stories/1063716253/print.

[188] FEMA, *Hazard Mitigation Assistance Mitigation Action Portfolio* (Aug. 2020), *available at* https://www.fema.gov/sites/default/files/2020-08/fema_mitigation-action-portfolio-support-document_08-01-2020_0.pdf; The Naturally Resilient Communities website (http://nrcsolutions.org/), which includes "case studies of successful projects from across the country to help communities learn more and identify which nature-based solutions might work for them," is another good resource. Another good resource is Glick, P., E. Powell, S. Schlesinger, J. Ritter, B.A. Stein, and A. Fuller. *The Protective Value of Nature: A Review of the Effectiveness of Natural Infrastructure for Hazard Risk Reduction.* (2020) Washington, DC: National Wildlife Federation, *available at https://www.nwf.org/-/media/Documents/PDFs/NWF-Reports/2020/The-Protective-Value-of-Nature.ashx?la=en&hash=A75F59611475502BEE58723F8B3C58423417E579*

academics, etc.). Natural resources experts are essential to provide the knowledge that is needed to integrate natural resource information throughout the plan, including the risk assessment and mitigation strategy. As a first step, state planners may wish to draw from the programs already identified in the capabilities section of the hazard mitigation plan to identify potential partners and team members.

The planning team should also examine the mitigation plan process itself to identify opportunities to focus on the value of natural systems and the benefits of integrating nature-based hazard mitigation strategies (e.g., dedicate at least one planning meeting to nature-based actions, ensure nature-based actions are thoughtfully discussed at community outreach meetings, etc.).

2. Conduct an explicit review of legal barriers or opportunities to integrating nature-based strategies in hazard mitigation planning. State law and policy may be an important driver for integrating natural resource protection and identification of nature-based hazard mitigation strategies. Looking toward existing climate adaptation law and planning efforts may be an opportunity. It may be equally important to identify any legal barriers that could be addressed in order to facilitate the identification and implementation of nature-based strategies for hazard mitigation.

3. Systematically evaluate the risk to natural systems and how the loss and degradation of natural habitats contributes to increased risk from hazards in the risk and vulnerability assessment. To be most effective, this would go beyond a short description of the potential impacts to the environment in each hazard profile to also include how the loss or degradation of natural systems affects vulnerability. Experts on the planning team can help to identify sources of data and other analyses that can help with evaluation of risk and vulnerability. For example, it is important for hydrologic assessments to be part of the risk assessment in order to most effectively address flood risks (e.g., determining which risks are associated with altered hydrology and disconnected floodplains and wetlands).

4. Develop and include goals that not only focus on how to protect the environment from natural hazards but also reflect the state's priority and commitment to use nature-based strategies to mitigate the state's risk. A good straightforward example is "Encourage hazard mitigation measures that promote and enhance nature-based solutions, natural processes, and ecosystem benefits while minimizing adverse impacts to the environment" from the California Plan. The companion spreadsheet for this report could serve as a resource for reviewing examples of goals and objectives from other state plans.[189]

5. Develop and integrate nature-based actions in the mitigation strategy. Both broad and specific actions could be useful. Broad actions communicate the state's commitment to pursuing nature-based projects and the flexibility to pursue federal funds when opportunities arise. More specific actions can give some weight to a given project that has been developed to address a specific risk or vulnerability. Identifying partners in these actions would also be useful. At the state level, Technical and Information actions may be especially valuable as the information collected can then feed back into the evaluation of risk and identification of mitigation actions, as well as into other resilience efforts.

[189] The companion spreadsheet is available at https://www.eli.org/land-biodiversity/hazard-mitigation-planning.

The companion spreadsheet for this report could serve as a resource for reviewing examples of actions from other state plans.[190] The action categories that we suggest here (Agency Coordination, Education and Awareness, Funding and Programmatic etc.) could be used as a guide for formulating, organizing, and reviewing actions. This frame might help states identify gaps in the types of actions they have and/or spur new ideas.

The capabilities section of the mitigation strategy is another opportunity to identify existing resources, programs, and partners that can be leveraged as mitigation actions. The natural resource experts on the planning team are an important resource for developing the capabilities section. Further, linking to or making reference to completed and ongoing efforts to prioritize habitat restoration projects or other climate adaptation planning efforts outside of the hazard mitigation planning process could help secure funds to implement those priority projects. Then as those prioritizations are updated (perhaps more frequently than the 5-year mitigation plans) they effectively help the mitigation plan stay current.

6. Invest in monitoring and assessment of nature-based hazard mitigation projects. Performance data will help planners communicate the success and value of nature-based projects to the public. Monitoring data can help convince local stakeholders that nature-based strategies will work in their specific case and offer numerical evidence that nature-based projects have positive environmental and mitigation effects. Monitoring data can also help planners design more effective nature-based hazard mitigation strategies in the future.

Finally, we have identified recommendations for FEMA to improve integration of nature-based goals and actions into hazard mitigation plans.

1. Examine FEMA's Hazard Mitigation Planning guidance documents to find opportunities to promote partnerships with natural resource experts and provide more information on how to identify and integrate appropriate nature-based actions. For example, FEMA's State Mitigation Planning Key Topics Bulletins (on the Mitigation Strategy, Mitigation Capabilities, Planning Process, and Risk Assessment) inform states on how to meet the regulatory and policy requirements for hazard mitigation planning.[191] Although natural resources are mentioned, these brief guides could be updated to highlight key approaches and resources that could be leveraged to better integrate natural system protection and nature-based strategies in hazard mitigation.

   In addition to the actions cataloged in this report, FEMA's (2013) Mitigation Ideas - A Resource for Reducing Risk to Natural Hazards includes many valuable examples of natural systems protection mitigation actions.[192] This document (as well as the actions identified in this report) could serve as a starting point for conversations among the planning team as it seeks to identify and integrate appropriate nature-based actions into the plan.

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[190] The companion spreadsheet is available at https://www.eli.org/land-biodiversity/hazard-mitigation-planning.
[191] FEMA, *State Mitigation Planning Key Topis Bulletin: Mitigation Strategy* (Oct. 2016), *available at* https://www.fema.gov/sites/default/files/2020-06/fema-state-mitigation-strategy-planning-bulletin_10-26-2016_0.pdf.
[192] FEMA, *Mitigation Ideas - A Resource for Reducing Risk to Natural Hazards* (Jan 2013), *available at* https://www.fema.gov/sites/default/files/2020-06/fema-mitigation-ideas_02-13-2013.pdf.

2. Examine the Benefit-Cost Analysis. As discussed above, FEMA has made a number of recent changes to the BCA to make it easier for nature-based strategies to pass. However, FEMA could make additional changes that would result in further improvement. For example, FEMA could make changes to the BCA Toolkit in order to further reduce barriers to nature-based solutions, such as creation of additional "pre-calculated benefits" for certain project types. FEMA could also aid in data collection on project benefits, such as lost revenue avoided and environmental benefits associated with nature-based projects.

3. Invest in more "case studies" of nature-based projects that have been successfully funded by FEMA that could help to demonstrate to other applicants that such projects are possible. FEMA's Mitigation Action Portfolio[193] is a good start. Other resources such as the case studies on the Naturally Resilient Communities website may also be valuable. We have also created two new case studies of successful projects.[194]

4. Invest in partnerships with natural resource agencies and organizations. As discussed above, partnerships with natural-resource experts are crucial for identifying projects, completing grant applications, and implementing nature-based hazard mitigation strategies. In addition to promoting such partnerships in the hazard mitigation planning guidance as a way to better integrate nature resource actions, FEMA should consider investing in coordinator positions to help states assemble the right mix of partners and push the partnership to scope nature-based projects and develop funding proposals.

[193] FEMA, *Hazard Mitigation Assistance Mitigation Action Portfolio* (Aug. 2020), *available at* https://www.fema.gov/sites/default/files/2020-08/fema_mitigation-action-portfolio-support-document_08-01-2020_0.pdf.

[194] The case studies are posted at https://www.eli.org/land-biodiversity/hazard-mitigation-planning

## Appendix 1: State and Tribal Plan Links, Dates, Agencies

| State | Year | Lead Agency | Other Agencies |
|---|---|---|---|
| Alabama | 2018 | Alabama Emergency Management Agency | Hagerty Consulting |
| Alaska | 2018 | State of Alaska, Division of Homeland Security and Emergency Management | AECOM |
| Arizona | 2018 | Arizona Department of Emergency and Military Affairs – Planning Branch (DEMA) | JE Fuller |
| Arkansas | 2018 | Arkansas Division of Emergency Management (ADEM) | BOLDplanning |
| California | 2018 | California Governor's Office of Emergency Services (Cal OES) | Cal Poly State University Support Team |
| Colorado | 2018 | Division of Homeland Security and Emergency Management; Colorado Department of Public Safety | Michael Baker International and Wood Environment & Infrastructure Solutions, Inc. |
| Connecticut | 2019 | Connecticut Department of Emergency Services and Public Protection (DESPPS)/Division of Emergency Management and Homeland Security (DEMHS) and Department of Energy and Environmental Protection (DEEP) | Dewberry and subcontractors Tetra Tech and Milone & MacBroom |
| Delaware | 2018 | Delaware Emergency Management Agency | Collaborative Planning Team |
| Florida | 2018 | Florida Division of Emergency Management | Dewberry, Florida Gateway College, Integrated Solutions Consulting, Lakeland Regional Health, Langton Consulting, Pegasus Engineering |
| Georgia | 2019 | Georgia Emergency Management and Homeland Security Agency (GEMA/HS) | University of Georgia, Carl Vinson Institute of Government, Information Technology Outreach Services (ITOS) |
| Hawai'i | 2018 | Hawai'i Emergency Management Agency | Tetra Tech |
| Idaho | 2018 | Idaho Office of Emergency Management | Tetra Tech, Inc. |
| Illinois | 2018 | Illinois Emergency Management Agency (IEMA) | State Planning Team |
| Indiana | 2019 | Indiana Department of Homeland Security | The Polis Center, Indiana University-Purdue |
| Iowa | 2018 | Iowa Homeland Security and Emergency Management | State Hazard Mitigation Team |
| Kansas | 2018 | Kansas Division of Emergency Management | Kansas Hazard Mitigation Team |
| Kentucky | 2018 | Kentucky Emergency Management (KYEM) | University of Kentucky Hazard Mitigation Grants Program Office (UK-HMGP) |

| State | Year | Lead Agency | Other Agencies |
|---|---|---|---|
| Klamath Tribes | 2017 | Klamath Tribal staff, planners, and tribal members | Bridgeview Consulting, LLC, Planning Team |
| Lac du Flambeau | 2019 | Emergency Management Department for the Lac du Flambeau Tribe | Bullock & Haddow LLC, Adaptation International, GLISA NOAA RISA |
| Louisiana | 2019 | Louisiana Governor's Office of Homeland Security | Department of Georgaphy and Anthropology; Department of Construction Management, Louisiana State University; University of New Orleans Center for Hazards Assessment, Response & Technology |
| Maine | 2019 | Maine Emergency Management Agency<br>Prepared by MEMA State Hazard Mitigation Officer & Natural Hazards Planner | Multiple partners participated, including The River Flow Advisory Commission, Drought Task Force, Climate Adaptation Workgroup, and 16 County Emergency Managers |
| Maryland | 2016 | Maryland Emergency Management Agency (MEMA) | Maryland Resiliency Partnership Group, Mitigation Advisory Council |
| Massachusetts | 2018 | Massachusetts Emergency Management Agency (MEMA) of the Executive Office of Public<br>Safety and Security, in partnership with the Executive Office of Energy and Environmental<br>Affairs (EOEEA) | AECOM Consulting |
| Michigan | 2019 | Emergency Management and Homeland Security Division, Michigan Department of State Police, and Michigan Citizen-Community emergency Response Coordinating Council | Various stakeholders |
| Minnesota | 2019 | Minnesota Department of Public Safety, Division of Homeland Security and Emergency Management | University of Minnesota Duluth |
| Mississippi | 2018 | Mississippi Emergency Management Agency | Mississippi Hazard Mitigation Council |
| Missouri | 2018 | Missouri State Emergency Management Agency | Wood Environment and Infrastructure Solutions (Wood E&IS), Inc. |
| Montana | 2018 | Montana Department of Military Affairs Disaster and Emergency Services | Tetra Tech |
| Nebraska | 2019 | Nebraska Emergency Management Agency (NEMA) Recovery Section staff; IEM | Members of the Governor's Task Force for Disaster Recovery, with<br>staff assistance from member agencies, including NEMA and NeDNR |

| State | Year | Lead Agency | Other Agencies |
|---|---|---|---|
| Nevada | 2018 | Nevada Division of Emergency Management | Nevada Hazard Mitigation Planning Committee |
| New Hampshire | 2018 | New Hampshire Homeland Security Emergency Management | State Hazard Mitigation Planning Committee |
| New Jersey | 2019 | New Jersey Office of Emergency Management | Michael Baker International |
| New Mexico | 2018 | New Mexico Department of Homeland Security and Emergency Management | Planning Team |
| New York | 2019 | New York State Division of Homeland Security and Emergency Services | State University of New York's Research Foundation & Albany Visualization and Informatics Lab (AVAIL) |
| North Carolina | 2018 | North Carolina Emergency Management | ESP Associates and Atkins |
| North Dakota | 2018 | North Dakota Department of Emergency Services (NDDES) | Hagerty Consulting, Inc. |
| Ohio | 2019 | Ohio Emergency Management Association | State Hazard Mitigation Team |
| Oklahoma | 2019 | Oklahoma Department of Emergency Management | State Hazard Mitigation Team and Officer |
| Oneida Nation | 2016 | Oneida Nation Pre-Disaster Mitigation Plan Steering Committee | Bay-Lake Regional Planning Commission |
| Oregon | 2015 | Oregon Office of Emergency Management | Department of Land Conservation and Development |
| Pennsylvania | 2018 | Pennsylvania Emergency Management Agency | Michael Baker International |
| Rhode Island | 2018 | Rhode Island Emergency Management Agency | Hagerty Consulting |
| South Carolina | 2018 | South Carolina Emergency Management Division | Team |
| South Dakota | 2019 | South Dakota Office of Emergency Management | Wood Environmental & Infrastructure Solutions |
| Tennessee | 2018 | TN Department of Military, Tennessee Emergency Management Agency | BOLD Planning Solutions |
| Texas | 2018 | Texas Division of Emergency Management | State Hazard Mitigation Team |
| Utah | 2019 | Utah Division of Emergency Management | Team of Organizations, Departments, Agencies |
| Vermont | 2018 | Vermont Division of Emergency Management | Team |
| Virginia | 2018 | Virginia Department of Emergency Management | Witt O'brien's |
| Washington | 2018 | Washington Emergency Management Division | Multi-Agency Hazard Mitigation Workgroup |
| West Virginia | 2018 | West Virginia Military Authority & West Virginia Emergency Management | Mitigation Planning Team |
| Wisconsin | 2017 | Wisconsin Emergency Management, Department of Military Affairs | State Hazard Mitigation Team |

| State | Year | Lead Agency | Other Agencies |
|---|---|---|---|
| Wyoming | 2016 | Wyoming Office of Homeland Security | Senior Advisory Committee, Mitigation Sub-Committee |

## Appendix 2: State and Tribal Nature-Based Hazard Mitigation Goals

| State | Goals | Goal Category |
|---|---|---|
| Alabama | Goal 2: Reduce the State of Alabama's vulnerability and increase resilience to hazards to protect people, property, and natural resources.<br>Objective 2.6 Promote hazard mitigation policies that reduce risk to people and property and protect the environment. | Broad goal that mentions protecting the environment in addition to protecting other state aspects |
| Alaska | -- | No relevant goals |
| Arizona | -- | No relevant goals |
| Arkansas | Goal 2: Promote sustainable and disaster resilient development within Arkansas and its communities.<br>Objective 2.2: Promote sustainable development and "smart growth" initiatives through coordination with state agencies and non-profit organizations. | Goal specifically focuses on natural infrastructure/nature-based solutions |
| California | Goal 3: Protect the environment;<br>Objective 1: Provide guidance to all levels of government about mitigation planning and project compliance with the California Environmental Quality Act (CEQA) and all other applicable environmental laws, and facilitate alignment of federal and state regulations across agencies to strengthen mitigation, response, and recovery efforts. (Modified)<br>Objective 2: Encourage hazard mitigation measures that promote and enhance nature-based solutions, natural processes, and ecosystem benefits while minimizing adverse impacts to the environment;<br>Objective 3: Encourage mitigation planning programs at all levels of government to protect the environment and promote enforcement of sustainable mitigation actions;<br>Objective 4: Coordinate and implement integrated and adaptive hazard mitigation, and watershed and habitat protection strategies, through public and private partnerships;<br>Objective 5: Coordinate hazard mitigation planning with state and federal programs designed to minimize the release and movement of toxic and hazardous substances in the environment. | Goal specifically focuses on the environment;<br><br>Goal specifically focuses on natural infrastructure/nature-based solutions |
| Colorado | Support mitigation initiatives and policies that promote disaster resiliency, nature-based solutions, cultural resources and historic preservation, and climate adaptation strategies; | Goal specifically focuses on natural infrastructure/nature-based solutions |

| State | Goals | Goal Category |
|---|---|---|
| Connecticut | Goal 1: Promote implementation of sound floodplain management and other natural hazard mitigation principles on a state and local level;<br>Strategy 1.6: Encourage less development in risk zones, statewide, by promoting the Community Rating System (CRS) and by encouraging open space planning. Also encourage low impact development tools and techniques, low-intensity uses of existing open space in risk areas, and the incorporation of floodplain resource management best management practices into local floodplain programs. | Goal specifically focuses on natural infrastructure/nature-based solutions |
| Delaware | -- | No relevant goals |
| Florida | Goal 4: Support mitigation initiatives and policies that protect the state's cultural, economic, and natural resources;<br>Objective 4-1: Support land acquisition programs that reduce or eliminate potential future losses due to natural hazards and that are compatible with the protection of natural or cultural resources;<br>Objective 4-2: Support restoration and conservation of natural resources wherever possible.<br>Objective 4.6: Coordinate effective partnerships between state agencies for floodplain management. | Broad goal that mentions protecting the environment in addition to protecting other state aspects; Goal specifically focuses on natural infrastructure/nature-based solutions |
| Georgia | -- | No relevant goals |
| Hawai'i | Goal 1: Reduce the long-term vulnerability of Hawaii's people, property and jurisdictions, including state-owned or operated buildings, infrastructure and critical facilities, to natural hazards while conserving the State's natural, historical, and cultural assets. This includes high risk properties such as repetitive loss (RL) and severe repetitive loss (SRL) properties. | Broad goal that mentions protecting the environment in addition to protecting other state aspects |
| Idaho | Goal 2: Reduce the adverse economic and environmental impacts of natural, technological, and human-caused hazard events. | Broad goal that mentions protecting the environment in addition to protecting other state aspects |
| Illinois | -- | No relevant goals |
| Indiana | -- | No relevant goals |

| State | Goals | Goal Category |
|---|---|---|
| Iowa | Goal 1: Protect the health, safety, and quality of life for Iowa citizens while reducing or eliminating property losses, economic costs, and damage to the natural environment caused by a disaster;<br>Objective 1: Establish regulatory measures or processes that reduce the number and severity of all hazard risks in order to alleviate death, injuries, environmental impact, and property losses.<br>Objective 2 (combined): Encourage property protection measures and construction projects to prevent and reduce structure and other property damage, and promote the health, safety and welfare of citizens, and protect the environment.<br>Objective 4: Build support, capacity, and commitment to prevent or reduce risks from all hazards for protection of Iowa's citizens, property, and natural resources. | Broad goal that mentions protecting the environment in addition to protecting other state aspects |
| Kansas | Goal 1: Minimize the vulnerability of the people, property, environment, and economy of Kansas and its communities to the impacts of natural and manmade hazards. | Broad goal that mentions protecting the environment in addition to protecting other state aspects |
| Kentucky | -- | No relevant goals |
| Klamath Tribes | Goal 1—Reduce or prevent future hazard-related injuries and losses of life, property damage, and environmental impact.<br>Goal 3—Encourage the development and implementation of long-term, cost-effective and environmentally sound mitigation projects.<br>Objective 7 – Establish a partnership among the Tribal Government and Tribal business leaders with surrounding area government and business community to improve and implement methods to protect life, property, and the environment, while preserving the cultural integrity of the Klamath Tribes.<br>Objective 12 - Encourage hazard mitigation measures that result in the least adverse effect on the natural environment and that use natural processes, while preserving and maintaining the cultural elements of the Klamath Tribes. | Goal specifically focuses on the environment;<br><br>Goal specifically focuses on natural infrastructure/nature-based solutions |

| State | Goals | Goal Category |
|---|---|---|
| Lac du Flambeau | Goal 2: The goal of these hazard mitigations actions is to reduce the risk and extent of loss of critical natural resources (plant and animal species) and the spread of invasive species on individuals, families, and the community as a whole. Implementation of these actions will help ensure the health and wellness of the community, as well as decrease the incidence of other man-made hazards.<br>Goal 9: The goal of these hazard mitigations actions is to protect people and the natural environment from adverse effects of hazardous materials incident. | Goal specifically focuses on the environment |
| Louisiana | Goal 1: Protect the people, property, and natural resources of Louisiana, by promoting strategies and policies that increase resiliency, and minimize vulnerability to natural hazards.<br>Objective 1.5: Establish and coordinate effective partnerships between state agencies for floodplain and watershed management and development. | Broad goal that mentions protecting the environment in addition to protecting other state aspects |
| Maine | Goals: To reduce the risk of loss to life and property from flooding through state level agency coordination and support.<br>Objective 4: Watershed management. Minimize increased downstream flooding caused by runoff from upstream development. | Broad goal that mentions protecting the environment in addition to protecting other state aspects |
| Maryland | Maryland Hazard Mitigation Plan Goal - To protect life, property, and the environment from hazard events through: Promote actions that protect natural resources, while enhancing hazard mitigation and community resiliency. | Goal specifically focuses on the environment |
| Massachusetts | Goal 4: Increase the resilience of State and local government, people, natural systems, the built environment, and the economy by investing in performance-based solutions. (Plus section 7.3 Importance of Nature-Based Solutions in Hazard Mitigation and Climate Adaption) | Broad goal that mentions protecting the environment in addition to protecting other state aspects |
| Michigan | Goal 2: Reduce Property Damage: Incorporate hazard mitigation considerations into land use planning, resource management, land development processes, and disaster-resistant structures.<br>Goal 3: Build Alliances: Forge partnerships with other public safety agencies and organizations to enhance and improve the safety and wellbeing of all Michigan communities.<br>Objective 3.1: Promote urban forestry and vegetation management programs and initiatives to develop more resilient woodlands, streetscapes, and landscapes in communities throughout Michigan. | Goal specifically focuses on natural infrastructure/nature-based solutions |

| State | Goals | Goal Category |
|---|---|---|
| Minnesota | Drought Goal: Reduce economic loss and environmental impacts due to drought (MN has 2 plan goals and then goals for each hazard) | Broad goal that mentions protecting the environment in addition to protecting other state aspects |
| Mississippi | Goal 1: Minimize loss of life, injury, and damage to property, the economy, and the environment from natural hazards; Preserve, create, and restore natural systems to serve as natural mitigation functions.<br>Objective 1.6 Preserve, create, and restore natural systems to serve as natural mitigation functions | Broad goal that mentions protecting the environment in addition to protecting other state aspects<br><br>Goal specifically focuses on natural infrastructure/nature-based solutions |
| Missouri | Goal 4: Implement mitigation actions that improve the protection of community tranquility from the adverse effects of disasters<br>Objective 4.2: Consider sustainability issues (ecologically sound, economically viable, socially just, and humane) when developing or reviewing mitigation projects and plans. | Goal specifically focuses on the environment |
| Montana | Goal 2: Reduce Impacts of Wildland and Rangeland Fires<br>Objective 2.4: Implement Natural Resource Protection Projects to Reduce Impacts from Wildfire.<br>Goal 3: Mitigate the Potential Loss of Life and Property from Flooding<br>Objective 3.3: Implement Natural Resource Protection Projects to Reduce Impacts from Flooding.<br>Goal 5: Reduce the Impacts from Drought<br>Objective 5.3: Support Natural Resource Protection Efforts to Reduce Impacts from Drought<br>Goal 8: Minimize Impacts from Disease Outbreaks<br>Objective 8.3: Implement Natural Resource Protection Projects to Reduce Impacts from Disease | Goal specifically focuses on natural infrastructure/nature-based solutions |

| State | Goals | Goal Category |
|---|---|---|
| Nebraska | GOAL 4: Encourage the development and implementation of long-term, cost effective, and resilient mitigation projects that preserve or restore the functions of natural systems.<br>Objective 4.1: Encourage the use of green and natural infrastructure for mitigation projects, when applicable.<br>Objective 4.2: Provide technical assistance to communities and stakeholders in the application and implementation of mitigation projects that preserve or restore natural systems.<br>Objective 4.3: Maintain and encourage ongoing relationships between state and local agencies and federal partners to play an active and vital role in identifying appropriate preservation and restoration of vulnerable natural systems.<br>Objective 4.4: Promote the continued use of natural systems and features, and open space preservation, in land use planning and development by local jurisdictions. | Goal specifically focuses on natural infrastructure/nature-based solutions |
| Nevada | -- | No relevant goals |
| New Hampshire | Overarching Goal: Minimize loss and disruption of human life, property, the environment, and the economy due to natural, technological, and human-caused hazards through a coordinated and collaborative effort between federal, State, and local authorities to implement appropriate hazard mitigation measures;<br>Natural Hazard Objectives:<br>-Ensure mitigation strategies consider the protection and resiliency of natural, historical, and cultural resources | Broad goal that mentions protecting the environment in addition to protecting other state aspects |
| New Jersey | Goal 2: Protect Property<br>Objective 2.3: Implement hazard mitigation policies to protect environmental resources that serve a natural hazard mitigation function;<br>Objective 2.4: Encourage cost-effective and environmentally-sound development and land use. | Goal specifically focuses on natural infrastructure/nature-based solutions |
| New Mexico | Goal 5: Shorten recovery time for both community function and the natural environment after natural hazard events. | Broad goal that mentions protecting the environment in addition to protecting other state aspects |

| State | Goals | Goal Category |
|---|---|---|
| New York | Goal 1: Promote a comprehensive state hazard mitigation policy framework for effective mitigation programs that includes coordination among federal, state, and local organizations for planning and programs.<br>Objective 1.1: Promote integrated land use planning and development to encourage resilience and sustainability through statewide programs that address zoning, building codes, smart growth, capital improvement programs, open space preservation, critical infrastructure siting, and storm water management regulations;<br>Goal 2: Protect existing property including public, historic, private structures, state-owned/operated buildings, and critical facilities and infrastructure.<br>Objective 2.3: Encourage resilient and sustainable structural practices that reduce vulnerabilities and encourage the use of green and natural infrastructure;<br>Objective 2.4: Promote the continued use of natural systems and features, open space preservation, and land use development planning within local jurisdictions;<br>Goal 4: Preserve or Restore Natural Systems: Encourage the development and implementation of long-term, cost effective, and resilient mitigation projects to preserve or restore the functions of natural systems;<br>Objective 4.1: Encourage the use of green and natural infrastructure;<br>Objective 4.2: Provide technical assistance to communities and stakeholders in the application and implementation of mitigation projects that preserve or restore natural systems;<br>Objective 4.3: Maintain and encourage ongoing relationships between state agencies and partners to play an active and vital role in preservation and restoration of vulnerable natural systems;<br>Objective 4.4: Facilitate, encourage, and manage retreat where appropriate. | Broad goal that mentions protecting the environment in addition to protecting other state aspects<br><br>Goal specifically focuses on natural infrastructure/nature-based solutions |
| North Carolina | To reduce the State's vulnerability and increase resilience to natural hazards, in order to protect people, property and natural resources. | Broad goal that mentions protecting the environment in addition to protecting other state aspects |

| State | Goals | Goal Category |
|---|---|---|
| North Dakota | Purpose: Minimize the vulnerability of the public, property, infrastructure, environment, and economy of North Dakota and its communities to the impacts of natural and technological hazards as well as adversarial threats;<br>Goal 4: Preserve/protect people, property, and natural and cultural resources from the impacts of hazards and threats. Ensure that communities are resilient to the impacts of hazards and threats.<br>Objective 4.1: Within five years, starting in 2019, reduce the vulnerability of people, property, and natural and cultural resources to hazards and threats. | Broad goal that mentions protecting the environment in addition to protecting other state aspects |
| Ohio | -- | No relevant goals |
| Oklahoma | Goal 3: To protect the environment. | Goal specifically focuses on the environment |
| Oneida Nation | Goal 1: Minimize human, economic, and environmental disruption from natural hazards<br>Goal 5: Promote and enhance the sue of natural resource protection measures as a means to reduce the impact if natural hazards on people and property. | Broad goal that mentions protecting the environment in addition to protecting other state aspects<br><br>Goal specifically focuses on natural infrastructure/nature-based solutions |
| Oregon | Goal 4: Minimize the impact of natural hazards while protecting, restoring, and sustaining environmental processes; | Goal specifically focuses on the environment |
| Pennsylvania | Goal 1: Protect lives, property, environmental quality, and resources of the Commonwealth, including RL and SRL properties.<br>Objective 1-13: Promote Natural Systems Protection mitigation in the Commonwealth between 2019 and 2023. | Broad goal that mentions protecting the environment in addition to protecting other state aspects<br><br>Goal specifically focuses on natural infrastructure/nature-based solutions |
| Rhode Island | Goal 5: The built environment, infrastructure, people, natural environment, and economy are resilient to the impacts of natural, technological, and human-caused hazards under current and future conditions (including repetitive loss [RL] and severe repetitive loss [SRL]). | Broad goal that mentions protecting the environment in addition to protecting other state aspects |
| South Carolina | Goal #7: Enhance and encourage the use of natural resource protection measures as a means to reduce the impacts of hazards on people and property. | Goal specifically focuses on natural infrastructure/nature-based solutions |

| State | Goals | Goal Category |
|---|---|---|
| South Dakota | Goal 4: Reduce impacts to the economy, the environment, and cultural resources from hazards;<br>Objective 4.1: Reduce loss to natural resources (i.e. forest and watershed health).<br>Drought Goal: Reduce drought impacts to South Dakota's economy, people, state assets, cultural resources, and environment; Reduce losses to natural resources (i.e., forest and watershed health) | Broad goal that mentions protecting the environment in addition to protecting other state aspects; Goal specifically focuses on the environment |
| Tennessee | -- | No relevant goals |
| Texas | Goal 5: Reducing adverse environmental, natural resource, and economic impacts from natural, technological, and human-caused hazard events. | Broad goal that mentions protecting the environment in addition to protecting other state aspects |
| Utah | Goal 8: Preserve, protect, and/or restore natural systems, natural resources, and other environmental conditions against hazard events; Combine hazard loss reduction efforts with other environmental, social, and economic needs of the state.<br>Goal 9. Combine hazard loss reduction efforts with other environmental, social, and economic needs of the state | Goal specifically focuses on the environment |
| Vermont | Mission: To protect life, property, natural resources and quality of life in Vermont by reducing our vulnerability to climate change and natural disasters;<br>Goal: Protect, restore and enhance Vermont's natural resources to promote healthy, resilient ecosystems;<br>Goal: Develop and implement plans and policies that create resilient natural systems, built environments, and communities. | Broad goal that mentions protecting the environment in addition to protecting other state aspects<br><br>Goal specifically focuses on natural infrastructure/nature-based solutions |
| Virginia | Vision: It is the Commonwealth's vision to promote resiliency and reduce the long-term impacts of hazards on human, economic, and natural resources throughout the state. | Broad goal that mentions protecting the environment in addition to protecting other state aspects |
| Washington | -- | No relevant goals |
| West Virginia | Vision: It is the vision of the State of West Virginia to promote resiliency and reduce the long-term effects of on the population, infrastructure, economy, and natural resources of the state. | Broad goal that mentions protecting the environment in addition to protecting other state aspects |

| State | Goals | Goal Category |
|---|---|---|
| Wisconsin | Goal 1: Minimize human, economic, and environmental disruption from natural, technological, and manmade hazards. | Broad goal that mentions protecting the environment in addition to protecting other state aspects |
| Wyoming | -- | No relevant goals |

## Appendix 3: State and Tribal Nature-Based Hazard Mitigation Actions

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Alaska** | FL Action 1.4.1: Encourage the State and communities to purchase flood-prone property and convert to open space for perpetuity. | Land Use | Multi-hazard |
| **Alaska** | Encourage non-structural mitigation and preparedness activities. | Policy and Law | Multi-hazard (EQ Action 4.1.1 |
| **Alaska** | Encourage developing erosion damaged embankment restoration projects that use natural vegetation to stabilize and fortify high risk coastal and riverine erosion damaged locations. | Restoration | Flood |
| **Alabama** | 76. Create technical bulletin that educates local floodplain managers about the benefit of evaluating the hazard posed by the encroachment of non-native plant species into floodways. | Education and Awareness | Flood |
| **Alabama** | 77. Create technical bulletin that educates local floodplain managers to account for and incorporate wetland protection and mitigation sites into the planning process when preparing new studies for watercourses. | Education and Awareness | Flood |
| **Alabama** | 112. Create a state program to promote the planting of indigenous trees that are more resilient to high wind events. | Funding and Programmatic | Wind |
| **Alabama** | 79. Reduce the flooding risk to communities by acquiring property located in the 100- year floodplain and return it to open space. | Land Use | Flood |
| **Alabama** | 75. Develop regulations that preserve and rehabilitate natural systems to serve natural hazard mitigation functions (i.e., floodplains, wetlands, watersheds, and urban interface areas) | Policy and Law | Flood |
| **Arizona** | -- | -- | - |
| **Arkansas** | 16. Use green mitigation techniques such as bio swales, rain gardens, and permeable pavers | Green Infrastructure | |
| **California** | Coordinate the activities of state agencies to improve air and water quality; protect natural resources and agricultural lands | Agency Coordination | |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **California** | Provide funding to local agencies in the Sacramento San Joaquin for levee maintenance and improvement and for habitat mitigation and enhancement | Funding and Programmatic | |
| **Colorado** | HH-1: Implement fuels reduction and forest health projects. | Conservation/ Preservation/ Management | Wildfire |
| **Colorado** | FHP 2.1: Enhance the natural and beneficial functions of floodplains by promoting an increased awareness of stream ecosystem function and its benefits to flood hazard mitigation. | Education and Awareness | Flood |
| **Colorado** | DMRP 6.7: River restoration for streams that are most vulnerable to drought impacts. | Restoration | Drought |
| **Connecticut** | 59. Increase support for state-level cultural and natural resources initiatives to increase resiliency of cultural and natural resources from disasters. Expand SHPO resiliency focused technical assistance project completed in 2018 to northern four counties. | Funding and Programmatic | |
| **Connecticut** | 60. Increase support for state-level cultural and natural resources initiatives to increase resiliency of cultural and natural resources from disasters. Expand SHPO resiliency focused technical assistance project completed in 2018 to northern four counties. | Funding and Programmatic | |
| **Connecticut** | 16. Conduct phragmites control/invasive plant control (herbicide and mowing) on state owned land tidal and freshwater marshes to reduce fuel load and wildfire risk in tidal areas for three-year period to control this invasive species. Reduce phragmites by 50% in year one; 40% in year two; 10% in year three with 100% reduction after three years. | Restoration | |
| **Connecticut** | 28. Encourage municipalities and COGs to conduct watershed-based hydrologic and hydraulic studies to evaluate potential flood mitigation alternatives along river and stream corridors. | Technical and Information | |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Connecticut** | 34. Continue to identify head-of-tide habitat within Connecticut and monitor the change in this habitat due to climate change through sentinel monitoring in order to determine those communities that may endure increased risk from coastal storms and associated flooding. LWRD is currently funding multiple monitoring and data synthesis projects in support of this activity | Technical and Information | |
| **Connecticut** | 35. Identify and map the locations of headwater, main stem and coastal dams, culverts, bridges, and other structures or land modifications that contribute to flood damage and act as barriers to habitat connectivity and assess the feasibility of removal or modification of these structures. | Technical and Information | |
| **Delaware** | 26. Encourage the acquisition of land in flood-prone areas. | Conservation/ Preservation/ Management | Flood |
| **Delaware** | 6. Encourage greenways "zoning" along river corridors | Land Use | Flood |
| **Delaware** | 5. Strongly encourage riparian buffer requirements. Recommend environmentally sensitive development such as greenways and trails as opposed to commercial and residential development. | Policy and Law | Flood |
| **Florida** | -- | -- | |
| **Georgia** | 27. Minimize damage to natural resources through the use of and compliance with greenspace, stream buffers, zoning ordinances as actions to protect Georgia communities | Land Use | All Hazards |
| **Georgia** | 88. Ensure there are no adverse effects of any proposed mitigation projects on Georgia's natural resources and/or threatened or endangered species | Policy and Law | All hazards |
| **Georgia** | 28. Create and maintain state wide map layer that identifies important natural and cultural resources | Technical and Information | All Hazards |
| **Hawai'i** | 2018-046—Green Infrastructure Study and Plan | Green Infrastructure | |
| **Hawai'i** | 2018-019—Support the Hawai'i Association of Watershed Partnerships | Partnerships | |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Hawai'i** | 2018-026—Assess, identify, and implement state nursery improvements needed to provide native plants for green breaks | Technical and Information | |
| **Hawai'i** | 2018-047—Report Assessing the Feasibility and Implications of Managed Retreat Strategies for Vulnerable Coastal Areas in Hawai'i | Technical and Information | |
| **Idaho** | -- | -- | |
| **Illinois** | Action 2.6.4.1. Work in developing and maintaining a database on all protected lands, identifying possible partners in the acquisition and maintenance of hazard prone lands contiguous to protected lands. | Technical and Information | |
| **Indiana** | 1. Develop an outreach program to educate communities on green infrastructure and provide opportunities for them to seek additional training | Education and Awareness | Flood |
| **Indiana** | 30. Retrofit state facilities to provide adequate capabilities in the event of disasters. Include green infrastructure to reduce unnecessary strain on water resources | Green Infrastructure | Winter Storm, Drought, Extreme Temps, Wildfire, Disease Outbreak, Fluvial Erosion Hazard |
| **Iowa** | 2.12 Encourage and implement green infrastructure practices to create healthier urban environments and manage storm water in cities. Practices include mechanisms that prevent soil erosion or provide flood protection, habitat, and cleaner air and water (riparian forest buffers, infiltration including bioswales, wet detention systems, storm water wetlands, vegetated swales, permeable pavement, and green roofs). | Green Infrastructure | |
| **Iowa** | 2.14 Use a comprehensive approach to address problems with water washing over or threatening public roads, and with public bridges and culverts that do not meet flow requirements. A comprehensive approach could simply mean elevation, replacement, or retrofit, OR it could be systemwide with a collection of projects/changes that might include green infrastructure, basins, and increased capacity of soil to retain water. | Green Infrastructure | |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Iowa** | 2.4 Acquire more flood prone properties (with priority for repetitive loss and SRL properties) and convert to open space/green space; or elevate to or at least one foot above base flood elevation. | Land Use | |
| **Iowa** | 1.4 Promulgate (and develop if necessary) a handbook explaining options and methods for communities to deal with property acquired from flood buyouts. | Restoration | |
| **Iowa** | 2.5 Implement floodplain and streambank restoration/channel improvement projects that reduce peak flow during flood events. | Restoration | |
| **Iowa** | 4.3 Minimize damage and also preserve/restore the functions of natural systems by establishing vegetated buffers and strategically-placed wetlands that capture runoff and drainage waters before they can negatively impact the surrounding environment. | Restoration | |
| **Kansas** | 33 Assess benefits from the restoration of flow, habitat, and flood storage in urban waterways. | Technical and Information | Flood |
| **Kentucky** | L4 Manage Vegetation, Wetlands | Conservation/ Preservation/ Management | Flooding |
| **Kentucky** | L10 Maintain Creek Banks | Conservation/ Preservation/ Management | Flooding |
| **Kentucky** | D22. Promote, develop Green Infrastructure/Low-Impact Development Projects | Green Infrastructure | Flooding/Landslides |
| **Kentucky** | L13 Realign Streams | Restoration | Flooding |
| **Kentucky** | Flood Action: Protect and restore natural floodplain functions | Restoration | |
| **Klamath Tribes** | Consider planting standards in wildland buffer areas to require fire-resistant plants with loose branching habits, non-resinous woody material, high moisture content leaves and limited seasonal accumulation of dead vegetation | Policy and Law | |
| **Klamath Tribes** | Continue working with Oregon Watershed Enhancement Board for various watershed improvement activities | Partnerships | |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Klamath Tribes** | Continue working on the Legacy Road Reconstruction program for projects such as: decommissioning/vacating of roadways of high negative impact to natural resources; road upgrades; surface drainage improvements; road stabilization, and culvert replacement for fish passage | Funding and Programmatic | |
| **Lac du Flambeau** | Work with Federal partners to preserve or restore wetlands ecosystems in buffer zones along rivers and lakes for flood control and water quality management. Re-assess buffer zone setbacks | Conservation/ Preservation/ Management | Severe Thunderstorms / Lightning / Hail |
| **Lac du Flambeau** | Protect and mitigate existing impacts to the forests along the wetlands and riparian areas, and within the wetlands system. Monitor vegetation changes in watersheds though ground cover surveys, aerial photography or by relying on the research from local conservation groups and universities; | Conservation/ Preservation/ Management Restoration | Severe Thunderstorms / Lightning / Hail |
| **Lac du Flambeau** | Expand opportunities to engage the community in nature preservation projects and efforts | Education and Awareness | Severe Thunderstorms / Lightning / Hail |
| **Lac du Flambeau** | Conduct education and outreach about green infrastructure to help control runoff, capture stormwater and reduce water demand. Some common green infrastructure practices include bioretention areas (rain gardens), low impact development methods, green roofs, swales (depressions to capture water) and the use of vegetation or pervious materials instead of impervious surfaces. | Education and Awareness Green Infrastructure | Severe Thunderstorms / Lightning / Hail |
| **Lac du Flambeau** | Expand programs working to protect sensitive land from development using land acquisition through purchase | Funding and Programmatic | Flood |
| **Lac du Flambeau** | Invest in and utilize green infrastructure to help control runoff, capture stormwater, and reduce water demand. Some common green infrastructure practices include bioretention areas (rain gardens), low impact development methods, green roofs, swales (depressions to capture water) and the use of vegetation or pervious materials instead of impervious surfaces | Green Infrastructure | Severe Thunderstorms / Lightning / Hail |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Lac du Flambeau** | Expand work with utility companies to reduce sediment and nutrient inputs into source water bodies, regulate runoff (construction site) and streamflow, buffer against flooding (e.g., wetlands) | Partnerships | Severe Thunderstorms / Lightning / Hail |
| **Lac du Flambeau** | Integrate policies into existing plans that protect, maintain, and enhance tree canopy in urban settings to reduce heat. | Policy and Law | Extreme Heat |
| **Lac du Flambeau** | Work with Federal partners to take action through existing authorities to ensure enforcement of water quality standards | Policy and Law | Severe Thunderstorms / Lightning / Hail |
| **Lac du Flambeau** | Ensure that the Conservation Code committee continue to meet periodically to discuss issues and recommend projects. | Policy and Law | Flood |
| **Lac du Flambeau** | Enhance existing ordinances which manage riparian buffers along rivers, streams, lakes and other water bodies; | Policy and Law | Flood |
| **Lac du Flambeau** | Develop flood management systems that better utilize natural floodplain processes | Technical and Information | Flood |
| **Louisiana** | No actions like other states, but a technical appendix describing a number of mitigation strategies. | | |
| **Maine** | -- | -- | |
| **Maryland** | #34 – Target Restoration, Preservation, & Mitigation within Special Flood Hazard Areas using the Water Resource Registry | Conservation/ Preservation/ Management Restoration | |
| **Maryland** | #18 - Increase opportunities for communication about adaptation planning in Maryland, facilitate the exchange of ideas between Chesapeake Bay watershed partners, and pilot green/grey infrastructure to prepare for and respond to climate impacts to vulnerable populations. | Education and Awareness Green Infrastructure | |
| **Maryland** | #15 – Coastal Restoration to Mitigate Hazards for Vulnerable Communities | Restoration | |
| **Massachusetts** | EOEEA: Review habitat management, land stewardship, coastal zone management, agricultural and invasive species programs and policies to develop strategies that promote coordination among agencies and support climate change adaptation and mitigation goals. | Agency Coordination | Precipitation Changes, Sea Level Rise, Rising Temperatures, Extreme Weather |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Massachusetts** | MassWildlife: In partnership with CZM, improve management of beach nourishment projects and other shoreline protection strategies and incorporate habitat considerations into coastal storm disaster response habitat and infrastructure on barrier beaches. | Conservation/ Preservation/ Management | Precipitation Changes, Sea Level Rise, Rising Temperatures, Extreme Weather |
| **Massachusetts** | MassDOT: Pilot Deerfield Watershed Stream Crossing Resilience Project. This project will produce GIS layers and a web viewer ranking the vulnerability of culverts and wildlife to climate change. The final report will document the methods used in the project. Next steps will include an evaluation of how to transfer the methods to the remaining watersheds in Massachusetts. | Technical and Information | Precipitation Changes, Sea Level Rise, Rising Temperatures, Extreme Weather |
| **Massachusetts** | DCR: Update the State Forest Action Plan to enhance climate change mitigation and adaptation strategies. Update State Forest Action Plan to incorporate strategies to deal with future conditions presented by a warming planet. These concepts will be incorporated into the 2020 update of the Plan | Funding and Programmatic | Precipitation Changes, Sea Level Rise, Rising Temperatures, Extreme Weather, Earthquake |
| **Massachusetts** | DER: Develop a prioritization and implementation strategy for barrier removal on cold water streams most impacted by warming temperatures. DER will work with federal, state, and local organizations and property owners to identify, prioritize, design, permit, and guide the removal of dams and replacement of culverts for the benefit of cold water habitat, public safety, and municipal infrastructure resilience. Removing barriers results in-stream temperatures decreasing and connectivity increasing for sensitive species in cold water streams, while also improving the safety of roadways, infrastructure and residents living in close proximity to dams and culverts. | Funding and Programmatic | Precipitation Changes, Rising Temperatures, Extreme Weather |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Massachusetts** | DER: Develop an implementation plan to build municipal capacity to replace undersized, deteriorated culverts with larger, safer structures that are resilient to extreme storms and provide passage for fish and wildlife. | Funding and Programmatic | Precipitation Changes, Rising Temperatures, Extreme Weather |
| **Massachusetts** | DER: Develop an implementation strategy and updated prioritization scheme to work with federal, state, and local partners and non-profit organizations to remove unwanted state-owned dams to reduce risk, increase resilience to extreme weather and climate change, and restore aquatic habitat. | Funding and Programmatic | Precipitation Changes, Rising Temperatures, Extreme Weather, Earthquake |
| **Massachusetts** | EOEEA: Based on results of vulnerability assessment for EOEEA properties and vulnerability assessments from other agencies, use climate change projections to develop stormwater management actions and projects. EOEEA properties held by agencies including DCR and MassWildlife such as parkways, parking lots, and other facilities may have opportunities for decreased stormwater runoff through the use of green techniques or traditional methods. Similarly, protected green space held by agencies may be able to buffer neighboring infrastructure held by others. EOEEA will work with its agencies to examine areas with the highest potential for best practice stormwater management projects, and develop a plan to implement these management actions. | Funding and Programmatic | Precipitation Changes |
| **Massachusetts** | DEP: Implement Updated Stream crossing culvert replacement guidance. DEP has an updated stream crossing / culvert replacement guidance to protect wildlife habitat and reduce flooding impacts. The agency will continuing to partner with the Department of Fish and Game, the Division of Ecological Restoration and others to secure funding for culvert replacement projects that will improve the resiliency of new structures, protect habitat and reduce flood damage. | Funding and Programmatic | Precipitation Changes, Sea Level Rise, Rising Temperatures, Extreme Weather |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Massachusetts** | EOEEA: Reassess and develop a climate change resiliency framework and criteria for all EOEEA agency land acquisition and grant funding for land acquisition to support natural resource conservation, wildlife, human health and public safety. While EOEEA has incorporated resiliency criteria into its land acquisition grant programs and agencies address it in their agency prioritization schemes, the overall natural land protection program should be reviewed, assessed and reprioritized to ensure protection of multiple resiliency goals including protecting critical ecosystem services, ensuring connectivity of wildlife, protecting climate-sensitive areas, avoiding repeat loss of infrastructure and property, increasing human health and safety, and preserving habitats of climate-sensitive species. | Funding and Programmatic | Precipitation Changes, Sea Level Rise, Rising Temperatures, Extreme Weather |
| **Massachusetts** | DER: Develop an implementation plan to reprioritize and accelerate tidal wetland restoration for climate adaptation and habitat restoration. DER will work with towns and private property owners as well as federal, state, and local organizations to identify, design, permit, and guide the construction of salt marsh restoration projects that benefit public safety, build resilience to extreme weather and sea level rise, and restore coastal habitat. Coastal wetlands provide benefits to people and communities such as flood reduction, protection from coastal storms, water quality improvement, and recreation. | Funding and Programmatic Restoration | Severe Thunderstorms / Lightning / Hail |
| **Massachusetts** | DER: Develop an implementation strategy for retired cranberry bog restoration for climate adaptation and habitat restoration by working with landowners, federal, state, and local partners and non-profit partners for climate resiliency, habitat quality, flood and water quality protection, and wildlife. | Funding and Programmatic Restoration | Precipitation Changes, Sea Level Rise, Rising Temperatures, Extreme Weather |

| State | Action | Action Category | Action Hazard |
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| **Massachusetts** | DER: Develop an implementation plan to complete priority water quality restoration projects for climate adaptation and habitat restoration. DER will work with partners to identify, prioritize, plan and complete projects that improve water quality and increase community resilience to water quality impacts stemming from climate change. Projects may include green infrastructure stormwater treatments; enhancing local and regional capacity for data collection, analysis, and leading restoration projects; restoration of riparian buffer functions and values; and support to communities developing ordinances and stormwater utilities. | Funding and Programmatic Restoration Green Infrastructure | Precipitation Changes, Rising Temperatures |
| **Massachusetts** | DER: In support of EOEEA's efforts on MVP, build the capacity of regional organizations to implement climate adaptation and habitat restoration at the local level.DER will partner with and support up to five regional organizations that help municipalities identify, develop, and implement projects that provide climate change adaptation and improved public safety for communities and habitat restoration benefits for fish and wildlife. DER will facilitate regional solutions at the watershed, river corridor, or coastline scale, which may cross municipal boundaries. | Partnerships | Precipitation Changes, Sea Level Rise, Rising Temperatures, Extreme Weather |
| **Massachusetts** | EOEEA: Review, evaluate, and implement revisions as needed to environmental and energy policies, regulations, and plans.: Review, evaluate, conduct outreach with stakeholders, and implement revisions that may be needed to key state environmental and energy policies, regulations and plans maintained by EOEEA and its agencies. This action has cross-cutting impact on risk reduction across the administration. | Policy and Law | Precipitation Changes, Sea Level Rise, Rising Temperatures, Extreme Weather |

| State | Action | Action Category | Action Hazard |
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| **Massachusetts** | DEP: Promulgate wetlands regulations to establish performance standards for work in land subject to coastal storm flowage. Promulgate wetlands regulations to establish performance standards for work in Land Subject to Coastal Zone Flowage. DEP Wetlands Protection Program is working to propose draft regulations that will establish performance standards for work in Land Subject to Coastal Zone Flowage. This resource area is critical for reducing coastal impacts from Storm event. DEP intends to align any proposed standards with FEMA mapping and the state building code for these areas. | Policy and Law | Precipitation Changes, Sea Level Rise, Rising Temperatures, Extreme Weather |
| **Massachusetts** | DER: Restore streamflow to flow-stressed rivers to increase resiliency for aquatic ecosystems and for water supplies. DER works to restore natural streamflow (the amount of water that flows through streams and rivers) in Massachusetts. DER works with partners to collect streamflow data and manages restoration projects aimed at restoring natural flow. Streamflow restoration projects increase community resilience to drought and improve aquatic habitats. | Restoration | Precipitation Changes, Rising Temperatures |
| **Massachusetts** | MassWildlife: Dam removals at the Merrill Ponds Wildlife Management Area. | Restoration | Precipitation Changes, Extreme Weather, Earthquake |

| State | Action | Action Category | Action Hazard |
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| **Massachusetts** | MassWildlife: Great Marsh Pilot Ditch Remediation Project. Because of the significance of the marsh, cost-effective experimental pilot projects are warranted to assess the feasibility of larger-scale interventions in the future. Marsh ditching during the past century has led to partial drying and lowering of the marsh bed. In cooperation with The Trustees of Reservations (TTOR), researchers at University of New Hampshire, and other partners, we propose to fill select ditches on MassWildlife and TTOR properties with organic material and measure the effects on marsh elevation and rates of sediment trapping. Preliminary indications are that this technique may prevent further subsidence, reduce the rate of marsh loss, and possibly even gradually elevate the marsh bed through sediment trapping. | Restoration | Precipitation Changes, Sea Level Rise, Rising Temperatures |
| **Massachusetts** | DER: Update and share a dam removal decision support tool that directly incorporates new climate change projections, climate adaptation benefits and helps municipalities and others prioritize dams for removal. Municipalities, federal, state, and local agencies and non-profit organizations want to remove outdated dams to reduce risk, improve public safety, and restore habitat. With more than 3,000 dams and limited resources, it is important to select the projects that will yield the greatest environmental and risk reduction benefits. DER has developed and published a web-based tool that evaluates dams for removal based on the expected ecological benefit. DER will update and publish the web-based tool to include risk reduction and climate adaptation benefits. | Technical and Information | Precipitation Changes, Rising Temperatures, Extreme Weather |
| **Massachusetts** | DEP: Update precipitation data used by wetlands program. Update Precipitation projections (models) used by the wetlands program to condition work in wetland resource areas and design stormwater controls. | Technical and Information | Precipitation Changes, Sea Level Rise, Rising Temperatures, Extreme Weather |

| State | Action | Action Category | Action Hazard |
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| **Massachusetts** | DEP: Regional water quality monitoring initiative. DEP is participating in a regional surface water quality monitoring initiative with the other New England states, EPA Regional offices, and tribes in the Northeast, Mid-Atlantic and Southeast. This effort monitors freshwater streams to detect climate-related changes related to temporal trends in biological, thermal, hydrologic, habitat and water chemistry data, and to gather information on response and recovery of organisms to extreme weather events. | Technical and Information | Precipitation Changes, Sea Level Rise, Rising Temperatures, Extreme Weather |
| **Massachusetts** | MassWildlife: Evaluation of climate change impacts on common species. MassWildlife is largely funded through the purchase of fishing and hunting licenses. Common species (e.g., yellow perch, pumpkinseed, chain pickerel, wild turkey, deer, bear,) provide recreational opportunities to the broadest number of anglers and hunters and yet little work has focused on understanding how these species will respond to climate change in Massachusetts. Climate change is likely to shift habitats that support common species as well as angler and hunter behavior. Understanding the direct and indirect effects of climate change on common species and angler/hunter behavior will allow the Division to foresee how management strategies may need adjustment to provide recreational opportunities to Commonwealth citizens into the future. | Technical and Information | Precipitation Changes, Sea Level Rise, Rising Temperatures, Extreme Weather |

| State | Action | Action Category | Action Hazard |
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| **Massachusetts** | MassWildlife: Updates to BioMap2. In 2010, the MassWildlife's Natural Heritage and Endangered Species Program completed a rigorous analysis of the status and location of rare species and natural communities in collaboration with The Nature Conservancy. The resulting document, BioMap2, identified areas where conservation efforts should be focused in order to protect plant and wildlife biodiversity in Massachusetts. For example, the document has been used to identify where land acquisition is likely to benefit the protection of rare species. Since completion of the document newer and finer-scaled climate change predictions have become available. Incorporation of the newer predictions as well as more recent species and habitat data can help the Division prioritize and tailor effective management actions. | Technical and Information | Precipitation Changes, Sea Level Rise, Rising Temperatures, Extreme Weather |
| **Massachusetts** | MassWildlife: Work with MassDOT to incorporate habitat and cold water fisheries considerations into MassDOT climate vulnerability assessments, adaptation projects, and community planning tools. | Technical and Information | Precipitation Changes, Sea Level Rise, Rising Temperatures, Extreme Weather |
| **Massachusetts** | MassWildlife: Evaluation of shifts in habitats and species distributions. Species habitats and distributions are expected to shift with changing environmental conditions, resulting in changes to the function and structure of ecosystems. The Division of Fisheries and Wildlife will need to understand the rate and extent of changes to ecosystems over different timescales in order to effectively manage resources. The Division is already considering these shifts in management decisions. For instance, emphasis has fallen away from purchasing areas that will likely be lost to sea level rise (e.g., salt marshes). However, comprehensive spatially-explicit analysis (where, how) of impacts to ecosystems and vulnerable species and habitats has not been completed. | Technical and Information | Precipitation Changes, Sea Level Rise, Rising Temperatures, Extreme Weather |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Massachusetts** | MassWildlife: Study impact of climate change on fish hatcheries held by MassWildlife. | Technical and Information | Precipitation Changes, Sea Level Rise, Rising Temperatures, Extreme Weather |
| **Massachusetts** | MassWildlife: Identification of areas with high native aquatic biodiversity to help prioritize aquatic adaptation actions as the climate changes. The Division of Fisheries and Wildlife is responsible for the conservation of freshwater fishes and wildlife throughout Massachusetts. Efforts (i.e. BioMap2) have been made to rigorously analyze and map rare species and natural community data in terrestrial ecosystems. These efforts identified lands critical for protecting and maintaining wildlife and plant biodiversity in Massachusetts. However, similar efforts have not been completed for the river and streams providing habitat to aquatic species (e.g., fishes, freshwater mussels) managed by MassWildlife. Identification of water bodies with high native aquatic biodiversity would provide critical information necessary for effective management and conservation of aquatic species in the state. | Technical and Information | Precipitation Changes, Rising Temperatures, Extreme Weather |
| **Massachusetts** | MassWildlife: Identification of cold water climate refugia and transitional waters for protections of CFRs. | Technical and Information | Precipitation Changes, Rising Temperatures, Extreme Weather |
| **Massachusetts** | MassWildlife: Mapping and control of invasive plant species. | Technical and Information | Precipitation Changes, Sea Level Rise, Rising Temperatures, Extreme Weather |
| **Michigan** | Conduct periodic educational programs on creating and maintaining a storm-resistant urban forest, targeted at urban forestry programs and local public works agencies, making their areas more resistant to severe winds, fires, lightning, ice storms, and invasive species. | Education and Awareness | |

| State | Action | Action Category | Action Hazard |
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| **Michigan** | Promote coordination and provide technical support for local urban forestry programs (professional guidance, training, and education; tree selection, planting, and maintenance; local tree ordinance development; public awareness and education; street and park tree management and planning; community climate adaptation planning; utility vegetation management, awareness, and safety; recognition/certification). | Partnerships | |
| **Minnesota** | Promote collective action between state agencies to address the stability of natural systems in the built environment by providing sufficient water storage, reducing volume, slowing velocity, and promoting practices to stabilize soils and maintain the diversity of native plant communities | Agency Coordination | |
| **Minnesota** | Flood goal: Stream corridor protection projects and restoration and soil erosion control projects will be used to prevent or reduce risks and increase the protection of natural resources from flooding. | Conservation/ Preservation/ Management Restoration | |
| **Minnesota** | Extreme Temperature Goal: Reduce Urban Heat Island Effect. Increase tree plantings around buildings to shade parking lots and along public rights-of-way. Encourage installation of green roofs and cool roofing products that reflect sunlight and heat away from a building. | Green Infrastructure | |
| **Minnesota** | Flood goal: #4 Require incorporation of water-sensitive infrastructure – such as protection of natural areas, development of green infrastructure, and minimization of impervious areas to treat both water quality and quantity – in all comprehensive plans and watershed plans. | Policy and Law<br><br>Green Infrastructure | |
| **Mississippi** | Preserve, create, and restore natural systems | Conservation/ Preservation/ Management Restoration | Hurricane |
| **Missouri** | -- | -- | |
| **Montana** | Project 5.4.2 - Encourage passive water storage where it will enhance natural function and increase water supply security. | Conservation/ Preservation/ Management | Drought |

| State | Action | Action Category | Action Hazard |
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| **Montana** | Project 1.5.1 - Continually update planning and zoning guidelines and model regulations (including growth policies, subdivision regulations, floodplain regulations, design standards for open space, setbacks and vegetative buffers) which recognize the risk from natural and manmade hazards and offer recommendations on best practices and smart growth solutions. | Land use | All hazards |
| **Montana** | Project 3.3.1 - Encourage appropriate entities to obtain conservation easements for land in the floodplain. | Partnerships | Flood |
| **Montana** | Project 5.3.1 - Continue to implement angling restrictions and closures to reduce drought impacts on Montana fisheries. | Policy and Law | Drought |
| **Montana** | Project 5.3.2 - Continue to administer Fish, Wildlife, and Parks' Water Rights and Water Reservations to protect instream flows during drought for the benefit of fish and wildlife | Policy and Law | Drought |
| **Montana** | Project 8.3.1 - Encourage water saving measures and institute fishing restrictions during drought to reduce stress on fish, which can make them more susceptible to disease. | Policy and Law | Disease Outbreaks |
| **Montana** | Project 3.4.5 - Encourage Natural Channel Design (NCD) techniques for stream restoration and bank restoration/stabilization projects to increase flood resiliency. | Restoration | Flood |
| **Montana** | Project 3.4.6 - Encourage projects that will increase stream length to regain natural function and reduce impact of flooding. | Restoration | Flood |
| **Montana** | Project 5.4.4 - Encourage removal of abandoned structures to improve stream connectivity. | Restoration | |
| **Nebraska** | Establish Floodplain Management Program for Channel Migration – A floodplain management program for channel migration should be implemented with the philosophy that infrastructure should work with the natural hydrology instead of changing the waterways to meet existing infrastructure, and emphasize nature-based solutions | Funding and Programmatic | Flood |

| State | Action | Action Category | Action Hazard |
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| **Nevada** | Provide native and accepted introduced seed species through the Nevada State seed bank program | Conservation/ Preservation/ Management | Wildfire |
| **Nevada** | Supply resources for rehabilitation efforts through the State Tree Nurseries in Las Vegas and Washoe Valley, and the Nevada State seed bank programs. | Funding and Programmatic | Wildfire |
| **Nevada** | Restore native and adapted vegetation and work to prevent areas being impacted by non-native or undesirable species conversions through collaborative efforts. | Restoration | Wildfire |
| **New Hampshire** | 58. Continue the development of local and regional river corridor stewardship programs such as the Rivers Management and Protection Program. | Funding and Programmatic | Inland Flooding |
| **New Hampshire** | 34. Promote funding and resources for land acquisition, conservation planning, land management programs, and land stewardship in areas at risk of loss or degradation due to sea level rise. | Funding and Programmatic | Coastal Flooding/Inland Flooding |
| **New Hampshire** | 47.Recommend a comprehensive planning and zoning policy such as development setbacks and limits on density and infrastructure in coastal and transitional zones to consider vulnerability to sea level rise and saltwater intrusion. | Land Use | Coastal Flooding/Inland Flooding |

| State | Action | Action Category | Action Hazard |
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| **New Hampshire** | 43.Continue to develop and maintain GIS layers as a multi-agency collaborative effort to capture data, including but not limited to: • NH DES-NHGS: Stream Crossing Initiative geodatabase. • NH DNCR-DHR: Sensitive natural and cultural resources and historical and archeological properties, and incorporation of archeological site data in the new Electronic Mapping and Management Information Tool (EMMIT) and promote use by municipalities, local heritage commissions, historical societies, and preservation professionals. • NH DNCR-DFL: LANDFIRE data layers (used to determine statistical probabilities of wildland fires). • NH DES Coastal Program: Coastal hazards (maximum flooding extent, nuisance flooding extent, etc.), locations of natural and manmade protective systems and barriers (salt marshes, seawalls, etc.), ongoing study locations, and others. Data collected in partnership with NH Fish and Game, UNH Sea Grant, and GRANIT. • NH HSEM: Maintain Hazard Mitigation Assistance (HMA)Program funded project layer. | Technical and Information | All Hazards |
| **New Jersey** | 2008 PSA 223 Continue the nonlapsing Shore Protection Fund for shore protection projects, stabilization, restoration or maintenance of the shore, including monitoring studies and land acquisition. | Funding and Programmatic | |
| **New Mexico** | 6. Implement Actions to Improve Forest and Watershed Health | Restoration | Drought, Flood, Wildfire |
| **New York** | Land Acquisition: Continue to purchase land & explore enhancement options that may prevent development encroachment into hazardous areas. Identifying alternate funding sources for land acquisition resulting in open space or some sort of development prevention in a hazard area is a fundamental form of hazard mitigation. | Conservation/ Preservation/ Management | Coastal Hazards \| Hurricane \| Flooding |

| State | Action | Action Category | Action Hazard |
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| **New York** | Sustainable Shoreline Project: Development of guidance for communities on the tradeoffs among management options for controlling shoreline erosion, including relative costs, impacts on habitat functions, and resilience to storms and sea level rise. The project included a series of green shoreline demonstration projects including the design of two ecologically-enhanced (or green") shoreline treatments to control erosion on shorelines in Cold Springs and Nyack." | Education and Awareness | Coastal Hazards |
| **New York** | Hudson Estuary Watershed Resilience Project: The Estuary Program is funding Cornell Cooperative Extension staff in Columbia, Dutchess, Greene, Orange and Putnam counties to conduct outreach to municipal and landowner audiences in target watersheds on flood resiliency. This effort will address the need for communities to enhance their understanding of stream dynamics, floodplain function and watershed planning to enhance their vulnerability to floods. The project will also evaluate the capacity of communities to respond to floods in a manner that ensures the long-term viability of stream systems and reduces future flooding impacts. | Education and Awareness | Flooding \| Coastal Hazards |
| **New York** | Green Infrastructure to Reduce Localized Flooding: Green infrastructure practices can reduce storm water runoff through infiltration. By strategically implementing appropriate green infrastructure practices, especially as retrofits, localized flooding problems can be reduced. Implementation can be site-specific or within a particular sub watershed to improve storm water management during storms. While many potential sites have already been identified, a component of this project could be a plan to identify the most strategic locations to specifically reduce flooding problems. | Green Infrastructure | Flooding \| Coastal Hazards |

| State | Action | Action Category | Action Hazard |
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| **New York** | Targeted Dam Removal Hudson Estuary Watershed: Dam infrastructure is aging, while precipitation is predicted to become more intense. These two factors increase the future risk of catastrophic, and unplanned, dam failures. Dams can also create upstream flooding around the impoundment. A regional program that identifies the highest risk dams to downstream flooding as well as those contributing to upstream flooding, will be identified, and dam removal will be pursued with willing dam owners to permanently eliminate dam related flood risks. | Restoration | Flooding |
| **New York** | Jones Beach State Park - Dune Creation Project: While most of Jones Beach State Park is buffered from coastal storms by natural dunes, there are no coastal dunes in front of the park,Äôs most developed section which includes the West Bathhouse, Central Mall, Boardwalk, and the East Bathhouse. These areas experienced significant damage during Hurricane Sandy. This project will construct a protective dune system as a natural protection measure for park facilities. | Restoration | Coastal Hazards |
| **New York** | Orient Beach State Park ,Äì Shoreline Protection: Most the entrance road to Orient Beach State Park has been stabilized with a rock revetment, but roughly 1,700 linear feet of the access road still requires protection. The roadway and nearby utility lines were damaged during many number of coastal storms, including Hurricane Sandy. | Restoration | Coastal Hazards |
| **New York** | Bayswater Park Project: Located on a Jamaica Bay historic estate, the park has lost most of its structured bulkhead to salt marsh grasses. This project will establish a natural, storm-resilient shoreline using native plantings by creating tidal wetlands and dunes. | Restoration | Coastal Hazards \| Flooding \| Hurricane |

| State | Action | Action Category | Action Hazard |
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| **New York** | Lake Kanawauke and Lake Sebago Project: The stream corridor that connects Lake Kanawauke and Lake Sebago was heavily damaged by flooding during Tropical Storm Irene. The stream passes through several culverts and pipes witn insufficient capacity for major flood events. This project will remedy the capacity problems and restore the stream to natural conditions, removing a potential impoundment hazard that is vulnerable to failure and increases risk to Lake Sebago dam and downstream communities. | Restoration | Flooding |
| **New York** | Fire Island Stabilization Project part of FIMP: Rebuild dunes to 15,Äô and beach re-nourishment; may involve property acquisition to allow new alignment | Restoration | Hurricane \| Coastal Hazards |
| **New York** | Integrating SLAMM results and stakeholder priorities to define marsh adaptation strategies: Building on the previous SLAMM project, this project will better incorporate roads and infrastructure into the analysis, better visualize marsh migration pathways, and develop a decision-support tool that will assist decision makers in planning adaptation strategies for marsh conservation and coastal community resiliency. The study area will consist of NYC, Westchester County, and Nassau County. | Technical and Information | Flooding \| Hurricane \| Coastal Hazards |
| **New York** | Assessing Flooding Risks and Mitigation Options from a Watershed Perspective: Use a watershed-based approach to study rivers and streams to determine flooding risks and mitigation options. The study will use watershed delineation, GIS mapping data, and hydraulic modeling to determine the most effective mitigation methods that can be locally implemented. | Technical and Information | Flooding \| Coastal Hazards |

| State | Action | Action Category | Action Hazard |
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| **New York** | Conduct a Climate Vulnerability and Economic Assessment for AtRisk Transportation Infrastructure in the Lake Champlain Basin: Prioritize road-stream crossings (culverts) and road segments that are most vulnerable to climate change impacts, and have significant safety and ecological roles; develop engineering-based design adaptation options; incorporate the benefits and costs of adaptation options. The study is also supporting the development of the USGS StreamStats tool for NYS, which will be expanded to allow projecting trends. | Technical and Information | Flooding \| Coastal Hazards |
| **New York** | Oakwood Beach Natural Infrastructure Feasibility Study: Mini-feasibility study to see if wetlands can be added to USACE project for South Shore of Staten Island Feasibility Study | Technical and Information | Hurricane \| Coastal Hazards |
| **New York** | Habitat Corridor Mapping in the Hudson Valley: Cornell University is working with the Estuary Program to develop a landscape-scale habitat connectivity map based on changes in species distribution caused by climate change. This will help to prioritize land conservation for north-south corridors to allow wildlife migration as the climate changes (plants, animals, and ecosystems). | Technical and Information | Flooding \| Coastal Hazards |
| **New York** | SLAMM Modeling in the Hudson Estuary: Cornell University and Scenic Hudson using the SLAMM (Sea Level Rise Affecting Marshes Model) to model potential marsh migration in the Hudson Estuary to develop shoreline conservation priorities and assess the need for barrier removal to facilitate the landward migration of tidal wetlands as sea level rises. Loss of tidal wetlands can impact water quality especially in drought or heat extremes. | Technical and Information | Flooding \| Coastal Hazards |

| State | Action | Action Category | Action Hazard |
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| **New York** | Marsh Migration Modeling with SLAMM: This project predicts how wetlands along New York State's coastlines may move and change due to sea-level rise. The results will help land-use planners identify appropriate adaptation strategies for these marshes and nearby areas. | Technical and Information | Hurricane \| Flooding \| Coastal Hazards |
| **North Carolina** | The state will provide training and publications to local governments, state agencies, and other organizations on emergency management and mitigation. Encompassed in this, the state will develop and implement an outreach program to receive feedback on mitigation programs and policies. These efforts may include:<br>-Conduct direct outreach on non-structural mitigation measures at Local, Tribal, and State agencies as well as with citizens. | Education and Awareness | All Hazards |
| **North Carolina** | Carry out projects that qualify under the most current version of Unified Hazard Mitigation Assistance program to protect/mitigate risk to people and personal property such as residences and businesses. Where possible, a primary focus of these programs will be on repetitive loss and severe repetitive loss properties. Project types that fall under this action could include, but are not limited to:<br>-Provide funds for purchase of conservation easements or purchase of land within floodplain<br>-Identify properties to be acquired that will support mitigation by coordinating with other entities (such as the Clean Water Task Force) to leverage other funding sources for acquisition to support additional state mandated goals.<br>-Develop funding source (with hazard funds) targeted to areas most vulnerable to earthquakes, sinkholes, and landslide/geochemistry for acquisition and/or conservation easements. | Funding and Programmatic | All Hazards |
| **North Dakota** | -- | -- | |

| State | Action | Action Category | Action Hazard |
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| **Ohio** | Explore the possibility of using Alternative Stormwater Infrastructure Loan Program to target properties purchased with HMA grants as future green infrastructure project sites. | Funding and Programmatic Green Infrastructure | |
| **Oklahoma** | -- | -- | |
| **Oneida Nation** | Maintain a stormwater management plan that includes such remediation techniques as surface detention basins, in-street detention units, and rain gardens | Green Infrastructure | |
| **Oregon** | 115. Maintain the Riparian Lands Tax Incentive Program. This program helps reduce sediment and protect stream banks which helps reduce the filling of river and stream channels | Funding and Programmatic | |
| **Oregon** | 26. Incorporate text addressing hazard mitigation into natural resource agencies' guidance and process documents focusing on environmental quality to ensure that natural resources are protected in the design and construction of hazard mitigation projects | Funding and Programmatic | |
| **Pennsylvania** | Action 1-13a. Identify cooperative funding opportunities for natural system protection projects. Obtain hazard mitigation funds for a stream corridor restoration or wetland restoration project associated with flooding. | Funding and Programmatic | |
| **Rhode Island** | 2019-48: Beach Ecosystem Preservation - Preserve the dynamic nature of beaches and barriers in future management of these critical natural systems. Differentiation between developed and undeveloped systems is necessary when considering management approaches. New development should be minimized in undeveloped beach and dune areas and retreat incentivized as a coastal adaptation strategy where possible. Offshore sand sources suitable for beach replenishment should be identified and beaches should be prioritized for re-nourishment. | Conservation/ Preservation/ Management | |
| **Rhode Island** | 2019-36: Green Stormwater Infrastructure: Enhance the capacity of traditional stormwater systems through the use of green infrastructure. | Green Infrastructure | |

| State | Action | Action Category | Action Hazard |
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| **Rhode Island** | 2019-50: Coastal Wetland Habitat Preservation: Monitor and assess coastal wetland habitats and management practices to evaluate and prioritize future actions. Statewide models, such as the SLAMM, should be updated to identify opportunities for restoration and assist in planning for future marsh migration. To minimize loss and preserve the benefits of coastal wetland habitats, conservation and management must be approached at multiple scales and timeframes. State agencies and their partners should continue to work with municipalities to identify opportunities for retreat, removal of derelict infrastructure, and enhancement of natural shoreline areas. Where possible, retreat rather than fortification should be emphasized as a coastal adaptation strategy. | Technical and Information | |
| **South Carolina** | Maintain healthy beach profile. | Conservation/ Preservation/ Management | |
| **South Carolina** | Fund the Beach Restoration and Improvement Trust Fund; Establish timely release of Beach Renourishment Trust Fund. | Funding and Programmatic | |
| **South Carolina** | Support Dune Restoration Efforts | Restoration | |
| **South Dakota** | -- | -- | |
| **Tennessee** | 4. Develop a strategy for empowering non-profit groups such as environment or watershed protection organizations to support local hazard mitigation planning by October 2021 | Partnerships | All Hazards |
| **Texas** | Restore and protect coastal wetlands and marshes. Coastal wetlands are transitional areas of vegetation and soils located between uplands and open marine water environments that are typically saturated or periodically inundated by tidal waters. | Conservation/ Preservation/ Management Restoration | Coastal Erosion |
| **Texas** | Encourage local communities to enforce above-minimum floodplain compliance. These include zero rise, 18 inch curb, fees for open space conversion, and freeboard ordinances on coastal properties | Land Use | Flood |

| State | Action | Action Category | Action Hazard |
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| **Texas** | Recruit conservancy agencies to purchase and maintain key undeveloped land in coastal areas. The National Fish and Wildlife Foundation (NFWF) administers and monitors the $2.544 billion Gulf Environmental Benefit Fund arising from the 2010 Deepwater Horizon explosion and oil spill in the Gulf of Mexico. The Fund will provide $203 million for natural resource projects in Texas. The NFWF, a Congressionally-chartered non-profit, is one of the largest private funders of conservation projects in the United States. | Partnerships | Hurricane/Storm Surge |
| **Texas** | Restore natural beach and dune system through beach nourishment and dune restoration | Restoration | Coastal Erosion |
| **Utah** | 3. Construct debris basins, flood retention ponds, bioswales & energy flow dissipaters in an effort to control the flow and release of flood waters. | Green Infrastructure | Flood |
| **Utah** | 6. River Restoration: Ogden City has lead the way in restoring a section of Ogden City and using FEMA grants to restore a section of the Weber river | Restoration | Flood |
| **Utah** | 7. Watershed Restoration: These projects would apply to drought, wildfire and erosion. Would include projects that address watershed protection and restoration, such as beaver dams, reseeding, fuel reduction, etc.. | Restoration | Flood, Drought, Wildfire, Erosion |
| **Vermont** | Conserve land identified in the critical headwater storage inventory through landowner outreach and existing conservation programs. | Conservation/ Preservation/ Management | Inundation; Fluvial Erosion |
| **Vermont** | Strategy: Connect water quality, flood resilience and native habitat connectivity through co-benefits. Action: Promote the use of Vermont Fish and Wildlife's Conservation Design Plan to achieve and maintain habitat connectivity and havens for Vermont rare, threatened, and endangered species (aquatic and terrestrial). | Conservation/ Preservation/ Management | Inundation; Fluvial Erosion |

| State | Action | Action Category | Action Hazard |
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| **Vermont** | Strategy: Connect water quality, flood resilience and native habitat connectivity through co-benefits Action: Promote the use of Vermont Fish and Wildlife's Conservation Design Plan to achieve and maintain habitat connectivity and havens for Vermont rare, threatened, and endangered species (aquatic and terrestrial). | Conservation/ Preservation/ Management | Invasive Species; Inundation; Fluvial Erosion |
| **Vermont** | Strategy: Improve flood resilience of agricultural lands Action: Expand use of USDA conservation programs to plant riparian buffers and flood chute grassed waterways to reduce future flood damage to farm fields, attenuate flood-borne sediment and debris, and reduce downstream flooding. | Funding and Programmatic | Inundation; Fluvial Erosion |
| **Vermont** | Strategy: Connect water quality, flood resilience and native habitat connectivity through co-benefits. Action: Create a "Reconnect Vermont Rivers" initiative (or similar State planning, prioritization, and tracking mechanism) to enhance the funding eligibility and incentives for flood resilience, water quality, and habitat projects as co-benefits. | Funding and Programmatic | Inundation; Fluvial Erosion |
| **Vermont** | Strategy: Establish a statewide conservation and buyout program. Action: Create a dedicated State fund to support the purchase or local match of hazard-prone properties and the purchase of easements to conserve river corridors, floodplains, and wetlands identified as key flood attenuation areas. | Funding and Programmatic | Inundation; Fluvial Erosion; Landslide |
| **Vermont** | Expand the eligibility criteria and increase funding for VHCB's conservation and buyout program, to address any flood-vulnerable structures. | Funding and Programmatic | Inundation; Fluvial Erosion |
| **Vermont** | Strategy: Promote land management standards for State and private lands Action: Work with land conservation organizations to include river corridor and floodplain protection provisions, and/or headwater storage in conservation easements. | Partnerships | Inundation; Fluvial Erosion |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Vermont** | Strategy: Improve headwater storage Action: Complete a pilot project in a strategic watershed, using the above inventory, to prioritize land conservation and determine the cost of averted flood damage. | Technical and Information | Inundation; Fluvial Erosion |
| **Vermont** | Strategy: Improve headwater storage Action: Develop an inventory of critical headwater and floodplain storage areas that would result in a measurable abatement of flooding. | Technical and Information | Inundation; Fluvial Erosion |
| **Vermont** | Identify critical headwater storage areas enrolled in the Current Use program and conduct outreach to inform landowners of the value of protecting these areas during harvesting operations. | Technical and Information | Inundation; Fluvial Erosion |
| **Vermont** | Identify stormwater-impaired headwater storage areas where stormwater treatment and stream restoration would result in hazard mitigation co-benefits. | Technical and Information | Inundation; Fluvial Erosion |
| **Vermont** | Strategy: Connect water quality, flood resilience and native habitat connectivity through co-benefits. Action: Develop hydraulic and stream power models for a range of flood frequencies to analyze and define valley areas supporting essential floodplains and river corridor functions that would increase the storage of flood flows, sediments, and nutrients. | Technical and Information | Inundation; Fluvial Erosion |
| **Virginia** | -- | -- | |
| **Washington** | Reduce the Conversion of Ecologically Important Lands for Development - Reducing development impacts on ecologically important lands and enhance the ecosystem services those lands provide. | Conservation/ Preservation/ Management | Coastal Hazards Flood Climate Change |
| **Washington** | Pest Program - Protect the agriculture, environment and natural resources of Washington State by preventing the introduction and spread of high risk invasive insects, terrestrial snails, plant diseases and noxious weeds. | Conservation/ Preservation/ Management | Agricultural Disease |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Washington** | Flood Control Assistance Account Program - To promote flood risk reduction throughout the state. This fund enables communities to do flood risk reduction planning and projects that can include house elevations and buyouts, levee work, and ecosystem improvements. Creation of comprehensive flood hazard management plans is a central goal of the program. Creation of comprehensive flood hazard management plans is a central goal of the program. | Funding and Programmatic | Flood |
| **Washington** | Shoreline Armoring Implementation Strategy - Increase the health of Puget Sound shores while ensuring people and their property are safe and able to continue enjoying Puget Sound beaches. Sustaining shoreline processes provides habitat necessary to support a diverse and resilient marine food web, and also provides opportunity for adaptation to sea level rise and climate-driven changes. A functioning nearshore provides recreation and a natural buffer that protects waterfront properties. | Funding and Programmatic | Coastal Hazards Flood Climate Change |
| **Washington** | Voluntary Stewardship Program - All 27 counties that opted into the Voluntary Stewardship Program have approved work plans that protect and enhance critical areas (wetlands, areas with a critical recharging effect on aquifers used for potable water, frequently flooded areas, geologically hazardous areas, and fish and wildlife habitat conservation areas) while maintain the viability of agriculture. | Funding and Programmatic | Flood Earthquake Landslide |
| **Washington** | Incorporate Hazard Mitigation and Disaster Recovery into Comprehensive Plans - Improve community resilience through better guidance and technical assistance to local government for comprehensive planning and Critical Areas Ordinance updates and through coordination between Commerce and EMD. Locally adopted comprehensive plans, development regulations and capital improvement plans (programs) consider the impacts of disasters on the natural and build | Funding and Programmatic | Earthquake Landslide Flood Goal 1 |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| | environments to ensure actionable local strategies are developed and, when adequately resourced, implemented. | | |
| **Washington** | Floodplains by Design: Further flood safety, floodplain ecological restoration, and support agriculture in floodplains around the state; Restoration | Partnerships | Flood |
| **Washington** | Critical Areas Ordinance/Hazard Mitigation Planning Coordination - COM and EMD will develop a process to coordinate on planning, guidance, and local-jurisdiction technical assistance to better align comprehensive plans, Critical Areas Ordinances and hazard mitigation plans with the aim of producing more effective, more accurate plans that better reduce long-term vulnerability and include more local stakeholders. | Policy and Law | Flood Landslide Earthquake Tsunami |
| **Washington** | Address Chronic Environmental Deficiencies (mitigate using nature-based solutions)- Chronic Environmental Deficiency sites (CEDs) are locations along the state highway system where recent, frequent, and chronic maintenance repairs to the state transportation system are causing impacts to fish and fish habitat. Address areas of repeated maintenance and include them in the Transportation Asset Management Plan. Mitigate using nature-based solutions that are resilient to climate hazards.; | Restoration | |
| **Washington** | Chehalis Basin Flood Reduction - In 2016, the Washington State Legislature created the Office of Chehalis Basin to "aggressively pursue implementation of an integrated strategy and administer funding for long-term flood damage reduction and aquatic species restoration in the Chehalis River Basin." | Restoration | Flood |
| **Washington** | Replace Undersized Culverts (mentions green infrastructure) - Remove and replace 30 barriers to fish migration, statewide, each year, currently funded to build 11-15 (depending on individual project costs).; | Restoration | |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Washington** | Coastal Resilience Technical Assistance - Avoid or minimize the existing and future impacts of coastal hazards on communities and natural resources. | Technical and Information | Flood Landslide Tsunami Coastal Hazards |
| **Washington** | Floodplain Management Technical Assistance - Reduce flood damage and support ecosystem recovery in floodplains. | Technical and Information | Flood |
| **West Virginia** | -- | -- | |
| **Wisconsin** | 2.1 Action: Encourage communities to sign up for and participate in the Conservation Reserve Enhancement Program (CREP) to reduce crop losses. | Conservation/ Preservation/ Management | |
| **Wisconsin** | 1.7 Action: Coordinate and incorporate hazard mitigation planning concepts in future updates to the State Guide on Developing the Natural Resources Element of the Comprehensive Planning Guides | Funding and Programmatic | |
| **Wisconsin** | 3.1 Action: Give extra points to communities applying for DNR Stewardship programs if their proposal includes mitigation elements. DNR's Stewardship grant program allocates additional points for projects that acquire, enhance, or protect natural areas that provide water quality and water quality benefits. Many of these projects often also serve as flood mitigation measures. Adding specific mitigation actions, such as increasing floodwater storage capacity, to the project ranking criteria would help conserve natural resources while reducing flood losses. | Funding and Programmatic | |
| **Wisconsin** | 3.18 Action: Implement the Municipal Flood Control and Riparian Restoration (MFC) grant program. Grants are available biennially, typically in the spring of even years, for projects that reduce flood risk. Projects shall minimize harm to existing beneficial functions of water bodies and wetlands, maintain natural aquatic and riparian environments, use stormwater detention and retention structures and natural storage to the greatest extent possible, and provide opportunities for public access to water bodies and to the floodplain. | Funding and Programmatic | |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Wisconsin** | 9.2 Action: Integrate hazard mitigation concepts into UW-Extension programs for community development, lake and watershed management, farm management, and housing. | Funding and Programmatic | |
| **Wisconsin** | 10.29 Action: Incorporate Climate Resilient Mitigation Activities (CRMAs) as defined by FEMA (including Aquifer Storage and Recovery; Floodplain and Stream Restoration; Flood Diversion and Storage; and Green Infrastructure) into WEM's scoring system for preapplications. | Funding and Programmatic | |
| **Wisconsin** | 3.6 Action: Provide workshops and distribute informational materials to improve understanding and enforcement of floodplain, coastal, shoreline, and wetland regulations, including mitigation techniques. | Policy and Law | |
| **Wisconsin** | 3.5 Action: Encourage restoration of natural wetland functions. Wetlands provide natural flood storage areas. Restoring the natural function of these areas can reduce the flooding potential of other areas in the watershed. For many years, the DNR has been working with NRCS, USFWS, and other entities interested in wetland restoration to streamline the regulatory processes of these activities. Efficient spending of federal funds promotes access to future funding opportunities. The DNR has worked with partners on enabling legislation to develop a permitting process for certain classes of federally-funded and -designed wetland restoration projects; to develop a general permitting process; and to train staff from impacted agencies. | Restoration | |
| **Wyoming** | Action #9 Implement Flood Mitigation Projects - Promote utilizing natural systems protections to protect and restore natural floodplain functions, such as stream restoration, forest management, conservation easements, and wetland preservation. | Conservation/ Preservation/ Management Restoration | |

## Appendix 4: State Risk Assessment and Vulnerability Assessment

| State | Risk Assessment and Vulnerability Assessment |
|---|---|
| Alabama | Little to no discussion of natural systems/environment in risk assessment. |
| Alaska | Little to no discussion of natural systems/environment in risk assessment. |
| Arizona | Each hazard profile has a description of environmental/cultural impacts for each hazard. Each hazard profile describes several categories of potential consequences and impacts and one of the categories is environmental/cultural. The discussion is generally very cursory. There is little information on habitats or ecosystems. More of the discussion is focused on human health. |
| Arkansas | Each hazard profile covers impacts to the environment in an impacts table. But the analysis is cursory (e.g., "The impact to the environment could be severe.") |
| California | California has an entire section on natural environment under the section on state assets at risk. This includes a short section on ecosystems at risk. There is more in-depth assessment of effects on the natural environment in the profile on wildfire. |
| Colorado | Each hazard has an impact summary table that includes an assessment of impacts to the environment. This is fairly cursory, but some more in-depth discussion. |
| Connecticut | Each hazard profile describes primary and secondary impacts, including impacts to natural infrastructure. Relatively little discussion of ecosystems/natural infrastructure in these sections. More discussion on at risk habitats in the section on sea level rise. |
| Delaware | Little to no discussion of natural systems/environment in risk assessment. |
| Florida | Each hazard profile includes a hazard impact analysis that includes impacts that are possible due to the hazard occurring in the state. This includes impacts affecting the environment. Impacts are bulleted lists under each category. The analysis is cursory. The Coastal Erosion hazard profile's vulnerability assessment includes an analysis of the Florida's critically eroded managed shoreline by region. |
| Georgia | Little to no discussion of natural systems/environment in risk assessment. |
| Hawai'i | Each hazard protocol has an exposure analysis (climate change and sea level rise, chronic coastal flood, dam failure, earthquake, event-based flood, hurricane, landslide and rockfall, tsunami, volcanic hazards, and wildfire) or qualitative analysis (drought, hazardous materials, health risks, and high windstorms) for environmental resources. The exposure analysis tables show the total extent and percent of total area environmental resources located in the hazard areas. The environmental assets included are critical habitat, wetlands, and parks are reserves (and reefs). |
| Idaho | Each hazard profile has a section on environmental impacts that goes into some depth on impacts, but there was no exposure analysis or vulnerability assessment. |
| Illinois | Little to no discussion of natural systems/environment in risk assessment. |
| Indiana | Little to no discussion of natural systems/environment in risk assessment. |
| Iowa | We were unable to obtain the 2018 risk assessment |

| State | Risk Assessment and Vulnerability Assessment |
|---|---|
| Kansas | Each hazard profile includes a consequence analysis (table) that includes the impact of each hazard on the environment. Each analysis includes a ranking (minimal to severe) and description of impacts. The description is not in depth (e.g., "The impact to the environment could be severe."). |
| Kentucky | Little to no discussion of natural systems/environment in risk assessment. |
| Louisiana | Little to no discussion of natural systems/environment in risk assessment. |
| Maine | Little to no discussion of natural systems/environment in risk assessment. |
| Maryland | Each hazard profile has a consequence analysis table that includes impacts to the environment. The discussion is minimal, "Floods impact the environment by spreading pollution; overloading water and wastewater treatment plants; carrying silt and debris; and disturbing wildlife and the natural area." |
| Massachusetts | Natural Resources and Environment are one of the sectors assessed for each hazard in the risk assessment. They define natural resources as "These are components of natural systems that exist without human involvement. For the purpose of this survey, key natural resource categories include forested ecosystems, aquatic ecosystems, coastal ecosystems, wetland ecosystems, and old field ecosystems. Each hazard profile has a table that discusses each sector assessed, including natural resources and the environment. Each profile also has a more in-depth discussion of impacts to natural resources and the environment (some hazards have more discussion than others). For example, the section on inland flooding includes a table on Natural Resources Exposure – Areas of Critical Environmental Concern (Table 4.9) that details the amount of critical habitat in the 1 percent annual chance flood event and 0.2 percent annual change flood event zones. Further Table 4.10 lists the Natural Resources Exposure from the Massachusetts BioMap2 Core Habitat analysis (including priority natural communities, species of conservation concern, vernal pools, wetlands, etc.). Again, this table details the amount of critical habitat in the 1 percent annual chance flood event and 0.2 percent annual change flood event zones. The sections on coastal flooding and hurricanes include similar tables. |
| Michigan | The risk analysis includes a Hazard Analysis Summary Table that includes a numerical risk rating for a number of considerations, including the environment (p. 41). No additional discussion. |
| Minnesota | No systematic/consistent discussion of risk/vulnerability/impacts to the environment or natural resources. There is a discussion of climate change in each hazard profile. |
| Mississippi | Some hazard profiles (dam failure, hurricane, winter storm) include a discussion of vulnerability of natural resources. The hurricane profile has a more detailed discussion on barrier island loss. |
| Missouri | Natural resources discussed in exposure analysis – including discussion of natural and beneficial functions and special status species. |
| Montana | No systematic treatment of risk/vulnerability to natural environment in the risk assessment section or hazard profiles. Short discussion in the hazard profile on drought. |
| Nebraska | Each hazard profile has an Impact/Consequences Summary table that describes impacts across categories, including the environment. Discussion is cursory – |

| State | Risk Assessment and Vulnerability Assessment |
|---|---|
| | "The environment in the inundated areas will be severely impacted with contaminates, erosion, and debris." The drought profile includes some discussion of impact to plants and wildlife. The flood profile includes a discussion of non-structural mitigation approaches. |
| Nevada | No systematic treatment of risk/vulnerability to natural environment in the risk assessment section or hazard profiles. The flood profile includes a discussion of "Reducing Flood Damage in Areas of High Flood Probability" which highlights a number of mitigation activities, that include non-structure projects. Nevada also profiles invasive species (Infestations) as a hazard. |
| New Hampshire | There is no consistent treatment of natural infrastructure in the hazard profiles (e.g., no tables). However, several of the hazard profiles include discussion of impacts to natural resources as well as how the loss of natural infrastructure can aggravate the hazard (drought, inland flooding, and coastal flooding, wildfire, climate change). |
| New Jersey | There is a section on environmental impacts in most hazard profiles (coastal erosion, dam and levee failure, drought, earthquake, hurricane and coastal storm, etc.). The section goes into some depth on impacts. The drought profile has more information on impacts to the environment, including habitats. |
| New Mexico | Discussion of the drought-wildfire-flood cycle in the hazard identification/risk assessment section, and the impact of ecosystem change on this cycle and the effect of the cycle on ecosystems. Each hazard profile has a table of impacts that includes environmental impacts. |
| New York | The risk assessment section describes "Critical and Environmental Infrastructure—the ability of critical and environmental infrastructure to recover from events—components may include water and sewage, transportation, power, communications, and natural infrastructure" as one of four critical dimensions of a consistent system of resilience indicators or measures. The risk assessment section online does not contain hazard profiles. |
| North Carolina | Each hazard description has a section on impacts, several of the profiles include impacts to the environment (e.g., drought). The vulnerability assessment includes a short section on environmental vulnerability. Each hazard vulnerability assessment profile includes a table on risk and consequence analysis. This includes an analysis of consequences for the environment. This includes analysis of damage to sensitive habitats. |
| North Dakota | Environment is one of the risk assessment categories. Each hazard profile includes a consequence analysis that includes impacts to the environment. |
| Ohio | No consistent analysis of environmental impacts/vulnerabilities. The climate change section includes some information on biodiversity and ecosystems. |
| Oklahoma | Little to no discussion of natural systems/environment in risk assessment. |
| Oregon | No consistent analysis of environmental impacts/vulnerabilities. The drought hazard profile has a small section on environmental impacts. Some discussion of impacts to forest assets and riparian importance (in terms of terrestrial and aquatic habitat values, water quality and quantity, and other ecological functions) in the section on wildfire vulnerability. |
| Pennsylvania | Each hazard profile has a section on environmental impacts, including impacts to wetlands and other habitats. The sections are fairly short (approx. 1 |

| State | Risk Assessment and Vulnerability Assessment |
|---|---|
| | paragraph). The consequence analysis has a short section on the environment that references the hazard profiles. |
| Rhode Island | Each hazard profile includes an analysis of risk and vulnerability to the environment (about 1 paragraph). Each hazard profile has a table that includes probable hazard magnitude to people, critical infrastructure, property, state operations, and the environment. |
| South Carolina | No consistent analysis of environmental impacts/vulnerabilities. Some discussion of habitat degradation in the drought profile. |
| South Dakota | Some discussion of impacts to plants and wildlife from drought. Each hazard consequence summary includes impacts to the environment. |
| Tennessee | Little to no discussion of natural systems/environment in risk assessment. |
| Texas | No consistent analysis of environmental impacts/vulnerabilities. Some discussion on loss of coastal habitat in the sections on coastal erosion, inland erosion, and subsidence. |
| Utah | The Hazard Consequence and Impact Analysis Matrix includes impact on the environment for each hazard. Each hazard was evaluated for vulnerability factor for each item in the matrix, including the environment (low, moderate, high, catastrophic). No consistent discussion of impacts to the environment in the hazard profiles. Some discussion in the drought, flood, and fire profiles. |
| Vermont | Potential impact on the environment is part of the hazard assessment. Table 16 evaluates each hazard across a number of potential impacts, including impacts to the environment. Each potential impact is ranked 1 – 4 (by frequency of occurrence and potential impact). Each hazard has a final score which is calculated by multiplying probability by average potential impact. Each hazard profile has a similar table. There is some discussion of impact to environment/habitat in several of the hazard profiles, but no consistent treatment except for the table. |
| Virginia | Each hazard profile has an emergency management accreditation program analysis of detrimental impacts, including the environment. None of the profiles includes an in-depth analysis of impacts to the environment. |
| Washington | Each hazard profile has a section on environmental impacts. |
| West Virginia | Little to no discussion of natural systems/environment in risk assessment. |
| Wisconsin | Hazard profiles have a risk analysis that includes impacts to the environment from the hazard. Each section on the environment includes a few bullet points. |
| Wyoming | Little to no discussion of natural systems/environment in risk assessment. |


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## Contents

## Executive Summary

Historically, hazard mitigation strategies have primarily focused on hard infrastructure, such as dams, seawalls, and levees, and designing and applying building construction practices for residential, commercial, and industrial structures. Recently, increased emphasis has been placed on non-structural and nature-based hazard mitigation solutions, such as the restoration of wetlands and floodplains, as cost-effective alternatives for hazard mitigation that also help achieve conservation goals like maintaining biodiversity and addressing climate impacts.

Much of the needed investment in identifying and implementing nature-based projects for hazard mitigation may be accomplished by leveraging and integrating existing institutions and programs. FEMA's Hazard Mitigation Assistance (HMA) grants can be one potential funding opportunity to pay for the restoration and protection of critical natural infrastructure and to improve outcomes and reduce costs from the next disaster. These grants provide funding for hazard mitigation planning as well as for cost-effective hazard mitigation activities. While Hazard Mitigation Grant Program (HMGP) funding is only available after a federal disaster declaration, the Building Resilient Infrastructure and Communities (BRIC) and Flood Mitigation Assistance (FMA) programs are available nationwide on an annual basis. FEMA's new BRIC program, for example, made $500 million dollars available to states, U.S territories, Indian tribal governments, and local communities for *pre-disaster* mitigation activities in 2020.[1] The FY2020 program priorities included incentivizing projects that incorporate nature-based solutions.

Nature-based solutions have been demonstrated as cost-effective hazard mitigation solutions. Coastal wetlands, for example, are one of the natural features that provide valuable protection from natural hazards. According to one study, existing wetlands prevented $625 million in property damage in areas affected by Hurricane Sandy.[2] Nature-based strategies also contribute important co-benefits like achieving conservation goals through improving biodiversity, increased carbon sequestration, water quality improvement, erosion reduction, habitat provision, support for recreation and tourism industries, and providing community green space.

Despite being eligible for federal funding to mitigate hazards identified in state, tribal, and local plans, relatively few nature-based solutions have been funded through FEMA hazard mitigation grant programs. Mitigation activities funded through FEMA's Hazard Mitigation Assistance Grants, including all nature-based projects, must be identified and implemented in accordance with priorities set out in state, tribal, or local hazard mitigation plans. Hazard mitigation plans identify the potential risks to the state, tribal, or local community, assess the capabilities of the government entity to address the risks, and develop goals and actions to reduce risk from the hazards across the plan area.

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[1] FEMA's BRIC grant program was created as part of Disaster Recovery Reform Act of 2018 and replaces the Pre-Disaster Mitigation program. The BRIC program is funded by a six percent set-aside from federal post-disaster grant expenditures. The 2020 FEMA Mitigation Action Portfolio highlights a wide range of innovative hazard mitigation projects that are possible to fund under the new BRIC program. FEMA, *Hazard Mitigation Assistance Mitigation Action Portfolio* (Aug. 2020), *available at* https://www.fema.gov/sites/default/files/2020-08/fema_mitigation-action-portfolio-support-document_08-01-2020_0.pdf.

[2] Beck et al., *Coastal Wetlands and Flood Damage Reduction: Using Risk Industry-based Models to Assess Natural Defenses in the Northeastern USA*, Lloyd's Tercentenary Research Foundation, London (2016) https://conservationgateway.org//ConservationPractices/Marine/crr/library/Documents/CoastalWetlandsandFloodDamageReductionReport.pdf.

It is not clear how well hazard mitigation plans are integrating nature-based goals and strategies. To address this knowledge gap, we reviewed 50 state hazard mitigation plans to better understand the extent they are incorporating nature-based strategies. In this review, we focused on the mitigation strategy – specifically looking at the goals and objectives of the strategy and the actions identified to address risk. We aimed to identify the range of practices as well as model examples of plan language that could be used by other states and tribes.

## *Results*

We found that thirty-eight of the 50 state plans had goals and objectives that were relevant to the natural systems protection. We identified three categories of mitigation goals: 1) broad goals that mention protecting the environment in addition to protecting other state aspects (24 plans), 2) goals that specifically focus on the environment (7 plans), and 3) goals that specifically focus on nature infrastructure/nature-based solutions (14 plans). Seven plans had more than one relevant goal type (e.g., New York had a broad goal that mentions the environment as well as a goal that specifically focuses on nature-based solutions).

### Mitigation Goals and Objectives Categories

| Goal Category | States |
|---|---|
| No Relevant Goal | AK, AZ, DE, GA, IL, IN, KY, NV, OH, TN, WA, WY |
| Broad goal that mentions protecting the environment in addition to protecting other state aspects | AL, FL, HI, ID, IA, KS, LA, ME, MA, MN, MS, NH, NM, NY, NC, ND, PA, RI, SD, TX, VT, VA, WV, WI |
| Goal specifically focuses on the environment | CA, MD, MO, OK, OR, SD, UT |
| Goal specifically focuses on natural infrastructure/nature-based solutions | AR, CA, CO, CT, FL, MI, MS, MT, NE, NJ, NY, PA, SC, VT |

We identified a total of 177 nature-based actions across thirty-nine state plans. Four states had more than 10 actions listed. The documented actions were sorted into categories to better understand the range of strategies included in state plans across the country. The categories identified included:

- **Conservation/Preservation/Management**: actions that are explicitly focused on protection or management of ecosystems or natural resources (e.g., protect wetlands, maintain creek banks, ecosystem preservation).
- **Restoration**: actions focused on restoration of natural habitats, usually wetlands, streambanks, floodplains, beaches, etc. These actions include dam removals, dune restoration, and restoration of native vegetation.
- **Green Infrastructure**: actions that call on the use of parcel-scale green infrastructure projects to address urban stormwater management.
- **Land Use**: actions that seek to address risks to communities through land use, including planning and zoning guidelines or policy and managing development in hazard-prone areas.
- **Funding and Programmatic**: actions that seek to create or expand preservation, restoration, or green infrastructure programs; develop or enhance funding programs; or develop implementation plans related to nature-based strategies.

- **Policy and Law**: actions that call upon different agencies to develop and implement policies and regulations that would encourage or facilitate conservation and/or nature-based mitigation actions.
- **Technical and Information**: actions related to studies, modeling, and development of tools (e.g., decision support tools).
- **Education and Awareness**: actions focused on development of guidance, conducting community outreach, and creating technical bulletins and training programs aimed at enhancing understanding of ecosystem services and non-structural mitigation measures.
- **Agency Coordination**: actions that encourage or promote coordination among state agencies or state and local agencies.
- **Partnerships**: actions that encourage partnerships with non-profits, utilities, or other organizations to conduct mitigation strategies.

We found the most actions in the state hazard mitigation plans were related to the Funding and Programmatic (37), Restoration (39), and Technical and Information (37) categories. Many of the action categories were distributed across a number of states. Fifteen states had one or more funding and programmatic actions, 19 states had one or more restoration actions, and 11 states had one or more technical and information actions. Many of the other action categories were also distributed across a number of states.

### Mitigation Actions in Reviewed State Plans by Action Category

| Action Category | Number of Actions* | Number of States |
|---|---|---|
| Agency Coordination | 3 | **3 states** (CA, MA, MN) |
| Conservation/ Preservation/ Management | 21 | **17 states** (CO, DE, KY, MD, MA, MN, MS, MT, NV, NY, RI, SC, TX, VT, WA, WI, WY) |
| Education and Awareness | 9 | **7 states** (AL, CO, IN, MI, NY, NC, MD) |
| Funding and Programmatic | 38 | **16 states** (AL, CA, CT, MA, NE, NV, NH, NJ, NC, OH, OR, PA, SC, VT, WA, WI) |
| Green Infrastructure | 13 | **12 states** (AR, HI, IN, IA, KY, MD, MA, MN, NY, OH, RI, UT) |
| Land Use | 8 | **8 states** (AK, AL, DE, GA, IA, MT, NH, TX) |
| Partnerships | 8 | **8 states** (HI, MA, MI, MT, TN, TX, VT, WA) |
| Policy and Law | 12 | **9 states** (AK, AL, DE, GA, MA, MN, MT, WA, WI) |
| Restoration | 39 | **19 states** (AK, CO, CT, IA, KY, MD, MA, MN, MS, MT, NV, NM, NY, SC, TX, UT, WA, WI, WY) |
| Technical and Information | 37 | **11 states** (CT, GA, HI, IL, KS, MA, NH, NY, RI, VT, WA) |
| No Actions Included | -- | **11 states** (AZ, FL, ID, LA**, ME, MO, ND, OK, SD, VA, WV) |

*Notes: * 11 actions were included in more than 1 category; ** The Louisiana plan does not include actions like other states, but has a technical appendix with possible mitigation actions*

The companion spreadsheet for the report could serve as a resource for reviewing examples of actions from other state plans.[3]

In recognition of tribal sovereignty and the unique needs of Indian Tribal governments, FEMA established requirements for Tribal Hazard Mitigation Plans separate from State and Local Mitigation Plans.[4] Tribal mitigation strategy requirements are similar to state hazard mitigation plans. However, the land within the Tribe's planning area may contain natural and cultural resources and sacred sites or other land of importance to the Tribe's culture, history, and values that must be taken into account when developing mitigation goals and strategies. Further, Tribal plans may include goals and objectives that have a particular focus on the wellbeing of the Tribal community. In a review of a small set of tribal mitigation plans, we found hazard mitigation goals and strategies that were similar to the kinds of goals and actions we found in state hazard mitigation plans. There is a need for more in-depth study of tribal hazard mitigation plans.

Through our review of state and tribal plans, we identified a number of conditions and opportunities that may influence the integration of nature-based strategies in the planning process. For example, in addition to the mitigation strategy component of the hazard mitigation plan, other parts of plan can inform the design of nature-based goals and actions that may most effectively mitigate risk. For example, better understanding of the role natural systems play in risk and vulnerability could aid planners in identifying and selecting nature-based projects that can provide effective mitigation. The capability section of the plan is another real opportunity for states to identify the natural resource programs and capacity that could be tapped to aid in the identification and implementation of nature-based projects. Equally important is the identification of possible funding sources for these projects.

Leveraging existing natural resource plans and facilitating key partnerships with natural resource experts are key enabling conditions that can increase the integration of natural system protection and nature-based strategies in hazard mitigation planning. Other state- or local-level plans, programs, and partners, if brought into the planning process, can provide a wealth of information that can inform the risk and vulnerability assessments and identify actions that could help the state achieve its hazard mitigation goals. For example, some states may have legal drivers that influence the integration of nature-based mitigation strategies in the hazard mitigation plan (e.g., state natural resource laws, state hazard mitigation laws, etc.). Further, involving technical experts in the planning and implementation process can help fill information gaps, aiding in identifying risks and identifying and prioritizing viable nature-based mitigation actions. These other analyses and programs may serve as opportunities to stimulate the inclusion of nature-based strategies for states that have not yet tapped into these opportunities, or that have only begun to do so.

## *Conclusions and Recommendations*

Based on the results of our review, we identified the following conclusions:

- There are many opportunities to integrate nature-based goals and actions into hazard mitigation plans. Many states have done this to some degree, but there are still opportunities to improve, including more comprehensive evaluation of the value of natural systems in the assessment of

[3] The spreadsheet is available at https://www.eli.org/land-biodiversity/hazard-mitigation-planning.
[4] Mitigation Planning 44 C.F.R § 201 at 72 Fed. Reg. 61720 (interim rule in October 2007 established the tribal mitigation plan, and 2009 final rule clarified tribal planning requirements).

risk and vulnerability, systematic inclusion of well thought out and specific nature-based hazard mitigation actions, and realistic prioritization and implementation of nature-based strategies.

- Most states had nature-based goals. However, plans with well-developed nature-based goals and objectives were not necessarily the same states that included higher numbers of nature-based actions, and vice versa.
- We identified very few geographically specific projects defined in mitigation plans. Although state plans are linked to local strategies, more specific activities may be found in local hazard mitigation plans. Local plans are more directly tied to community needs and goals and thus may provide an important opportunity for integrating nature-based actions.
- Identifying and integrating nature-based hazard mitigation actions in hazard mitigation plans is an important first step toward advancing and expanding the use of these techniques to address risk associated with natural hazards. Funding, implementing, and monitoring these projects are important next steps. More demonstration projects are needed to show the multiple benefits of nature-based projects.
- It is important to understand some of the other challenges in getting nature-based hazard mitigation strategies in the ground. For example, the Benefit-Cost Analysis (BCA) methods (all projects funded by FEMA Hazard Mitigation Assistance grants must pass a benefit cost analysis) may present challenges for showing the cost-effectiveness of nature-based strategies. FEMA could make updates to the BCA Toolkit and invest in more guidance and decision support tools that help communities consider nature-based project types. Further, FEMA or state governments could assist in the collection of more data to inform benefit-cost analyses.

We have identified a series of steps states and tribes can take to improve integration of nature-based goals and actions into their plans.

1. Identify and include natural resource protection and restoration experts as key members of the planning team (such experts could include state agency staff, NGOs, watershed groups, academics, etc.).
2. Conduct an explicit review of legal barriers or opportunities to integrating nature-based strategies in hazard mitigation planning.
3. Systematically evaluate the risk to natural systems and how the loss and degradation of natural habitats contributes to increased risk from hazards in the risk and vulnerability assessment.
4. Develop and include goals that not only focus on how to protect the environment from natural hazards, but also reflect the state's priority and commitment to use nature-based strategies to mitigate the state's risk. The companion spreadsheet for this report could serve as a resource for reviewing examples of goals and objectives from other state plans.[5]
5. Develop and integrate nature-based actions in the mitigation strategy. Both broad and specific actions could be useful. The companion spreadsheet for this report could serve as a resource for reviewing examples of actions from other state plans.[6] The action categories that we suggest here could be used as a guide for formulating, organizing, and reviewing actions. This framing might help states identify gaps in the types of actions they have and/or spur new ideas.
6. Invest in monitoring and assessment of nature-based hazard mitigation projects. Performance data will help planners communicate the success and value of nature-based projects to the public.

[5] The companion spreadsheet is available at https://www.eli.org/land-biodiversity/hazard-mitigation-planning.
[6] The companion spreadsheet is available at https://www.eli.org/land-biodiversity/hazard-mitigation-planning.

Finally, we have identified recommendations for FEMA to improve integration of nature-based goals and actions into hazard mitigation plans.

1. Examine FEMA's Hazard Mitigation Planning guidance documents to find ways to promote partnerships with nature resource experts and provide more detail on how to identify and integrate appropriate nature-based actions.
2. Examine the Benefit-Cost Analysis. FEMA could make additional changes that would result in further improvement. For example, FEMA could make changes to the BCA Toolkit in order to further reduce barriers to nature-based solutions, such as creation of additional "pre-calculated benefits" for certain project types. FEMA could also aid in data collection on project benefits, such as lost revenue avoided and environmental benefits associated with nature-based projects.
3. Invest in more "case studies" of nature-based projects that have been successfully funded by FEMA that could help to demonstrate to other applicants that such projects are possible and can result in multiple benefits.
4. Invest in partnerships with natural resource agencies and organizations. Partnerships with natural-resource experts are crucial for identifying projects, completing grant applications, and implementing nature-based hazard mitigation strategies.

## Introduction

Historically, hazard mitigation strategies have primarily focused on hard infrastructure, such as dams, seawalls, and levees, and designing and applying building construction practices for residential, commercial, and industrial structures. Recently, increased emphasis has been placed on non-structural and nature-based hazard mitigation solutions, such as the restoration of wetlands and floodplains, as cost-effective alternatives for hazard mitigation that also help achieve conservation goals like maintaining biodiversity and addressing climate impacts.

Much of the needed investment in identifying and implementing nature-based projects for hazard mitigation may be accomplished by leveraging and integrating existing institutions and programs. FEMA's Hazard Mitigation Assistance (HMA) grants can be one potential funding opportunity to pay for the restoration and protection of critical natural infrastructure and to improve outcomes and reduce costs from the next disaster. These grants provide funding for hazard mitigation planning as well as for cost-effective hazard mitigation activities (See Box 1). In its recent resources, FEMA has placed some emphasis on nature-based hazard mitigation, identifying natural systems protection actions for reducing risk to natural hazards and disasters in resources for planners[7] and communities.[8] In 2015, FEMA announced the eligibility of a suite of new activities, including floodplain and stream restoration, for its hazard mitigation funding.[9] FEMA has also made a series of changes to its Benefit-Cost Analysis Toolkit and supporting policies, most recently in 2020, to allow "for easier inclusion of nature-based solutions into risk-based mitigation projects."[10] Additionally, FEMA's new Building Resilient Infrastructure and Communities (BRIC) program made $500 million dollars available to states, U.S territories, Indian tribal governments, and local communities for *pre-disaster* mitigation activities in 2020.[11] The FY2020 program priorities included incentivizing projects that incorporate nature-based solutions.[12] Although nature-based methods are eligible for FEMA funding to mitigate almost any hazard identified by state and local

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[7] FEMA, *Mitigation Ideas - A Resource for Reducing Risk to Natural Hazards* (2013), *available at* https://www.fema.gov/sites/default/files/2020-06/fema-mitigation-ideas_02-13-2013.pdf.

[8] FEMA, *Building Community Resilience with Nature-Based Solutions- A Guide for Local Communities* (2020), *available at* https://www.fema.gov/sites/default/files/2020-08/fema_riskmap_nature-based-solutions-guide_2020.pdf.

[9] FEMA, *Floodplain and Stream Restoration Fact Sheet* (2015), *available at* https://www.epa.gov/sites/production/files/2016-04/documents/fema_floodplain_stream_restoration_fact_sheet-sept_2015.pdf

[10] FEMA*, Ecosystem Service Benefits in Benefit-Cost Analysis for FEMA's Mitigation Programs Policy* FEMA Policy FP-108-024-02 (All projects funded by FEMA Hazard Mitigation Assistance grants must pass a benefit cost analysis using FEMA software), *available at* https://www.fema.gov/sites/default/files/2020-09/fema_ecosystem-service-benefits_policy_september-2020.pdf (last visited March 31, 2021); Thomas Frank, *FEMA ends policy favoring flood walls over green protection,* E&E News Reporter (Oct. 15, 2020) https://www.eenews.net/stories/1063716253/print.

[11] FEMA's BRIC grant program was created as part of Disaster Recovery Reform Act of 2018 and replaces the Pre-Disaster Mitigation program. The BRIC program is funded by a six percent set-aside from federal post-disaster grant expenditures. The 2020 FEMA Mitigation Action Portfolio highlights a wide range of innovative hazard mitigation projects that are possible to fund under the new BRIC program. https://www.fema.gov/sites/default/files/2020-08/fema_mitigation-action-portfolio-support-document_08-01-2020_0.pdf

[12] FEMA, *Building Resilient Infrastructure and Communities Notice of Funding Opportunity (NOFO) FY 2020,* (2020), *available at* https://www.fema.gov/sites/default/files/2020-08/fema_fy20-bric-notice-of-funding-opportunity_federal-register_August-2020.pdf

**Box 1: Hazard Mitigation Assistance Grants**

Much of the needed investment in natural protection projects may be accomplished by leveraging and integrating existing institutions and programs. FEMA's Hazard Mitigation Assistance (HMA) grants provide potential funding that could pay for the restoration and protection of critical natural infrastructure, like wetlands and natural floodplains, and improve outcomes and reduce costs from the next disaster. These grants provide funding for hazard mitigation planning as well as for cost-effective hazard mitigation activities (see Table below). While Hazard Mitigation Grant Program (HMGP) funding is only available after a federal disaster declaration, the Building Resilient Infrastructure and Communities (BRIC) and Flood Mitigation Assistance (FMA) programs are available nationwide on an annual basis.

| Description of Hazard Mitigation Assistance Program Grants | | |
|---|---|---|
| | **Description** | **Mitigation Projects Allowed** |
| Hazard Mitigation Grant Program | HMGP helps states, tribes, and local communities reduce the loss of life and property from natural disasters and enables the implementation of mitigation measures following a Presidential disaster declaration. The HMGP funds voluntary actions that protect either public or private property in accordance with priorities set out in state, tribal, or local hazard mitigation plans. | Property acquisition, structure elevation, dry floodproofing, generators, localized and non-localized flood risk reduction projects, structural and non-structural retrofitting, safe room construction, wind retrofit, infrastructure retrofit, soil stabilization, wildfire mitigation, code enforcement, advance assistance, aquifer and storage recovery, flood diversion and storage, floodplain and stream restoration, green infrastructure, capability and capacity building, other |
| Building Resilient Infrastructure and Communities (BRIC) | BRIC assists states, local communities, tribes, and territories with hazard mitigation projects to minimize risk from disasters and natural hazards. BRIC replaces the existing Pre-Disaster Mitigation (PDM) program.<br><br>The FY2020 priorities include incentivizing public infrastructure projects; projects that mitigate risk to one or more lifelines; projects that incorporate nature-based solutions; and projects that facilitate the adoption and enforcement of the latest published editions of building codes. | Provides funding for projects falling under these categories:<br>(1) Capability- and Capacity-Building, including building codes activities, partnerships, project scoping, mitigation planning and planning-related activities, and other activities<br>(2) Mitigation Projects<br>(3) Management Costs |
| Flood Mitigation Assistance Program | The FMA program funds projects that reduce or eliminate the risk of flood damage to buildings insured under NFIP. FMA funds two types of activities: planning and projects." | Property acquisition, structure elevation, mitigation reconstruction, dry floodproofing, localized flood risk reduction projects, non-structural retrofitting, aquifer and storage recovery, flood diversion and storage, floodplain and stream restoration, green infrastructure, capability and capacity building, other |

plans, relatively few of these projects have been funded through FEMA hazard mitigation grant programs so far.[13]

Mitigation activities funded through FEMA's Hazard Mitigation Assistance Grants, including all nature-based projects, must be consistent with priorities set out in state, tribal, or local hazard mitigation plans.[14] Hazard mitigation plans identify potential risks the state, tribal, or local community faces from hazards, assess the capabilities of the government entity to address the risks, and develop goals and actions to reduce risk from the hazards across the plan area.

## *Purpose of this Study*

Despite nature-based mitigation actions providing multiple benefits, it is not clear how well state and tribal hazard mitigation plans are integrating nature-based goals and strategies. We reviewed 50 state hazard mitigation plans to better understand to what extent they are incorporating nature-based strategies, such as the conservation and restoration of wetlands and floodplains and the use of green infrastructure, looking particularly at plan goals and explicit hazard reduction strategies. We also reviewed a small set of tribal plans. Over 200 tribal governments across the country have current tribal hazard mitigation plans.[15] We aimed to identify the range of practice as well as model examples of plan language that could be used by states in future iterations of their plans. We conclude with some observations on the state hazard mitigation plan development process and how planning elements can serve as opportunities to stimulate states and tribes to identify and use nature-based strategies.[16]

### Hazard Mitigation Plans

Hazard mitigation attempts to break the cycle of disaster damage, reconstruction, and repeated damage from the next disaster. From 2007 to 2016, FEMA provided $8.3 billion (adjusted for inflation) in mitigation grants to help communities rebuild and improve resilience.[17] This investment has repeatedly been shown to be cost-effective. According to a 2019 study conducted by the National Institute of Building Sciences, the impacts of federal mitigation grants resulted "in a national benefit of $6 for every $1 invested."[18]

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[13] Although there may be relatively few FEMA-funded grants for projects that are primarily nature-based, there are some examples of these kinds of projects. Examples of some nature-based projects that were funding primarily or in part by FEMA grants can be found on the Naturally Resilient Communities website. http://nrcsolutions.org/. We also have prepared two case studies of FEMA-funded nature-based projects (See https://www.eli.org/land-biodiversity/hazard-mitigation-planning). There are likely a greater number of FEMA grant funded projects that have nature-based components.

[14] FEMA, *State Mitigation Plan Review Guide,* at p. 47 (2015) https://www.fema.gov/sites/default/files/2020-06/fema-state-mitigation-plan-review-guide_03-09-2015.pdf

[15] FEMA, *Hazard Mitigation Plan Status* (2021), *available at* https://www.fema.gov/emergency-managers/risk-management/hazard-mitigation-planning/status.

[16] We also produced an accompanying report on local hazard mitigation plans, *available at* https://www.eli.org/land-biodiversity/hazard-mitigation-planning

[17] The Pew Charitable Trusts, *Natural Disaster Mitigation Spending Not Comprehensively Tracked* (2018) *available at* https://www.pewtrusts.org/en/research-and-analysis/issue-briefs/2018/09/natural-disaster-mitigation-spending--not-comprehensively-tracked.

[18] National Institute of Building Sciences, *Natural Hazard Mitigation Saves* (2019), *available at* https://cdn.ymaws.com/www.nibs.org/resource/resmgr/reports/mitigation_saves_2019/mitigationsaves2019report.pdf.

**Box 2: State Hazard Mitigation Plan Requirements**

States must have FEMA-approved Standard Mitigation Plans that comply with certain requirements in order to be considered eligible for non-emergency Stafford Act assistance and FEMA mitigation grants. These plans must be developed through a **planning process** that coordinates with other state and federal agencies, interested groups, and other ongoing state planning and mitigation efforts. The planning process must also include processes for reviewing and updating the plan every 5 years.

Beyond this, plans must include the following elements:

- A description of the planning process
- A **Risk Assessment**, providing the factual basis for activities, that characterizes and analyzes natural hazards and risks throughout the state, enabling comparison of potential losses and determining priorities for mitigation, including overviews of:
    - Type and location of natural hazards, including previous occurrences and future probabilities, and maps as needed;
    - State vulnerability to relevant hazards, based on local risk assessments;
    - Losses to vulnerable structures, including estimations of dollar losses to state-owned and operated facilities.
- A **Mitigation Strategy** for reducing losses from hazards identified in the risk assessment, including a discussion of:
    - State goals to guide activity selection;
    - State capabilities to mitigate hazards, including state and local policies and funding capacities;
    - Prioritization of cost-effective, environmentally sound, and technically feasible mitigation activities and description of linkages to overall strategy and local plans;
    - Sources of funding to implement activities;
    - Severe and repetitive loss activities and strategy.
- A section discussing **Coordination of Local Mitigation Planning**, including:
    - State processes to support local plans;
    - State process to coordinate, review, and link local plans to state plan;
    - Process of prioritizing community and local jurisdictions for support.
- A **Plan Maintenance Process** including:
    - Monitoring and evaluation for updates;
    - Monitoring and implementation of mitigation measures;
    - Review of progress towards mitigation goals
- A **Plan Adoption Process**
- **Assurances** of compliance with relevant State and Federal statutes and regulations of that period.

44 CFR § 201.4

States may also develop Enhanced State Plans, which make them eligible to receive additional HGMP funds,

FEMA requires every state to have a state hazard mitigation plan in order to be eligible for certain types of FEMA funding (e.g., Public Assistance, Hazard Mitigation Grant Program, Building Resilient Infrastructure and Communities program). The plans must meet certain requirements (Box 2) and be updated every five years. The purpose of a state hazard mitigation plan is to reduce or eliminate the risk to human life and property from hazards experienced by the state. To do this, state hazard mitigation plans identify potential risks and hazards the state faces, assess the capabilities of the state to address the hazards, and identify goals and actions to reduce risk from the hazards. Hazard mitigation plans are developed by a variety of actors, often involving committees that include members from federal, state,

and local agencies, but generally led by a state or local emergency management agency (or a consultant hired by that agency).

FEMA recommends incorporating agencies and stakeholders with mitigation capabilities from the following sectors:

- Hazard data
- Climate projections and data
- Emergency management
- Economic development
- Land use and development
- Housing
- Health and social services
- Infrastructure, and
- Natural and cultural resources[19]

These groups also can help with the implementation of actions, or actions can be delegated to or worked on with other organizations with expertise.

The state hazard mitigation plan "must describe the current process used to update the plan, including how the plan was prepared, the schedule or timeframe, specific milestones and activities, the agencies and stakeholders who were involved in the process, and if the mitigation planning process was integrated to the extent possible with other state planning efforts."[20] The plan must include a description of the other state and federal agencies and other stakeholders involved in the process, including emergency management; economic development; land use and development; housing; health and social services; infrastructure; and natural and cultural resources.[21] Where coordination with agencies and stakeholders representing these sectors is not practicable, the plan must describe the limitations. Once the hazard mitigation plan has been completed, it must be formally adopted by the state and approved by FEMA. The plan then must be implemented and consistently reviewed and updated.[22]

This report focuses primarily on the *mitigation strategy* section of the state plans. The mitigation strategy includes "a description of State goals to guide the selection of activities to mitigate and reduce potential losses."[23] FEMA defines mitigation goals as "broad, long-term policy and vision statements

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[19] FEMA, *State Mitigation Plan Review Guide,* at p. 11 (2015) https://www.fema.gov/sites/default/files/2020-06/fema-state-mitigation-plan-review-guide_03-09-2015.pdf (States report that a number of different agencies are involved in disaster mitigation, preparedness, response, and recovery activities, including conservation/natural resources/forestry and environmental protection agencies); *See* The Pew Charitable Trusts, *What We Don't Know About State Spending on Natural Disasters Could Cost Us - Data limitations, their implications for policymaking, and strategies for improvement* (2018), *available at* https://www.pewtrusts.org/-/media/assets/2018/06/statespendingnaturaldisasters_v4.pdf.

[20] FEMA, *State Mitigation Plan Review Guide,* at p. 12 (2015) https://www.fema.gov/sites/default/files/2020-06/fema-state-mitigation-plan-review-guide_03-09-2015.pdf.

[21] *Id.*

[22] Standard State Mitigation Plans 44 C.F.R. § 201.4.

[23] *Id.*

that explain what is to be achieved by implementing the mitigation strategy."[24] These should be directly tied to the risks, vulnerabilities, and capacities identified in the Risk Assessment and State Capability sections. The Mitigation Strategy section must also include "an identification, evaluation, and prioritization of cost-effective, environmentally sound, and technically feasible mitigation actions and activities the State is considering and an explanation of how each activity contributes to the overall mitigation strategy."[25] Actions identified in the hazard mitigation plans must be linked directly to the state's risks, capabilities, and objectives.[26] They should also be linked to local plans, where specific local actions and projects are identified.

Finally, the mitigation strategy includes an analysis of state capabilities to mitigate hazards (e.g., state programs) and funding opportunities. The state capability assessment should not only address the ways the state's existing capabilities can aid the mitigation effort, but also address areas in which the state needs to strengthen its capabilities. The capabilities section is "an assessment based on existing capabilities that demonstrates the state's commitment to mitigation, [that] identifies a wide range of resources from which to implement mitigation activities, and reveals areas to target improvements."[27]

The specific actions included in the mitigation strategy provide the basis for proposing and applying for funding for specific mitigation projects (see Box 1 for information on FEMA's Hazard Mitigation Assistance Grants). As such, the more the Mitigation Strategy is able to frontload cost and risk assessments for nature-based projects, the easier the application process will likely be for those projects. In fact, a recent Government Accountability Office (GAO) report highlighted the challenges state and local officials face when applying to hazard mitigation grant programs, "including challenges with the required benefit-cost analysis, the complexity of the application processes, the timeliness of grant awards, and the technical capacity required to successfully apply."[28] State and local officials described the application process as complex and lengthy and cited challenges with applicants' technical capacity to successfully apply for grants. These challenges apply to any type of project, including nature-based strategies.

## Nature-Based Hazard Mitigation Strategies

Nature-based strategies (also called natural infrastructure, green infrastructure or nature-based solutions) are actions that use the conservation or restoration of nature, such as ecosystems like

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[24] FEMA, *State Mitigation Planning Key Topis Bulletin: Mitigation Strategy* (Oct. 2016), *available at* https://www.fema.gov/sites/default/files/2020-06/fema-state-mitigation-strategy-planning-bulletin_10-26-2016_0.pdf.

[25] Standard State Mitigation Plans 44 C.F.R. § 201.4. FEMA has characterized suggested mitigation actions into four types: (1) Local Planning and Regulations, (2) Structure and Infrastructure Projects, (3) Natural Systems Protection, and (4) Education and Awareness Programs. FEMA, *Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards* (2013) https://www.fema.gov/sites/default/files/2020-06/fema-mitigation-ideas_02-13-2013.pdf.

[26] FEMA, *Flood Mitigation Assistance (FMA) Grant* https://www.fema.gov/flood-mitigation-assistance-grant-program (last visited Mar. 31, 2021).

[27] FEMA, *State Mitigation Plan Review Guide,* at p. 19 (2015) https://www.fema.gov/sites/default/files/2020-06/fema-state-mitigation-plan-review-guide_03-09-2015.pdf.

[28] United States Government Accountability Office. Disaster Resilience: *FEMA Should Take Additional Steps to Streamline Hazard Mitigation Grants and Assess Program Effects* (Feb. 2021), *available at* https://www.gao.gov/assets/720/712172.pdf.

wetlands, or green infrastructure projects like green (vegetated) roofs, to address hazards (See Box 1).[29] Nature-based *mitigation* strategies can help reduce the likelihood of future disasters occurring and minimize negative impacts when they do occur. These strategies also provide environmental and social co-benefits, such as increasing habitat and biodiversity, and creating recreational spaces for communities.

Coastal wetlands, for example, are one of the natural features that provide valuable protection from natural hazards. According to one study, existing wetlands prevented $625 million in property damage in areas affected by Hurricane Sandy.[30] The study showed a "correlation between wetland cover and avoided property damages: the greater the extent of the wetland, the more protection it provides. Even relatively degraded wetlands in highly urban areas like New York City provided hundreds of millions of dollars in flood protection."

Nature-based mitigation strategies can also be more cost-effective than traditional "gray" solutions in many contexts, achieving the same hazard mitigation benefits while requiring lower upfront (capital) and ongoing (operation and maintenance and repair) costs.31 For example, installing living shorelines in the South Atlantic is estimated to cost, on average, $361/linear foot, which is approximately a third of the estimated cost to install concrete bulkheads.32 Similarly, investment in natural infrastructure up-

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[29] There are no universal definitions for nature-based solutions. Nature-based Solutions (NbS) are defined by IUCN as "actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits." Commission on Ecosystem Management, *Nature-based Solutions* https://www.iucn.org/commissions/commission-ecosystem-management/our-work/nature-based-solutions#:~:text=Nature%2Dbased%20Solutions%20(NbS),%2Dbeing%20and%20biodiversity%20benefits%E2%80%9D; CA law defines natural infrastructure as "the preservation or restoration of ecological systems, or utilization of engineered systems that use ecological processes, to increase resiliency to climate change, manage other environmental hazards, or both. This may include, but is not limited to, floodplain and wetlands restoration or preservation, combining levees with restored natural systems to reduce flood risk, and urban tree planting to mitigate high heat days." CA Assembly Bill No. 1482 Chapter 603 https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201520160AB1482; The Nature Conservancy added the concept of natural processes providing services. NBS—sometimes called natural infrastructure and green infrastructure—incorporate the natural environment that mimic or work in concert with natural processes to provide clean water, clean air, flood, fire and drought risk reduction, and other benefits. Unlike many forms of grey infrastructure, NBS also offer an array of economic, social, and environmental co-benefits. *Strategies for Operationalizing Nature-Based Solutions in the Private Sector* (2018), https://www.nature.org/content/dam/tnc/nature/en/documents/NBSWhitePaper.pdf.

[30] Beck et al., *Coastal Wetlands and Flood Damage Reduction: Using Risk Industry-based Models to Assess Natural Defenses in the Northeastern USA*, Lloyd's Tercentenary Research Foundation, London (2016) https://conservationgateway.org//ConservationPractices/Marine/crr/library/Documents/CoastalWetlandsandFloodDamageReductionReport.pdf.

[31] Environmental and Energy Study Institute, *Fact Sheet: Nature as Resilient Infrastructure – An Overview of Nature-Based Solutions* (Oct. 16, 2019), *available at* https://www.eesi.org/papers/view/fact-sheet-nature-as-resilient-infrastructure-an-overview-of-nature-based-solutions. Glick, P., E. Powell, S. Schlesinger, J. Ritter, B.A. Stein, and A. Fuller. *The Protective Value of Nature: A Review of the Effectiveness of Natural Infrastructure for Hazard Risk Reduction.* (2020) Washington, DC: National Wildlife Federation, *available at https://www.nwf.org/-/media/Documents/PDFs/NWF-Reports/2020/The-Protective-Value-of-Nature.ashx?la=en&hash=A75F59611475502BEE58723F8B3C58423417E579*

[32] Anne N. Connor, *Why you want oysters and a salt marsh between you and a hurricane*, Vox (June 3, 2019). *available at* https://www.vox.com/2019/6/3/18262182/hurricane-season-2019-storm-protection

front can save communities money down the road. For example, for every $1 spent on wetland and reef restoration in the Gulf of Mexico, communities have saved up to $7 in "flood-reduction benefits."[33]

**Box 3: Nature-Based Hazard Mitigation Actions**

There is a wide variety of types of nature-based hazard mitigation strategies,[a] from land conservation and restoration to green infrastructure to land use policy. These projects can address a range of hazards while also providing other environmental and community benefits.

Types of projects include:

- **Land conservation** – Identifying and protecting land for hazard mitigation and ecosystem benefits.
- **Wetland, floodplain, habitat restoration** –Restoring functions and habitat areas that have been lost or degraded for hazard mitigation benefits.
- **Green infrastructure** – Parcel-scale land conservation and storm water management projects (e.g., bioswales, rain gardens, green roofs) that provide flood and drought mitigation benefits, generally in urban areas.
- **Land use projects** – Land use policy and regulatory actions such as zoning, greenways, and growth management in high hazard areas.
- **Dune restoration, living shorelines, coastal wetland restoration** – Coastal protection and restoration projects that provide protection from flooding and storm surge.

Nature-based projects provide mitigation benefits for a variety of hazards, including:

- Riverine flooding
- Urban flooding
- Coastal flooding and storm surge
- Drought
- Wildfire

Nature-based projects provide additional co-benefits, including:

- Habitat protection
- Wildlife protection
- Other ecosystem services (e.g., improved water quality)
- Increased property values for neighboring properties
- Green jobs
- Recreation space for the surrounding community
- Public health benefits
- Carbon sequestration

a - FEMA, *Mitigation Ideas - A Resource for Reducing Risk to Natural Hazards* (2013), *available at* https://www.fema.gov/sites/default/files/2020-06/fema-mitigation-ideas_02-13-2013.pdf; FEMA, *Building Community Resilience with Nature-Based Solutions - A Guide for Local Communities* (2020), *available at* https://www.fema.gov/sites/default/files/2020-08/fema_riskmap_nature-based-solutions-guide_2020.pdf.

[33] NOAA Office for Coastal Management, Fast Facts – Natural Infrastructure, *at* https://coast.noaa.gov/states/fast-facts/natural-infrastructure.html

Natural infrastructure may also require fewer post-disaster repairs. For example, after Hurricane Matthew (2016), a study found living shorelines reduced erosion just as effectively as bulkheads, but required no repairs post-disaster, while ¾ of the bulkheads required repairs.[34]

## *Methods*

### Plan Identification

We compiled the most recently available and approved state hazard mitigation plans from 50 states from state web pages and/or by contacting the State Hazard Mitigation Officers. Plan links, approval years, and lead planning agencies can be seen in Appendix 1.

### Plan Review

A key word search approach was used as an initial screen to identify natural and nature-based goals, objectives, strategies and actions. The key words used included: wetland; environment; natur- (e.g., natural and nature-based); green (e.g., green infrastructure); conserv- (e.g., conserve, conservation); preserv- (e.g., preserve, preservation); restor- (e.g., restore, restoration); stream; and living shore. We searched the entire plan for the key words, including the Risk Assessment, Mitigation Strategy, and Planning Process sections. We documented all identified mentions including relevant goals, objectives, and mitigation actions.

The key word search was followed by a more detailed review of the risk assessment and mitigation strategy sections of the plan to ensure all relevant mentions and actions were included in the data. Each plan's mitigation goals/objectives and actions were reviewed to better understand the context of each action and determine if it was relevant to inclusion in the study. Some of the plans include a description of each action, others just list actions without additional information.

### Data Collected

#### *State Plan Summaries*

We created summary documents for each plan reviewed that include all of the information collected from the plan review, including:

- Year
- Planning Timeframe
- Date of Next Planned Revision
- Responsible Planning Agency (including the Planning Team and Identified Stakeholders)
- Relevant Goals and Objectives
- Relevant Actions

[34] Smith et al., *Living shorelines enhanced the resilience of saltmarshes to Hurricane Matthew*, Ecological Applications, 28(4), (2016), *available at* https://esajournals.onlinelibrary.wiley.com/doi/full/10.1002/eap.1722?sid=nlm%3Apubmed

### *Goals and Objectives*

We identified goals and objectives that address the environment, natural resource protection, or nature-based strategies. These ranged from broad goals that mentioned the environment to more specific goals focused on minimizing harm to the environment or identifying ways to integrate nature-based solutions.

We categorized plans as including:

- No relevant goals: The plan did not have any goals or objectives that mention the environment, natural resources, or habitat.

- Broad goal that mentions protecting the environment in addition to protecting other state assets: The plan includes a broad goal that includes the environment or natural resources in addition to other state assets (e.g., reduce state's "vulnerability and increase resilience to hazards to protect people, property, and natural resources")[35]

- Goal specifically focuses on the environment: The plan includes a goal(s) or objective(s) that specifically identifies reducing risk to natural resources or the environment.

- Goal specifically focuses on natural infrastructure/nature-based solutions: The plan includes a goal(s) or objective(s) that explicitly identifies protecting or restoring natural infrastructure as a hazard mitigation strategy.

### *Mitigation Actions*

We documented plan actions that were explicitly related to the environment, natural infrastructure, or nature-based solutions. Some plans included explanatory text for their actions, providing an opportunity for planners to be more specific in the approaches or tactics to be employed for that action. Many plans, on the other hand, only included the title or a brief description of their actions, making it difficult to interpret what the action might entail. We therefore took a conservative view of relevant actions to include in our analysis. We included only actions that explicitly discussed natural infrastructure or nature-based strategies (e.g., habitat conservation or restoration projects, green infrastructure projects, protection policies, etc.). We did not include the following types of actions:

- references to buyouts or acquisitions that just focused on the purchase of structures (unless they explicitly talked about converting the land to open or green space),
- stormwater projects (e.g., detention ponds or construction/clearing of drainage structures or creation of drainage management plans) that did not mention habitat restoration,
- drought-tolerant landscaping plans or ordinances (or vegetation management for drought that did not mention habitat conservation or restoration),
- beach re-nourishment (that did not talk about dune restoration),
- erosion control plans/programs (or projects) that did not mention habitat,

[35] Alabama Emergency Management Agency, *Alabama State Hazard Mitigation Plan,* p 5 (July 18, 2019), *available at* https://alabamaema.files.wordpress.com/2018/11/state-of-alabama_state-hazard-mitigation-plan-2018-update_final_07182018.pdf [hereinafter Alabama Plan].

- tree management, when focused only on pruning, and
- fire vegetation management (that did not mention habitat conservation or restoration).

We included actions where it was reasonable to interpret the action as primarily (or in large part) a nature-based activity. It is possible that in practice some of the actions or programs focus on other non-nature-based programmatic components to varying degrees. It is also possible that we screened out some actions that are in practice relevant nature-based strategies.

The documented actions were sorted into categories to better understand the range of strategies included in state plans across the country. The categories identified included:

- **Conservation/Preservation/Management**: Conservation/Preservation/Management actions are those that explicitly focus on protection or management of ecosystems or natural resources (e.g., protect wetlands, maintain creek banks, ecosystem preservation).

- **Restoration**: Restoration actions are those focused on restoration of natural habitats, usually wetlands, streambanks, floodplains, beaches, etc. These actions include dam removals, dune restoration, and restoration of native vegetation.

- **Green Infrastructure**: These actions call on the use of green infrastructure projects to address stormwater management.[36] Green infrastructure is generally implemented at the parcel-scale and is primarily conducted in urban areas. Many of the actions identified in this study broadly mention promoting or investing in green infrastructure projects, others describe more specific green infrastructure projects such as bioswales, rain gardens, or green roofs.

- **Land Use**: Land Use actions seek to address risks to communities through land use, including acquiring properties and converting to open space, planning and zoning guidelines or policy, and managing development in hazard-prone areas.

- **Funding and Programmatic**: Funding and Programmatic actions seek to create or expand preservation, restoration, or green infrastructure programs; develop or enhance funding programs; or develop implementation plans related to nature-based strategies.

- **Policy and Law**: Policy and Law actions call upon different agencies to develop and implement policies and regulations that would encourage or facilitate conservation and/or nature-based mitigation actions. These include promulgating wetland regulations, ensuring enforcement of policies, and integrating protection policies into existing plans.

- **Technical and Information**: Technical and Information actions include those related to studies, modeling, and development of tools (e.g., decision support tools). Sometimes these actions are related to better understanding risk and other times they include actions to identify future projects that will address identified risk.

[36] Green infrastructure refers to a way to collect and clean rainwater where it falls. Using plants and soil, green infrastructure projects reduce the amount of rainwater entering 'gray' water infrastructure (e.g., storm sewers, pipes). This can help reduce flooding. Green infrastructure projects can also help to clean and conserve water and provide recreational and other benefits to the community.

- **Education and Awareness**: Education and Awareness actions include those focused on development of guidance, conducting community outreach, and creating technical bulletins and training programs aimed at enhancing understanding of ecosystem services and non-structural mitigation measures.

- **Agency Coordination**: Agency Coordination actions encourage or promote coordination among state agencies or state and local agencies.

- **Partnerships**: Partnership actions encourage partnerships with non-profits, utilities, or other organizations to conduct mitigation strategies.

We also recorded which hazard the actions addressed and the plan goal/objective with which the actions were correlated. We were able to record these data for many, but not all, of the actions.

## Findings

Overall, plans varied widely in the extent to which they incorporated nature-based mitigation goals and objectives and actions.

### *Goals and Objectives*

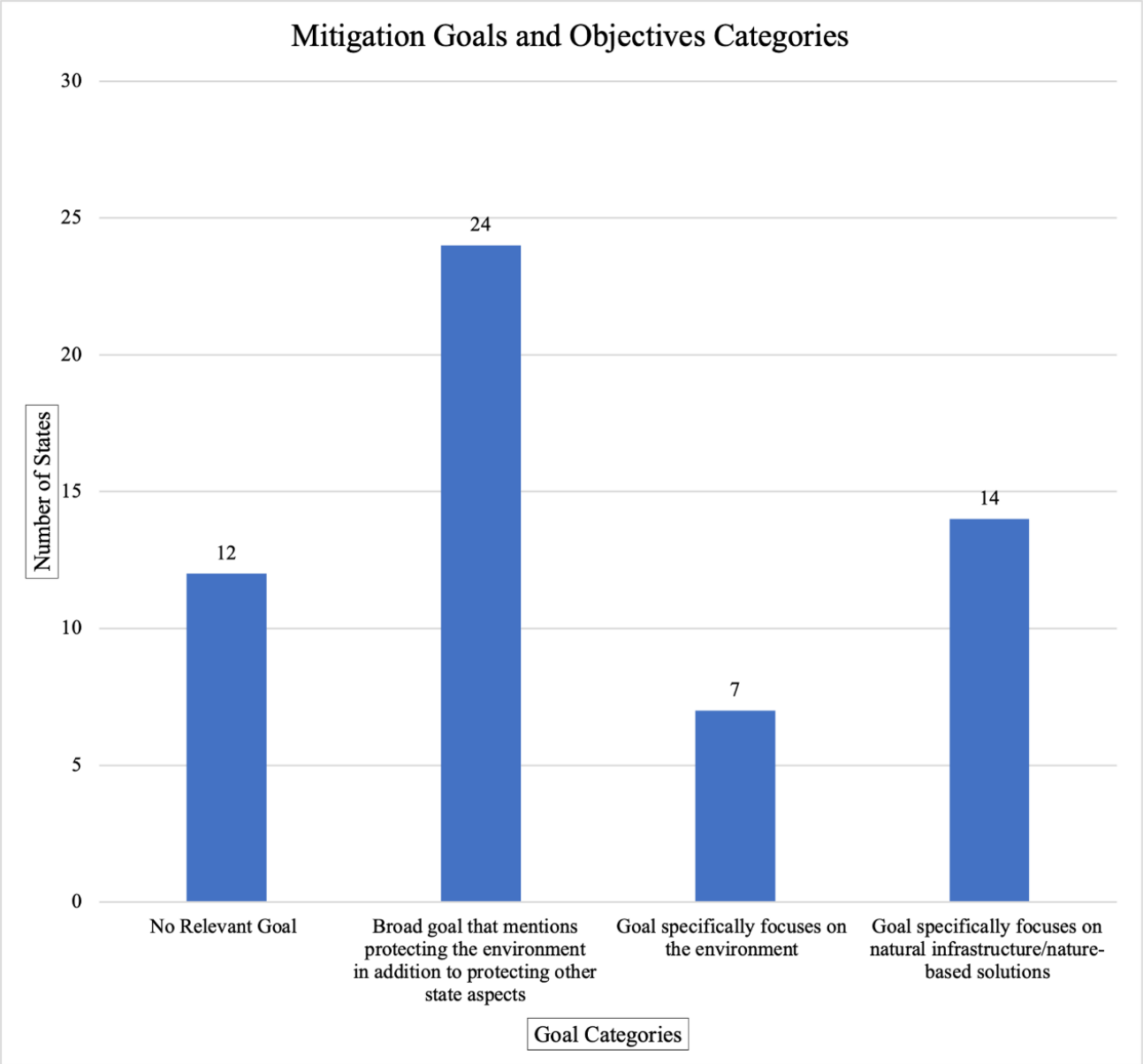
Mitigation goals are meant to guide the mitigation strategy and actions selection. As described by the state of Washington, plan goals are meant "to be general policy statements that reflect the state's priorities and commitment to risk reduction."[37] We identified 38 plans that had goals and objectives that were relevant to the environment (Table 1, and Appendix 2). Twelve plans did not include goals or objectives that explicitly mentioned the environment or natural resources. We identified three categories of plan goals, 1) broad goals that mention protecting the environment in addition to protecting other state aspects, 2) goals that specifically focus on the environment, and 3) goals that specifically focus on nature infrastructure/nature-based solutions (Table 1, Figure 1). Seven plans had more than one relevant goal type (e.g., New York had a broad goal that mentions the environment as well as a goal that specifically focuses on nature-based solutions).

**Table 1: Mitigation Goals and Objectives Categories**

| Goal Category | States Including Goal Category |
|---|---|
| No Relevant Goal | AK, AZ, DE, GA, IL, IN, KY, NV, OH, TN, WA, WY |
| Broad goal that mentions protecting the environment in addition to protecting other state aspects | AL, FL, HI, ID, IA, KS, LA, ME, MA, MN, MS, NH, NM, NY, NC, ND, PA, RI, SD, TX, VT, VA, WV, WI |
| Goal specifically focuses on the environment | CA, MD, MO, OK, OR, SD, UT |
| Goal specifically focuses on natural infrastructure/nature-based solutions | AR, CA, CO, CT, FL, MI, MS, MT, NE, NJ, NY, PA, SC, VT |

[37] Washington Emergency Management Division, *Washington State Enhanced Hazard Mitigation Plan,* p 168 (2018), *available at* https://mil.wa.gov/asset/5d1626c2229c8 [hereinafter Washington Plan].

**Figure 1: Mitigation Goals and Objectives**




*Note: 38 plans that had goals and objectives that were relevant to the environment. We identified three categories of goals: 1) broad goals that mention protecting the environment in addition to protecting other state aspect; 2) goals that specifically focus on the environment; and 3) goals that specifically focus on nature infrastructure/nature-based solutions.*

Almost half of the state plans (24) included broad goals that listed the environment or natural resources in a list of other state assets. For example, Idaho had a stated goal of reducing "the adverse economic and environmental impacts of natural, technological, and human-caused hazard events."[38] Similarly,

[38] Idaho Office of Emergency Managment, *State Hazard Mitigation Plan*, p 1-27 (2018), *available at* https://ioem.idaho.gov/preparedness-and-protection/mitigation/state-hazard-mitigation-plan/ [hereinafter Idaho Plan].

Alabama had a goal to "reduce the State of Alabama's vulnerability and increase resilience to hazards to protect people, property, and natural resources," and a sub-point objective to "promote hazard mitigation policies that reduce risk to people and property and protect the environment."[39]

Several plans (7) incorporated a goal specifically focused on the environment. For example, Maryland's goal: "Maryland Hazard Mitigation Plan Goal - To protect life, property, and the environment from hazard events through: Promote actions that protect natural resources, while enhancing hazard mitigation and community resiliency."[40] Oregon included a goal to "minimize the impact of natural hazards while protecting, restoring, and sustaining environmental processes,"[41] and Missouri included an objective to "consider sustainability issues (ecologically sound, economically viable, socially just, and humane) when developing or reviewing mitigation projects and plans."[42]

Other plans (14) sought to have the environment considered more specifically in the identification and implementation of mitigation strategies. Colorado, for instance, included a goal to "Support mitigation initiatives and policies that promote disaster resiliency, nature-based solutions, cultural resources and historic preservation, and climate adaptation strategies."[43] South Carolina's Goal 7 was to "enhance and encourage the use of natural resource protection measures as a means to reduce the impacts of hazards on people and property."[44] Similarly, Goal 3 in the California Plan recognized the importance of mitigating impacts to natural systems, while also addressing the connection between protecting the environment and improving disaster resilience:

> "Goal 3: Protecting the environment . . .
>
> > Objective 2: Encourage hazard mitigation measures that promote and enhance nature-based solutions, natural processes, and ecosystem benefits while minimizing adverse impacts to the environment.
> >
> > Objective 3: Encourage mitigation planning programs at all levels of government to protect the environment and promote enforcement of sustainable mitigation actions.

[39] Alabama Plan, p 313.
[40] Maryland Emergency Management Agency, *State of Maryland 2016 Hazard Mitigation Plan,* p 5-2 (Aug. 2016), *available at* https://mema.maryland.gov/community/Documents/2016_Maryland_Hazard_Mitigation_Plan_final_2.pdf [hereinafter Maryland Plan].
[41] Oregon Office of Emergency Management, *Oregon Natural Hazards Mitigation Plan,* p 21 (2015), *available at* https://www.oregon.gov/LCD/NH/Documents/Approved_2015ORNHMP.pdf [hereinafter Oregon Plan].
[42] Missouri State Emergency Management Agency, *Missouri Hazard Mitigation Plan,* p 4.4 (2018), *available at* https://sema.dps.mo.gov/docs/programs/LRMF/mitigation/MO_Hazard_Mitigation_Plan2018.pdf [hereinafter Missouri Plan].
[43] Colorado Department of Public Safety, *2018-2023 Colorado Hazard Mitigation Plan*, p 5-4 (2018) *available at https://drive.google.com/file/d/1bp0qDZTfOTO6bQa6TA8hv7_FLZZqSwxp/view* [hereinafter Colorado Plan].
[44] South Carolina Emergency Management Division, *South Carolina Hazard Mitigation* Plan, p 248 (Oct. 2018), *available at* https://www.scemd.org/media/1391/sc-hazard-mitigation-plan-2018-update.pdf [hereinafter South Carolina Plan].

Objective 4: Coordinate and implement integrated and adaptive hazard mitigation, and watershed and habitat protection strategies, through public and private partnerships."[45]

The New York Plan also provides a useful example in which the mitigation goals more specifically include green infrastructure and nature-based solutions:

> "Goal 4: Encourage the development and implementation of long-term, cost effective, and resilient mitigation projects to preserve or restore the functions of natural systems.
>
> 4.1: Encourage the use of green and natural infrastructure.
>
> 4.2: Provide technical assistance to communities and stakeholders in the application and implementation of mitigation projects that preserve or restore natural systems.; Build stronger by promoting mitigation actions that emphasize sustainable construction and design measures to reduce or eliminate the impacts of natural hazards now and in the future."[46]

In addition to including these specific objectives under the environmentally-focused Goal 4, the New York Plan mentioned natural infrastructure under Goal 2, which was to "Protect existing property including public, historic, private structures, state-owned/operated buildings, and critical facilities and infrastructure."[47] The relevant objectives under that goal were to:

> "2.3: Encourage resilient and sustainable structural practices that reduce vulnerabilities and encourage the use of green and natural infrastructure.
>
> 2.4: Promote the continued use of natural systems and features, open space preservation, and land use development planning with local jurisdictions."[48]

### Other Approaches

In addition to the mitigation goals and objectives, some plans indicated their prioritization of nature-based strategies and environmental protections in other ways and in other components of their plans. The Massachusetts Plan included a broad goal that includes protecting the environment, but also included a section in its Hazard Mitigation and Climate Adaptation Strategy entitled "Importance of Nature-Based Solutions in Hazard Mitigation and Climate Adaption," which appeared after their Goals & Objectives.[49] The section defines Nature-Based Solutions (NBS) and gives specific examples of co-benefits from NBS projects for specific hazards (e.g. flooding), other initiatives (e.g. carbon

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[45] California Governor's Office of Emergency Services (Cal OES), *2018 California State Hazard Mitigation Plan,* p 70 (2018), *available at* https://www.caloes.ca.gov/HazardMitigationSite/Documents/002-2018%20SHMP_FINAL_ENTIRE%20PLAN.pdf [hereinafter California Plan].

[46] New York State Division of Homeland Security and Emergency Services, *2019 New York State Hazard Mitigation Plan, Mitigation Strategy* (2019), *available at* https://mitigateny.availabs.org/strategies/actions [hereinafter New York Plan].

[47] *Id.*

[48] *Id*.

[49] Massachusetts Emergency Management Agency, *Massachusetts State Hazard Mitigation and Climate Adaptation Plan,* p 7-3 (2018), *available at* https://www.mass.gov/files/documents/2018/10/26/SHMCAP-September2018-Full-Plan-web.pdf [hereinafter Massachusetts Plan].

sequestration), and measures of well-being (e.g. air and water quality).[50] It explicitly states that the co-benefits should be considered in decision-making and that "NBS should receive strong consideration over 'hard' infrastructure solutions, where feasible."[51] In addition, the plan noted that the prioritization framework the planners "used to rank the action items . . . includes nature-based approaches specifically designed to conserve and/or employ natural resources as the highest-priority ranking."[52] As we describe below, the Massachusetts plan had the most relevant actions of any of the plans reviewed for this study.

## *Mitigation Actions*

Thirty-nine of the 50 plans that we reviewed had relevant nature-based actions, such as the conservation and restoration of wetlands and floodplains and green infrastructure (Table 2, and Appendix 3). We identified 177 actions over the reviewed plans. With 30 relevant actions, Massachusetts was the state with the most actions. Three other plans had more than 10 relevant actions (New York, Vermont, Washington). The remaining states had fewer than 10 actions, most with five or fewer actions. Eleven states had no relevant actions.

As we described above, we identified a series of categories to organize the identified actions. We found the most actions were related to the Funding and Programmatic (37), Restoration (39), and Technical and Information (37) categories (Table 3, Figure 2). Many of the action categories were distributed across a number of states. Fifteen states had one or more funding and programmatic actions, 19 states had one or more restoration actions, and 11 states had one or more technical and information actions (Table 3, Figure 3).

**Table 2: Number of Mitigation Actions Per State**

| State | Number of Mitigation Actions per Hazard Mitigation Plan |
|---|---|
| Alaska | 3 |
| Alabama | 5 |
| Arizona | 0 |
| Arkansas | 1 |
| California | 2 |
| Colorado | 3 |
| Connecticut | 6 |
| Delaware | 3 |
| Florida | 0 |
| Georgia | 3 |
| Hawaii | 5 |

[50] Nature-based solutions (NBS) are defined as: The conservation, enhancement, and restoration of nature to reduce emissions, adaptation, and enhance resiliency. These types of solutions use natural systems, mimic natural processes, or work in tandem with traditional engineering approaches to address natural hazards like flooding, erosion, drought, and heat islands. Massachusetts Plan.

[51] Massachusetts Plan, p 7-3.

[52] Massachusetts Plan, p 7-4.

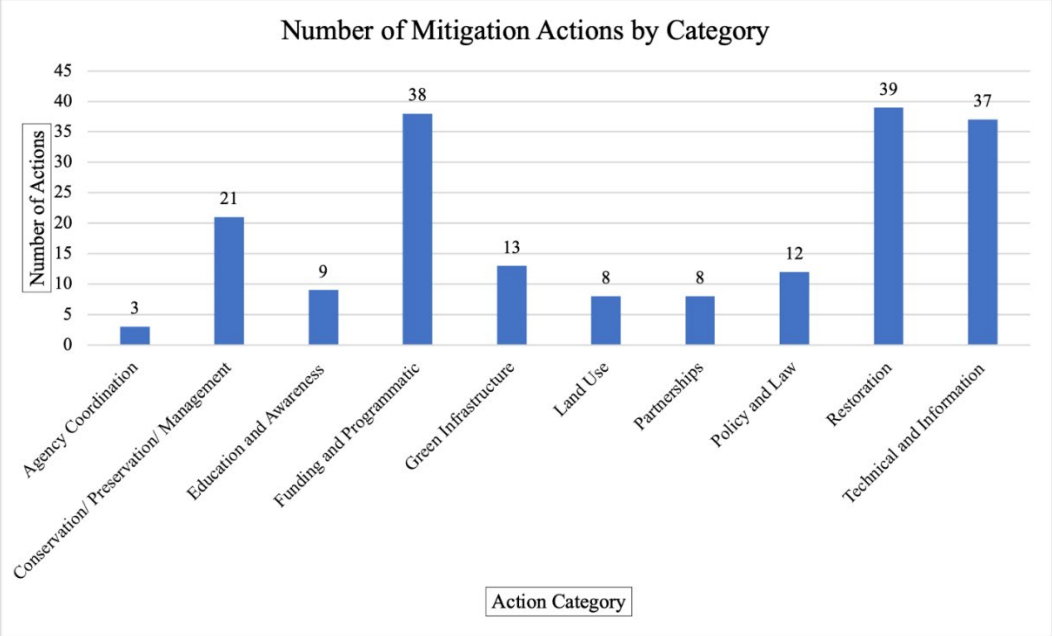
| State | Number of Mitigation Actions per Hazard Mitigation Plan |
|---|---|
| Idaho | 0 |
| Illinois | 1 |
| Indiana | 2 |
| Iowa | 6 |
| Kansas | 1 |
| Kentucky | 5 |
| Louisiana | 0 |
| Maine | 0 |
| Maryland | 3 |
| Massachusetts | 30 |
| Michigan | 2 |
| Minnesota | 4 |
| Mississippi | 1 |
| Missouri | 0 |
| Montana | 9 |
| Nebraska | 1 |
| Nevada | 3 |
| New Hampshire | 4 |
| New Jersey | 1 |
| New Mexico | 1 |
| New York | 17 |
| North Carolina | 2 |
| North Dakota | 0 |
| Ohio | 1 |
| Oklahoma | 0 |
| Oregon | 2 |
| Pennsylvania | 1 |
| Rhode Island | 3 |
| South Carolina | 3 |
| South Dakota | 0 |
| Tennessee | 1 |
| Texas | 4 |
| Utah | 3 |
| Vermont | 13 |
| Virginia | 0 |
| Washington | 13 |
| West Virginia | 0 |
| Wisconsin | 8 |
| Wyoming | 1 |

## Table 3: Mitigation Actions in Reviewed State Plans by Action Category

| Action Category | Number of Actions* | Number of States |
|---|---|---|
| Agency Coordination | 3 | **3 states** (CA, MA, MN) |
| Conservation/ Preservation/ Management | 21 | **17 states** (CO, DE, KY, MD, MA, MN, MS, MT, NV, NY, RI, SC, TX, VT, WA, WI, WY) |
| Education and Awareness | 9 | **7 states** (AL, CO, IN, MI, NY, NC, MD) |
| Funding and Programmatic | 38 | **16 states** (AL, CA, CT, MA, NE, NV, NH, NJ, NC, OH, OR, PA, SC, VT, WA, WI) |
| Green Infrastructure | 13 | **12 states** (AR, HI, IN, IA, KY, MD, MA, MN, NY, OH, RI, UT) |
| Land Use | 8 | **8 states** (AK, AL, DE, GA, IA, MT, NH, TX) |
| Partnerships | 8 | **8 states** (HI, MA, MI, MT, TN, TX, VT, WA) |
| Policy and Law | 12 | **9 states** (AK, AL, DE, GA, MA, MN, MT, WA, WI) |
| Restoration | 39 | **19 states** (AK, CO, CT, IA, KY, MD, MA, MN, MS, MT, NV, NM, NY, SC, TX, UT, WA, WI, WY) |
| Technical and Information | 37 | **11 states** (CT, GA, HI, IL, KS, MA, NH, NY, RI, VT, WA) |
| No Actions Included | -- | **11 states** (AZ, FL, ID, LA**, ME, MO, ND, OK, SD, VA, WV) |

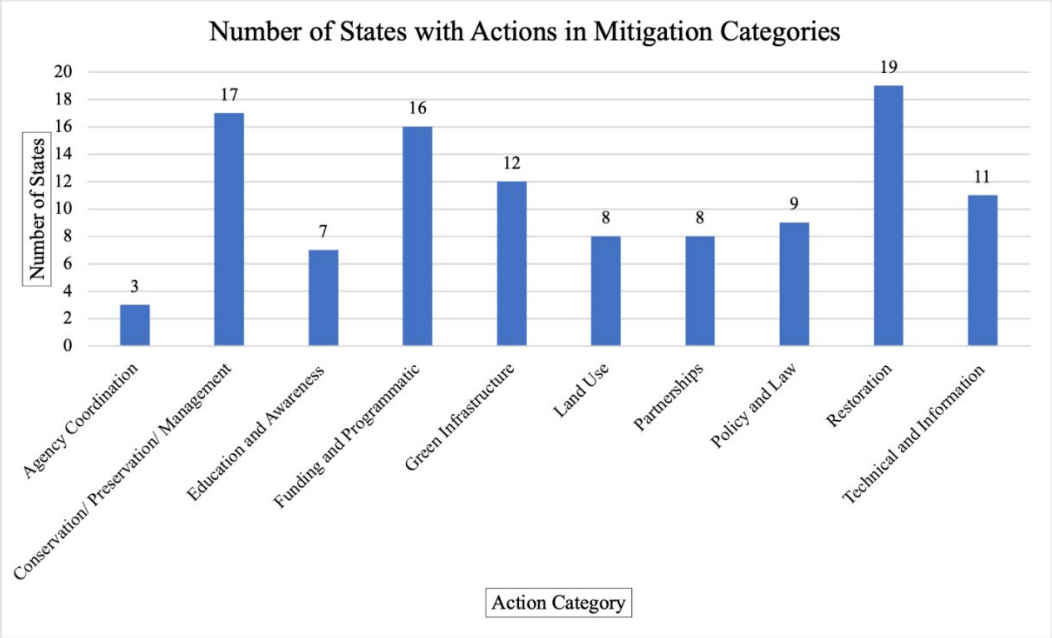
*Notes: * 11 actions were included in more than 1 category. ** The Louisiana plan does not include actions like other states, but has a technical appendix with possible mitigation actions.*

## Figure 2: Number of Mitigation Actions by Category




*Note: We identified a series of categories to organize the identified actions. The number of actions in each category varied by category; 11 actions were included in more than 1 category. We found the Restoration, Funding and Programmatic, and Technical and Information categories contained the most actions.*

## Figure 3: Mitigation Action Categories




*Note: We identified a series of categories to organize the identified actions. The number of states including a given category of action in their plan varied by the category. We found the most states had actions related to Restoration, Conservation/Preservation/Management, and Funding and Programmatic.*

Some plans identified the specific hazard that the action was meant to address (see Appendix 3). Many actions addressed a single hazard (e.g., flood); however, a number of actions were meant to address a range of identified hazards. Other plans did not identify a specific hazard for the identified action. We did not specifically focus on flood-related actions, but many of the nature-based actions were developed to address flood hazards.

Plans included varying levels of detail regarding each mitigation action proposed in their Mitigation Strategy. Some, such as the Kentucky Plan, only included what is suggested by FEMA regulations: the action itself, the hazards addressed, responsible agencies, and a funding option.[53] Others, such as the Alabama Plan, clearly delineated how each action contributed to the Mitigation Goals and Objectives, as well as information about priority levels and implementation planning. Other plans incorporated more narrative information, which can include anything ranging from rationale for the action, potential project approaches, connections with other ongoing programs, or more. The Wisconsin Plan, for example, included the action, supporting agencies, implementation status, background, and 2011 and 2016 update status for each action.

The following section elaborates on the different types of nature-based actions that were included in the plans.

[53] Kentucky Emergency Management, *2018 Kentucky Hazard Mitigation Plan* (2018), *available at* https://kyem.ky.gov/recovery/Pages/2018-Kentucky-Hazard-Mitigation-Plan-.aspx [hereinafter Kentucky Plan].

## Conservation/Preservation/Management

Conservation and preservation actions were those that were oriented towards protecting or managing natural areas or the mitigation and ecosystem services provided by a given ecosystem.

Many of these actions were directed towards a particular natural feature. The Kentucky Plan, for example, has an action to "Maintain Creek Banks."[54] Another example is Rhode Island's "Beach Ecosystem Preservation"[55] action, which aims to "preserve the dynamic nature of beaches and barriers in future management of these critical natural systems."[56] The Texas Plan included an action to "Restore and protect coastal wetlands and marshes. Coastal wetlands are transitional areas of vegetation and soils located between uplands and open marine water environments that are typically saturated or periodically inundated by tidal waters."[57]

Some plans explicitly tied the conservation of a habitat type to the ecosystem/mitigation services it provides. For example, a Minnesota action stated "[s]tream corridor protection projects and restoration and soil erosion control projects will be used to prevent or reduce risks and increase the protection of natural resources from flooding."[58]

Others, however, focused on the ecosystem services provided by a given feature and the importance of protecting those features from the impacts hazards pose, including Washington's action to "[r]educe the Conversion of Ecologically Important Lands for Development."[59] Other actions explicitly noted that the intention of the nature-based action was to reduce hazards and improve ecological outcomes. For example, one of Wyoming's actions was "[p]romote utilizing natural systems protections to protect and restore natural floodplain functions, such as stream restoration, forest management, conservation easements, and wetland preservation."[60]

## Restoration

A number of mitigation actions were oriented towards restoring the natural mitigation functions served by an ecosystem feature, usually wetlands, streambanks, floodplains, beaches, etc. Some of these, such as Texas's action to "[r]estore and protect coastal wetlands and marshes"[61] were brief and directed

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[54] Kentucky Plan, p Ms38.
[55] Rhode Island Emergency Management Agency, *State of Rhode Island State Hazard Mitigation Plan,* p 6-8 (2018), *available at* http://www.riema.ri.gov/forms-additional-resources/documents/Rhode%20Island%202019%20State%20Hazard%20Mitigation%20Plan-COMBINED_DRAFT.pdf [hereinafter Rhode Island Plan].
[56] Rhode Island Plan, p F-19.
[57] Texas Division of Emergency Management, *State of Texas Hazard Mitigation Plan,* p 304 (2018) *available at* http://tdem.wpengine.com/wp-content/uploads/2019/08/01-Texas-SHMP-FINAL-Adopted-10.17.2018.pdf [hereinafter Texas Plan].
[58] Minnesota Department of Public Safety & Division of Homeland Security and Emergency Management, *Minnesotta Hazard Mitigation* Plan, p 227 (2019), available *at* https://dps.mn.gov/divisions/hsem/hazard-mitigation/Documents/2019-mn-hmp-only.pdf [hereinafter Minnesota Plan].
[59] Washington Plan, p 236.
[60] Wyoming Office of Homeland Secutiry, *Wyoming State Mitigation Plan*, p 301 (2016), *available at* https://www.wsspc.org/wp-content/uploads/2019/07/Final_Wyoming-State-Mitigation-plan_012516.pdf [hereinafter Wyoming Plan].
[61] Texas Plan, p 304.

towards an ecosystem feature. Other similar actions include Maryland's "[c]oastal Restoration to Mitigate Hazards for Vulnerable Communities,"[62] and Mississippi's "[p]reserve, create, and restore natural systems to serve as natural mitigation functions."[63]

Others, such as Wisconsin's action to "[e]ncourage restoration of natural wetland functions,"[64] explicitly recognized the hazard mitigation potential of wetlands. In the background section on the action, the Wisconsin Plan stated "[w]etlands provide natural flood storage areas. Restoring the natural function of these areas can reduce the flooding potential of other areas in the watershed."[65] Iowa's action to "[i]mplement floodplain and streambank restoration/channel improvement projects that reduce peak flow during flood events,"[66] was explicit about the hazard mitigation value of restoration efforts. A similar Iowa action sought to "[m]inimize damage and also preserve/restore the functions of natural systems by establishing vegetated buffers and strategically-placed wetlands that capture runoff and drainage waters before they can negatively impact the surrounding environment."[67]

Other plans encouraged nature-based restoration using specific techniques. For example, Montana proposed to "[e]ncourage Natural Channel Design (NCD) techniques for stream restoration and bank restoration/stabilization projects to increase flood resiliency" and "projects that will increase stream length to regain natural function and reduce impact of flooding."[68] Restoration projects that explicitly encouraging hydrologic restoration or projects that highlight specific ecological outcomes where natural infrastructure is optimized are especially valuable.

### Green Infrastructure

Twelve state plans sought to incorporate green infrastructure[69] into urban spaces to address stormwater and flood (and other) hazards. Often, these actions called on the use of green infrastructure techniques to address certain challenges, such as using "[g]reen stormwater infrastructure"[70] to expand the capacity of traditional stormwater systems in the Rhode Island Plan or "[p]romote, develop Green

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[62] Maryland Plan, p 5-21.

[63] Mississippi Emergency Management Agency, *State of Mississippi Standard Mitigation Plan*, p 2-15 (2018), *available at* https://www.msema.org/wp-content/uploads/2020/10/State-of-Mississippi-2018-plan-update-with-Dam-Safety-FEMA-revisions-2020-07-15.pdf [hereinafter Mississippi Plan].

[64] Wisconsin Emergency Management, *2016 State of Wisconson Hazard Mitigation Plan*, p 3-34 (2016), *available at* https://dma.wi.gov/DMA/wem/mitigation/2016-hazard-mitigation-plan [hereinafter Wisconsin Plan].

[65] *Id.*

[66] Iowa Department of Homeland Security and Emergency Management, *2018 Iowa Hazard Mitigation Plan,* p 5-54 (2018), *available at* https://homelandsecurity.iowa.gov/disasters/hazard-mitigation/ [hereinafter Iowa Plan].

[67] Iowa Plan, 5-55.

[68] Montana Department of Military Affairs Disaster and Emergency Services, *2018 Update State of Montana Multi-Hazard Mitigation Plan Statewide Hazard Assessment,* p 5-13 (2018), *available at* https://drought.unl.edu/archive/Plans/GeneralHazard/State/MT_2018.pdf [hereinafter Montana Plan].

[69] As defined by FEMA, "[g]reen infrastructure is a sustainable approach to natural landscape preservation and storm water management that can be used for hazard mitigation activities as well as provide additional ecosystem benefits. Green infrastructure provides a framework and methodology for implementing flood risk reduction and drought mitigation actions in a manner that also incorporates ecosystem benefits and helps build a community's resilience to the impacts of climate change." https://www.fema.gov/media-library-data/1487161212568-3b313a4502545a8cf6846f36d53e1367/GI_Fact_Sheet_Feb2017_COMPLIANT.pdf

[70] Rhode Island Plan, p F-16.

Infrastructure/Low-Impact Development Projects"[71] to address flooding and landslides in the Kentucky Plan. The Arkansas Plan's action to "[u]se green mitigation techniques such as bio swales, rain gardens, and permeable pavers,"[72] provided examples of specific green infrastructure actions that could be employed.

The Iowa Plan provided specific green infrastructure techniques and their hazard mitigation benefits:

> Encourage and implement green infrastructure practices to create healthier urban environments and manage storm water in cities. Practices include mechanisms that prevent soil erosion or provide flood protection, habitat, and cleaner air and water (riparian forest buffers, infiltration including bioswales, wet detention systems, storm water wetlands, vegetated swales, permeable pavement, and green roofs).[73]

In addition to addressing the mitigation benefits of green infrastructure strategies, some actions included the broader ecosystem benefits they confer. The Minnesota Plan, for example, sought to use green infrastructure to mitigate the environmental drivers of natural hazards they experience: "Reduce Urban Heat Island Effect. Increase tree plantings around buildings to shade parking lots and along public rights-of-way. Encourage installation of green roofs and cool roofing products that reflect sunlight and heat away from a building."[74]

Finally, some plans proposed actions that incorporated both green and gray infrastructure. The Utah Plan included an action to "[c]onstruct debris basins, flood retention ponds, bioswales & energy flow dissipaters in an effort to control the flow and release of flood waters."[75] Other actions mention green infrastructure as an example of a strategy that could be used to implement a particular action. The Indiana Plan, for example, includes an action to "[r]etrofit state facilities to provide adequate capabilities in the event of disasters … [and] include green infrastructure to reduce unnecessary strain on water resources."[76]

Some states have proposed actions that seek to determine how green infrastructure might best be implemented in their state. Maryland, for example, has proposed to "[i]ncrease opportunities for communication about adaptation planning in Maryland, facilitate the exchange of ideas between Chesapeake Bay watershed partners, and pilot green/grey infrastructure to prepare for and respond to climate impacts to vulnerable populations."[77] Additional actions that seek to increase technical capacity around green infrastructure will be further discussed in the section on Technical and Information actions.

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[71] Kentucky Plan, p MS 37.
[72] Arkansas Division of Emergency Management, *State of Arkansas All-Hazards Mitigation Plan*, p 6-5 (2018), *available at* https://www.dps.arkansas.gov/emergency-management/adem/plan-prepare/hazard-mitigation/ [hereinafter Arkansas Plan].
[73] Iowa Plan, p 5-54.
[74] Minnesota Plan, p 231.
[75] Utah Division of Emergency Management, *State of Utah Hazard Mitigation Plan*, p 380 (2019), *available at* https://hazards.utah.gov/state-of-utah-hazard-mitigation-plan/ [hereinafter Utah Plan].
[76] Indiana Department of Homeland Security, *2019 State of Indiana Standard Multi-Hazard Mitigation Plan,* p 250 (2019), *available at* https://www.in.gov/dhs/files/Indiana-State-Mitigation-Plan-2019-Optimized.pdf [hereinafter Indiana Plan].
[77] Maryland Plan, p 5-25.

## Land Use

Various plans sought to address risks to communities through land use plans or through zoning, growth management guidelines, or other land use regulations.

Various regulatory actions sought to improve or establish new zoning requirements that would encourage conservation and nature-based actions. Some of these targeted development in vulnerable areas, such as New Hampshire's action that recommended "a comprehensive planning and zoning policy such as development setbacks and limits on density and infrastructure in coastal and transitional zones to consider vulnerability to sea level rise and saltwater intrusion."[78] Others, such as Delaware's action to "[e]ncourage greenways 'zoning' along river corridors"[79] to address flooding, referred more directly to nature-based strategies. Georgia included an action seeking to improve implementation of such ordinances: "Minimize damage to natural resources through the use of and compliance with greenspace, stream buffers, zoning ordinances as actions to protect Georgia communities."[80]

Most plans included at least one acquisition-related action.[81] While these may be helpful in preserving open space, we only included actions in our analysis that were explicit about converting the land to open space. For example, the Iowa plan proposed to "[a]cquire more flood prone properties (with priority for repetitive loss and SRL [Severe Repetitive Loss] properties) and convert to open space/green space; or elevate to or at least one foot above base flood elevation."[82]

## Funding and Programmatic Actions

Funding and Programmatic actions are those that seek to create or expand state or local preservation, restoration, or green infrastructure programs; develop or enhance of state or local funding programs; or develop implementation plans related to nature-based strategies.

Some actions proposed to improve initiatives through existing programs that would encourage green infrastructure or nature-based strategies include Washington's Voluntary Stewardship Program, which "provides an alternative approach for counties to address [the] state's Growth Management Act requirements through ecological protection like wetlands/other areas deemed critical,"[83] and

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[78] New Hampshire Homeland Security Emergency Management, *State of New Hampshire Multi-Hazard Mitigation Plan,* p 244 (2018), *available at* https://prd.blogs.nh.gov/dos/hsem/wp-content/uploads/2015/11/State-of-New-Hampshire-Multi-Hazard-Mitigation-Plan-Update-2018_FINAL.pdf [hereinafter New Hampshire Plan].

[79] Delaware Emergency Management Agency, *State of Delaware All-Hazard Mitigation Plan,* p 6.2-7 (2018), *available at* https://www.dema.delaware.gov/contentFolder/pdfs/HazardMitigationPlan.pdf [hereinafter Delaware Plan].

[80] Georgia Emergency Management and Homeland Security Agency (GEMA/HS), *Georgia Hazard Mitigation Strategy*, p 137 (2019), *available at* https://gema.georgia.gov/document/publication/2019-georgia-hazard-mitigation-strategypdf/download [hereinafter Georgia Plan].

[81] Floodplain buyouts, or the voluntary acquisition of flood-damaged property, are intended to mitigate flood damage by moving people and structures out of harm's way. Buyouts can be completed under federal, state, and sometimes local programs, but the largest source of funding is FEMA's Hazard Mitigation Grant Program (HMGP). Once structures are removed and the land is graded, acquired properties must be dedicated to "open space." Deed restrictions that effectively mitigate future risk of structural damage must be attached to the property title.

[82] Iowa Plan, p. 5-49.

[83] Washington Plan, p 236; Washington Plan, p 11 (The Growth Management Act (GMA) of 1990 requires all cities, towns and counties to identify and protect critical areas, such as frequently flooded areas and geologically

Wisconsin's proposal to "give extra points to communities applying for DNR Stewardship programs if their proposal includes mitigation elements (including removing floodplain from development)."[84] Similarly, the New Hampshire Plan included an action to "[c]ontinue the development of local and regional river corridor stewardship programs such as the Rivers Management and Protection Program."[85]

A number of actions were centered around funding programs. Some sought to facilitate funding opportunities, such as Pennsylvania's action to "[i]dentify cooperative funding opportunities for natural system protection projects."[86] Others endorsed implementation of nature-oriented projects, such as Wisconsin's action to "[i]mplement the Municipal Flood Control and Riparian Restoration (MFC) grant program."[87] Some of these actions simply described providing funding for specific actions. For example, California's action to "[p]rovide funding to local agencies in the Sacramento San Joaquin for levee maintenance and improvement and for habitat mitigation and enhancement."[88]

The Vermont Plan provides examples of actions that also describe how the state will support such efforts and ensure that they are environmentally sound. Its plan included actions to "[e]stablish a statewide conservation and buyout program" and to "[c]reate a dedicated State fund to support the purchase or local match of hazard-prone properties and the purchase of easements to conserve river corridors, floodplains, and wetlands identified as key flood attenuation areas."[89] Similarly, one of Vermont's actions tied the nature-based action to a particular hazard and its impacts: "Expand use of USDA conservation programs to plant riparian buffers and flood chute grassed waterways to reduce future flood damage to farm fields, attenuate flood-borne sediment and debris, and reduce downstream flooding."[90]

Some plans include actions related to climate change. New Hampshire's action to "[p]romote funding and resources for land acquisition, conservation planning, land management programs, and land stewardship in areas at risk of loss or degradation due to sea level rise" focused on the impacts associated with sea-level rise.[91] Wisconsin included an action to "[i]ncorporate Climate Resilient Mitigation Activities (CRMAs) as defined by FEMA (including Aquifer Storage and Recovery; Floodplain and Stream Restoration; Flood Diversion and Storage; and Green Infrastructure) into WEM's scoring

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hazardous areas, and for the fastest-growing counties (and their cities) to develop comprehensive land use plans to limit growth to identified urban growth areas (RCW 36.70A)).

[84] Wisconsin Plan, pp 3-32, 135.

[85] New Hampshire Plan, p 246.

[86] Pennsylvania Emergency Management Agency, *Commonwealth of Pennsylvania 2018 State Hazard Mitigation Plan,* p 735 (Oct. 2018), *available at* https://pahmp.com/wp-content/uploads/2018/10/PA-2018-Approved-HMP.pdf [hereinafter Pennsylvania Plan].

[87] According to the Background for this action, "Grants are available biennially, typically in the spring of even years, for projects that reduce flood risk. Projects shall minimize harm to existing beneficial functions of water bodies and wetlands, maintain natural aquatic and riparian environments, use stormwater detention and retention structures and natural storage to the greatest extent possible, and provide opportunities for public access to water bodies and to the floodplain." Currently the main focus of the program is supporting the non-federal match needed for FEMA buyouts. Wisconsin Plan.

[88] California Plan, Appendix C-23.

[89] Vermont Division of Emergency Management, *2018 State Hazard Mitigation Plan,* p 149 (Nov. 2018), *available at* https://vem.vermont.gov/plans/SHMP [hereinafter Vermont Plan].

[90] *Id.*

[91] New Hampshire Plan, p 241.

system for preapplications,"[92] noting in the action background that "[c]limate resilience is a state and national priority. FEMA has identified several new project types (CRMAs) that are eligible for funding under the HMA grant programs.[93] BCA guidance for these new project types has also been released. To show the importance of these types of projects, WEM [Wisconsin Emergency Management] will adjust the scoring for the pre-applications for the HMA grant programs to include points for CRMAs."

### Policy and Law Strategies

These actions mainly call upon different agencies to make changes to policies and regulations that would encourage or facilitate conservation or nature-based actions. These include promulgating wetland regulations, ensuring enforcement of policies, and integrating protection policies into existing plans.

Some actions addressed developing or modifying state or local regulations. The Alabama Plan included an action to "[d]evelop regulations that preserve and rehabilitate natural systems to serve natural hazard mitigation functions (i.e., floodplains, wetlands, watersheds, and urban interface areas)."[94] Massachusetts had an action to "[p]romulgate wetlands regulations to establish performance standards for work in land subject to coastal storm flowage."[95]

A different type of policy and law action aimed to integrate policies into other planning efforts. The Minnesota Plan, for example, had an action to "[r]equire incorporation of water-sensitive infrastructure – such as protection of natural areas, development of green infrastructure, and minimization of impervious areas to treat both water quality and quantity – in all comprehensive plans and watershed plans."[96] A couple of plans included actions related to enforcement. For example, the Wisconsin Plan stated, "[p]rovide workshops and distribute informational materials to improve understanding and enforcement of floodplain, coastal, shoreline, and wetland regulations, including mitigation techniques."[97]

### Technical and Information Actions

An important set of actions can orient states towards achieving higher technical capacity and know-how with respect to conservation and nature-based solutions. Technical and information actions include those related to studies, modeling, and development of tools (e.g., decision support tools). Sometimes these actions were related to better understanding risk and other times they included actions to identify future projects that would address identified risk.

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[92] Wisconsin Plan, p 3-68.
[93] "Climate Resilient Mitigation Activities including green infrastructure methods, expanded ecosystem service benefits, and three flood reduction and drought mitigation activities: Aquifer Storage and Recovery (ASR), Floodplain and Stream Restoration (FSR), and Flood Diversion and Storage (FDS)." FEMA, *Floodplain and Stream Restoration Fact Sheet* (2015), *available at* https://www.epa.gov/sites/production/files/2016-04/documents/fema_floodplain_stream_restoration_fact_sheet-sept_2015.pdf
[94] Alabama Plan, p 339.
[95] Massachusetts Plan, p 7-26.
[96] Minnesota Plan, p 226.
[97] Wisconsin Plan, p 3-35.

A number of plans included actions related to conducting studies aimed at identifying future projects. For example, the Connecticut Plan included an action to "[i]dentify and map the locations of headwater, main stem and coastal dams, culverts, bridges, and other structures or land modifications that contribute to flood damage and act as barriers to habitat connectivity, and assess the feasibility of removal or modification of these structures."[98] The Illinois Plan included an action to "[w]ork in developing and maintaining a database on all protected lands, identifying possible partners in the acquisition and maintenance of hazard prone lands contiguous to protected lands."[99]

Two plans discussed the development of decision-support tools. New York called for "[i]ntegrating SLAMM [Sea Level Affecting Marshes Model] results and stakeholder priorities to define marsh adaptation strategies: Building on the previous SLAMM project, this project will better incorporate roads and infrastructure into the analysis, better visualize marsh migration pathways, and develop a decision-support tool that will assist decision makers in planning adaptation strategies for marsh conservation and coastal community resiliency."[100] The Massachusetts Plan included an action to "[u]pdate and share a dam removal decision support tool that directly incorporates new climate change projections, climate adaptation benefits and helps municipalities and others prioritize dams for removal."[101]

Massachusetts also had a number of species-related actions, including "valuation of climate change impacts on common species,"[102] "[u]pdates to BioMap2" (identifies areas where conservation efforts should be focused in order to protect plant and wildlife biodiversity in Massachusetts),[103] and "[i]dentification of areas with high native aquatic biodiversity to help prioritize aquatic adaptation actions as the climate changes."[104]

Other plans included actions related to gathering specific data or models. For example, the Massachusetts Plan included an action to "[u]pdate precipitation data used by wetlands program."[105] The Vermont Plan included an action to "[d]evelop hydraulic and stream power models for a range of flood frequencies to analyze and define valley areas supporting essential floodplains and river corridor functions that would increase the storage of flood flows, sediments, and nutrients."[106] Several plans mentioned mapping studies or development of GIS layers. For example, the New Hampshire Plan included the action to "[c]ontinue to develop and maintain GIS layers as a multi-agency collaborative effort to capture data."[107]

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[98] Connecticut State Division of Emergency Management and Homeland Security, *Connecticut Hazard Mitigation Plan*, p 470 (2019) https://portal.ct.gov/-/media/DEMHS/_docs/Plans-and-Publications/EHSP0023--NaturalHazardMitPlan.pdf [hereinafter Connecticut Plan].

[99] Illinois Emergency Management Agency, *2018 Illinois Natural Hazard Mitigation Plan*, p. IV-41 *(*2018), *available at* https://www2.illinois.gov/iema/Mitigation/documents/Plan_IllMitigationPlan.pdf [hereinafter Illinois Plan].

[100] New York Plan.

[101] Massachusetts Plan, p 7-18.

[102] Massachusetts Plan, p 7-31.

[103] *Id.*

[104] Massachusetts Plan, p 7-50.

[105] Massachusetts Plan, p 7-26.

[106] Vermont Plan, p 148.

[107] New Hampshire Plan, p 243.

## Education and Awareness

Education and awareness actions included those focused on development of guidance, conducting community outreach, and creating technical bulletins and training programs aimed at enhancing understanding of ecosystem services and non-structural mitigation measures.

An important type of capacity-building action sought to incorporate natural infrastructure or conservation into other strategies or to create new plans or policies. Some of these sought to provide more information for practitioners on natural infrastructure, such as Wisconsin's proposal to "[p]rovide workshops and distribute informational materials to improve understanding and enforcement of floodplain, shoreline, coastal, and wetland regulations."[108] Similarly, an Alabama action sought to "[c]reate technical bulletin that educates local floodplain managers to account for and incorporate wetland protection and mitigation sites into the planning process when preparing new studies for watercourses."[109] In another example, Colorado's Plan had an action to "[e]nhance the natural and beneficial functions of floodplains by promoting an increased awareness of stream ecosystem function and its benefits to flood hazard mitigation."[110]

Some of these actions were oriented towards increasing knowledge among residents and community members. The Indiana Plan included an action to ""[d]evelop an outreach program to educate communities on green infrastructure and provide opportunities for them to seek additional training."[111]

## Agency Coordination

We found a few actions that specifically encouraged or promoted coordination among state agencies or state and local agencies. For example, "coordinate the activities of state agencies to improve air and water quality; protect natural resources and agricultural lands"[112] in California and "promote collective action between state agencies to address the stability of natural systems in the built environment by providing sufficient water storage, reducing volume, slowing velocity, and promoting practices to stabilize soils and maintain the diversity of native plant communities" in Minnesota.[113] The Massachusetts Plan included an action to promote coordination to achieve climate change adaption—"review habitat management, land stewardship, coastal zone management, agricultural and invasive species programs and policies to develop strategies that promote coordination among agencies and support climate change adaptation and mitigation goals."[114]

## Partnerships

Some mitigation actions also supported synergies and opportunities for integration with other groups and/or plans. For example, several plans included actions to build partnerships for conservation, including "[r]ecruit conservancy agencies to purchase and maintain key undeveloped land in coastal

[108] Wisconsin Plan, p 3-35.
[109] Alabama Plan, p 327.
[110] Colorado Plan, 5-26.
[111] Indiana Plan, p 246.
[112] California Plan, Appendix C-8.
[113] Minnesota Plan, p 225.
[114] Massachusetts Plan, p 7-55.

areas"[115] in Texas, to "[w]ork with land conservation organizations to include river corridor and floodplain protection provisions, and/or headwater storage in conservation easements"[116] in Vermont, and "[s]upport the Hawai'i Association of Watershed Partnerships" in Hawai'i.[117]

The Tennessee Plan included an action to bring in non-profit organizations into the plan development itself: "Develop a strategy for empowering non-profit groups such as environment or watershed protection organizations to support local hazard mitigation planning by October 2021."[118] This is a good example of how states could support and build the capacity of natural resource organizations to participate in the planning process; thereby increasing the opportunities for informed nature-based strategies to be included in future plans.

### Including Detailed or Location-Specific Actions

There is some tension over the degree of specificity plans should use when detailing their proposed actions.[119] On one hand, greater detail may facilitate the process of getting grant funding for projects that closely match the action in question, and signals that more thought and preparation has gone into the development of the idea. On the other hand, more general actions provide some flexibility to take advantage of project opportunities as they arise (especially for state plans). The majority of the state plans did not include any geographically specific actions. However, we did identify a few plans that included some actions for specific projects. Further, as they are more directly tied to community needs and goals, local plans may provide a better opportunity for integrating more specificity in projects and thus may provide an important opportunity for integrating restoration goals and actions.[120]

The New York Plan provided an interesting example as to how the mitigation strategy could incorporate actions that were highly geographically specific while still allowing for flexibility. The Plan added some geographic-specific actions in addition to some related broader actions. For example, it had both an action on "Wetlands restoration: Include wetlands restoration as part of waterfront development

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[115] Texas Plan, p 296.

[116] Vermont Plan, p 147.

[117] Hawai'i Emergency Management Agency, *State of Hawai'i 2018 Hazard Mitigation Plan*, p. 6-8 (2018), *available at* https://dod.hawaii.gov/hiema/files/2018/11/State-of-Hawaii-2018-Mitigation-Plan.pdf [hereinafter Hawai'i Plan].

[118] Tennessee Emergency Management Agency, *State of Tennessee Hazard Mitigation Plan*, p.13 (2018), *available at* https://www.tn.gov/content/dam/tn/tema/documents/hazard-mitigation-plan/Tennessee%20Hazard%20Mitigation%20Plan%202018%20FINAL.pdf [hereinafter Tennessee Plan].

[119] In California, for example, local mitigation plans include only broad descriptions of potential mitigation actions that are not yet fully flushed out projects due to the possibility of triggering a California Environmental Quality Act (CEQA) environmental review on the plan. The CEQA review can occur during the adoption process of a final local hazard mitigation plan if the local jurisdiction governing board feels there is anything "actionable" in the plan, specifically mitigation actions. A CEQA review could hold up the LHMP approval. Personal communication with California Governor's Office of Emergency Services.

[120] For example, the Nebraska state plan focuses primarily on reducing risk from all hazards through supporting implementation of mitigation actions identified in Local Hazard Mitigation Plans. The 2021 plan included only 5 state level mitigation actions that address the 2019 flooding event. Nebraska Emergency Management Agency, *2021 Nebraska State Hazard Mitigation Plan* (2021), *available at* https://nema.nebraska.gov/sites/nema.nebraska.gov/files/doc/hazmitplan2021.pdf. ELI examined 119 local hazard mitigation plans to identify examples of how states are including natural infrastructure or natural resource protection or restoration as mitigation goals and actions. We found over 275 relevant actions. See our report at https://www.eli.org/land-biodiversity/hazard-mitigation-planning

projects to comply with aesthetic permitting or stormwater management requirements," and an action on "Flushing Airport Wetlands Restoration: Implement Flushing Airport Wetlands Mitigation Project in College Point, Queens."[121] The Plan is innovative and unique in that the state has published it in the form of a website rather than a document, so that it is more user-friendly and can be updated in between the 5-year validity intervals.[122]

## *Tribal Hazard Mitigation Plans*

In recognition of tribal sovereignty and the unique needs of Indian Tribal governments, FEMA established requirements for Tribal Hazard Mitigation Plans separate from State and Local Mitigation Plans.[123] Prior to the 2009 final rule, tribal governments could prepare a State-level Mitigation Plan (if they intended on applying directly for FEMA funds as a grantee), or a Local-level Mitigation Plan (if they intended on applying for FEMA funds through the State as a subgrantee). Final Tribal Mitigation Planning Guidelines became effective March 2010.[124] According to FEMA's website, 222 tribal governments across the country have current tribal hazard mitigation plans.[125]

Tribal planning requirements are similar to the state requirements, but with some differences.[126] Tribal plans must document the planning process, "including how it was prepared, who was involved in the process, and how the public was involved." This process must include an opportunity for public comment, **"**including a description of how the Indian tribal government defined 'public.'"[127] In addition, the planning process must provide an opportunity for "neighboring communities, tribal and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia, and other private and nonprofit interests to be involved in the planning process." The process must also review and incorporate "existing plans, studies, and reports," and "be integrated to the extent possible with other ongoing tribal planning efforts as well as other FEMA programs and initiatives."[128]

FEMA regulations recognize the need for Tribal governments to have opportunity to define "public" and determine how to best involve tribal members and stakeholders. The planning process, including how public meetings are announced and facilitated, may be different for Indian Tribal governments. A successful tribal planning process must be inclusive and work within the traditions, culture, and methods most appropriate for the Indian Tribal government. In the end, the process must ensure that

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[121] New York Plan.
[122] Colin Wood, *Why New York City spend a year converting its 500-page hazard plan into a website,* State Scoop (May 22, 2019) https://statescoop.com/why-new-york-city-spent-a-year-converting-its-500-page-hazard-plan-into-a-website/.
[123] Mitigation Planning 44 CFR 201 at 72 Fed. Reg. 61720 (interim rule in October 2007 established the tribal mitigation plan, and 2009 final rule clarified tribal planning requirements).
[124] FEMA, *Tribal Multi-Hazard Mitigation Planning Guidance* (March 2010), *available at* https://emilms.fema.gov/IS318/assets/tribal_planning_guidance_may2010.pdf.
[125] FEMA, *Hazard Mitigation Plan Status* (Feb. 24, 2021), *available at* https://www.fema.gov/emergency-managers/risk-management/hazard-mitigation-planning/status.
[126] Tribal Mitigation Plans 44 CFR § 201.7; FEMA, *Tribal Mitigation Planning Handbook* (May 2019), *available at* https://www.fema.gov/sites/default/files/2020-06/fema-tribal-planning-handbook_05-2019.pdf.
[127] FEMA, *Tribal Multi-Hazard Mitigation Planning Guidance* (March 2010), *available at* https://emilms.fema.gov/IS318/assets/tribal_planning_guidance_may2010.pdf.
[128] Tribal Mitigation Plans 44 CFR § 201.7.

participants understand the risks and vulnerabilities addressed in the plan and that goals, priorities, and mitigation actions reflect Tribal values.

Tribal governments may seek opportunities to honor traditional beliefs and cultural and natural resources in the planning process and in the plan itself, in a way state or local planners may not. The Lac du Flambeau Plan, for example, opens with a statement of the importance of natural resources to the people of Lac du Flambeau: "For the Lac du Flambeau Tribe, water is part of their daily existence. About half of their reservation is open water or wetlands and water nourishes both the people and the natural resources on the reservation. For the Ojibwe people, natural resources are cultural resources and water plays a vital role in ensuring that the community continues to thrive with a changing climate."[129] This introduction sets the tone for the rest of the plan and establishes resource stewardship as a critical principle guiding the rest of the plan development.

Tribal mitigation strategy requirements are similar to state hazard mitigation plans. Tribal plans must have a "description of mitigation goals," "a section that identifies and analyzes a comprehensive range of specific mitigation actions and projects," an action plan describing how the mitigation actions identified will be "prioritized, implemented, and administered," a discussion on tribal capabilities, and a section on "current and potential sources of Federal, tribal, or private funding to implement mitigation activities."[130] However, the land within the Tribe's planning area may contain natural and cultural resources and sacred sites or other land of importance to the Tribe's culture, history and values that must be taken into account when developing mitigation goals and strategies. Further, Tribal plans may include goals and objectives that have a particular focus on the wellbeing of the Tribal community.

In a review of a small set of tribal mitigation plans, we found hazard mitigation goals and strategies that were similar to the kinds of goals and actions we found in state hazard mitigation plans. For example, the Lac du Flambeau Tribe Hazard Mitigation Plan (Wisconsin) include a goal specifically focused on the environment, recognizing the wellbeing of the natural environment as well as the community.

- Goal 2: The goal of these hazard mitigations actions is to reduce the risk and extent of loss of critical natural resources (plant and animal species) and the spread of invasive species on individuals, families, and the community as a whole. Implementation of these actions will help ensure the health and wellness of the community, as well as decrease the incidence of other man-made hazards.
- Goal 9: The goal of these hazard mitigations actions is to protect people and the natural environment from adverse effects of hazardous materials incident.[131]

The Lac du Flambeau plan also listed twelve nature-based hazard mitigation strategies across a number of the categories we describe above. The actions include:

- Conservation/Preservation/Management: For example, "Work with Federal partners to preserve or restore wetlands ecosystems in buffer zones along rivers and lakes for flood control and

[129] Emergency Management Department for the Lac du Flambeau Tribe, *Lac du Flambeau Tribe Hazard Mitigation Plan,* p 9 (April 2019), *available at* https://ldftribe.com/files/Lac%20du%20Flambeau%20Tribe%20All%20Hazards%20Mitigation%20Plan%20Draft%20for%20Public%20Comment.pdf [hereinafter Lac du Flambeau Plan].
[130] Tribal Mitigation Plans 44 CFR § 201.7.
[131] Lac du Flambeau Plan. p. 79, 87.

water quality management. Re-assess buffer zone setbacks" and "Protect and mitigate existing impacts to the forests along the wetlands and riparian areas, and within the wetlands system."[132]

- Green Infrastructure: For example, "Invest in and utilize green infrastructure to help control runoff, capture stormwater, and reduce water demand. Some common green infrastructure practices include bioretention areas (rain gardens), low impact development methods, green roofs, swales (depressions to capture water) and the use of vegetation or pervious materials instead of impervious surfaces."[133]
- Policy and Law: For example, "Enhance existing ordinances which manage riparian buffers along rivers, streams, lakes and other water bodies,"[134] and "[i]ntegrate policies into existing plans that protect, maintain, and enhance tree canopy in urban settings to reduce heat."[135]
- Education and Awareness: For example, "Expand opportunities to engage the community in nature preservation projects and efforts."[136]
- Funding and Programmatic: For example, "Expand programs working to protect sensitive land from development using land acquisition through purchase."[137]
- Partnerships: For example, "Expand work with utility companies to reduce sediment and nutrient inputs into source water bodies, regulate runoff (construction site) and streamflow, buffer against flooding (e.g., wetlands)."[138]

The Oneida Nation Pre-Disaster Mitigation Plan (Wisconsin) includes a goal that mentions protecting the environment in addition to protecting other tribal aspects as well as a goal that specifically focuses on natural infrastructure/nature-based solutions:

- Goal 1: Minimize human, economic, and environmental disruption from natural hazards
- Goal 5: Promote and enhance the use of natural resource protection measures as a means to reduce the impact if natural hazards on people and property.[139]

The Oneida plan also includes one nature-based mitigation strategy.

- Green Infrastructure: "Maintain a stormwater management plan that includes such remediation techniques as surface detention basins, in-street detention units, and rain gardens."[140]

The Klamath Tribes Hazard Mitigation Plan (Washington) includes several relevant goals and objectives that recognizes the wellbeing of the natural environment as well as the community. The Plan includes a goal that mentions protecting the environment in addition to protecting other tribal aspects as well as a goal that specifically focuses on natural infrastructure/nature-based solutions.

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[132] Lac du Flambeau Plan. p. 81.
[133] *Id*.
[134] Lac du Flambeau Plan, p 84.
[135] Lac du Flambeau Plan, p 89.
[136] Lac du Flambeau Plan, p 79.
[137] Lac du Flambeau Plan, p 84.
[138] Lac du Flambeau Plan, p 81.
[139] Oneida Nation, *Oneida Nation 2015-2020 Pre-Disaster Mitigation Plan*, p 61 *(2015)*, *available at* https://baylakerpc.org/application/files/7915/2830/1159/oneida_nation_haz_plan_update_final.pdf [hereinafter Oneida Plan].
[140] Oneida Plan, Section 4.

- Goal 1—Reduce or prevent future hazard-related injuries and losses of life, property damage, and environmental impact.
- Goal 3—Encourage the development and implementation of long-term, cost-effective and environmentally sound mitigation projects.
- Objective 7 – Establish a partnership among the Tribal Government and Tribal business leaders with surrounding area government and business community to improve and implement methods to protect life, property, and the environment, while preserving the cultural integrity of the Klamath Tribes.
- Objective 12 - Encourage hazard mitigation measures that result in the least adverse effect on the natural environment and that use natural processes, while preserving and maintaining the cultural elements of the Klamath Tribes.[141]

The Plan also includes three nature-based actions.

- Policy and Law: "Consider planting standards in wildland buffer areas to require fire-resistant plants with loose branching habits, non-resinous woody material, high moisture content leaves and limited seasonal accumulation of dead vegetation."[142]
- Partnerships: "Continue working with Oregon Watershed Enhancement Board for various watershed improvement activities."[143]
- Funding and Programmatic: "Continue working on the Legacy Road Reconstruction program for projects such as: decommissioning/vacating of roadways of high negative impact to natural resources; road upgrades; surface drainage improvements; road stabilization, and culvert replacement for fish passage."[144]

A more thorough review of tribal plans would be valuable for Tribal planners, as well as state and local planners.

## *Enabling Conditions*

As we detail above, state hazard mitigation plans are incorporating natural systems protection and nature-based solutions as goals or explicit hazard reduction strategies in a wide range of ways. Most, but not all, plans include goals/objectives that are related to impacts to the environment from natural hazards or use nature-based strategies to address the state's risk. Some plans have gone much further and have identified a larger number of nature-based actions. Whether and how these strategies are implemented in practice and their effectiveness at mitigating risk were not a focus of this study but would be an important follow-up effort.

The state hazard mitigation plan development process and planning elements other than the goals, objectives, and actions (e.g., risk assessment and capability sections) can serve as opportunities to stimulate states to evaluate the role of natural systems in risk and to identify and use nature-based

[141] Klamath Tribal staff, planners, and members, *Klamath Tribes Hazard Mitigation Plan*, p 19-1-2 (2017), *available at* https://klamathtribes.org/wp-content/uploads/2019/10/HAZARD-MITIGATION-PLAN-Draft.pdf [hereinafter Klamath Plan].
[142] Klamath Plan, p 19-9.
[143] Klamath Plan, p 19-10.
[144] *Id.*

strategies. Other natural resource focused state- or local-level plans, programs, and partners, if brought into the planning process, can provide a wealth of information that can inform the risk and vulnerability assessments and can identify actions that could help the state achieve its hazard mitigation goals. These other analyses and programs may serve as opportunities to stimulate the inclusion of nature-based strategies for states that have not yet tapped into these opportunities, or that have only begun to do so. We discuss some of these enabling conditions and how they have played a role in various plans below.

### Risk assessment

The risk assessment section of the state hazard mitigation plan characterizes the type and location of hazards and the state's vulnerability to the hazards "based on estimates provided in local risk assessments as well as the State risk assessment."[145] The risk assessment includes an analysis of losses to vulnerable structures and estimations of dollar losses to state owned and operated facilities. Plans generally include a section or profile for each of the hazards that the state has identified for analysis. This analysis provides the factual basis for the activities that are then included in the hazard mitigation strategy.[146] A robust assessment of how natural hazards impact the environment or how loss of natural infrastructure influences risk could help planners to better understand the habitats and natural areas that are at risk and the services that might be lost if these habitats are lost. It can also identify the location or types of natural infrastructure projects that may help the state to address their risk.[147]

We reviewed the risk assessment sections of the state plans to determine how they address risk to natural environments/ecosystems and/or how the loss of these habitats contributes to increased risk from hazards (See Appendix 4). Many states (14) have no consistent discussion of natural systems or the environment in the risk assessment or vulnerability analysis.[148] 35 states have some more consistent discussion of the impacts to natural resources. For many of these plans, the discussion is limited to a summary table for each hazard that generally includes a very brief discussion of impacts of the hazard to the environment among a list of other components (e.g., health and safety public; health and safety of responders; continuity of operations; property, facilities, and infrastructure; economic condition; and public confidence in jurisdiction's governance).[149]

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[145] Standard State Mitigation Plans 44 CFR § 201.4.

[146] *Id.*

[147] It is important to remember that dynamic natural habitats rely on natural processes (including seal level rise and episodic storm events) to help them function and persist into the future. However, when development or other activities prevent habitats from migrating inland with sea level rise or otherwise disrupt the natural processes that make them function, then natural hazards can become a problem for nature. Natural systems need to be able to respond to rising sea level and even episodic storms in order to be viable for further climate changes yet to come. Risk assessments need to take into account this dynamism and ability of natural systems to respond or adapt to changing conditions.

[148] We were unable to obtain the 2018 risk assessment for the state of Iowa.

[149] The categories examined are often those (or are similar to those) included in the Emergency Management Accreditation Program's (EMAP) standards on Hazard Identification, Risk Assessment and Consequence Analysis standard. The EMAP Standards by the Emergency Management Accreditation Program (EMAP) is designed as a tool for continuous improvement as part of a voluntary accreditation process for emergency management programs (https://www.emap.org/index.php/root/about-emap/57-draft-2016-emergency-management-standard/file). The Hazard Identification, Risk Assessment and Consequence Analysis includes responsibilities and activities associated with the identification of hazards and assessment of risks to persons, public and private property and structures. This includes conducting a consequence analysis for the hazards to consider the impact on the public; responders; continuity of operations including continued delivery of services; property, facilities, and,

A few states go into some more depth. California has an entire section on the natural environment under the section on state assets at risk. This includes a short section on ecosystems at risk. There is also a more in-depth assessment of effects on the natural environment in the profile on wildfire. In the New Jersey Plan there is a section on environmental impacts in most hazard profiles (e.g., the profiles on coastal erosion, dam and levee failure, drought, earthquake, hurricane and coastal storm, etc.). The individual sections go into some depth on impacts. The drought profile has more information on impacts to the environment, including habitats.

The Hawai'i Plan includes an exposure analysis (in the hazard profiles on climate change and sea level rise, chronic coastal flood, dam failure, earthquake, event-based flood, hurricane, landslide and rockfall, tsunami, volcanic hazards, and wildfire) or qualitative analysis (in the hazard profiles on drought, hazardous materials, health risks, and high wind storms) for environmental resources in each hazard protocol. The exposure analysis tables show the total extent and percent of total area of certain environmental resources located in the hazard areas. The environmental assets included are critical habitat, wetlands, and parks and reserves (and reefs) (see Table 4). The plan discusses the importance of these habitats and the impacts of their loss. For example, the loss of wetlands "could reduce the coast's ability to buffer impacts from storms and flooding" and "wetlands and coral reefs provide protection from rising sea levels and damaging wave action."[150]

### Table 4. Exposure Analysis Table for Environmental Resources Located in Sea-Level Rise Hazard Areas in Hawaii

| Environmental Asset | Total Square Miles of Asset | SLR-XA-3.2 Area | Percent (%) of Total Asset Area | 1%CFZ-3.2 Area | Percent (%) of Total Asset Area |
|---|---|---|---|---|---|
| Critical Habitat[a] | 915.2 | 1.6 | 0.2% | 2.2 | 0% |
| Wetlands | 260.0 | 15.7 | 6.1% | 31.1 | 12% |
| Parks and Reserves | 2,607.7 | 7.2 | 0.3% | 17.7 | 1% |
| **Total[b]** | **3,837.6** | **79.3** | **2.1%** | **105.7** | **2.8%** |

*Note: Hawai'i Emergency Management Agency, State of Hawai'i 2018 Hazard Mitigation Plan, Table 4.2-17, Environmental Resources Located in the Sea Level Rise Hazard Areas (2018), available at https://dod.hawaii.gov/hiema/files/2018/11/State-of-Hawaii-2018-Mitigation-Plan.pdf.*

The Massachusetts Plan includes Natural Resources and Environment as one the sectors assessed for each hazard in the risk assessment. The plan defines natural resources as "components of natural systems that exist without human involvement. For the purpose of this survey, key natural resource categories include forested ecosystems, aquatic ecosystems, coastal ecosystems, wetland ecosystems, and old field ecosystems."[151] Each hazard profile has a table that discusses each sector assessed, including natural resources and the environment. Each profile also has a more in-depth discussion of impacts to natural resources and the environment (some hazards have more discussion than others).

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infrastructure; the environment; the economic condition of the jurisdiction and public confidence in the jurisdiction's governance. Thirty-six states are accredited programs, not all of these states included consistent discussion of impacts to the environment or natural resources.

[150] Hawai'i Plan, p. 4-52.

[151] Massachusetts Plan, p 3-13.

For example, some sections of the risk assessment (e.g., precipitation-related flood, coastal flooding, and hurricanes and tropical storms) include a table that measures the amount of land in key natural areas vulnerable to 1% annual chance and 0.2% annual chance flood events, respectively, by county (see Table 5).[152] These habitat areas include those designated as Areas of Critical Environmental Concern,[153] BioMap2[154] Core Habitat,[155] and BioMap2 Critical Natural Landscapes. Critical Natural Landscapes are "intact landscapes in the state that are better able to support ecological processes and disturbance regimes and a wide array of species and habitats over a long time frame," providing functions such as "buffering uplands around coastal, wetland, and aquatic core habitats, maintaining connectivity among habitats, and enhancing ecological resilience."[156] These measures account for the level of risk to ecosystems as well as the hazard mitigation benefits they provide.

The Massachusetts Plan has the most extensive treatment of risk to critical ecosystems of any of the state hazard mitigation plans. It also has, by far, the most nature-based mitigation actions identified. In general, however, the degree to which the environment is addressed in the risk assessment of state plans does not strongly correlate with the number of actions included in the plan. Hawai'i, New Jersey, Idaho all go into some depth on impacts to the environment in the risk assessment/vulnerability analysis but are not among the states with the most actions. Therefore, there is an opportunity to better understand how the risk assessment could better set up planners to identify the kinds of natural infrastructure projects that may be most effective at addressing risk, and the locations to which the state should pay the most attention when contemplating these types of projects.

[152] Massachusetts Plan, p 4-36.

[153] Places in Massachusetts that have been designated by the EOEEA and that receive special recognition because of the quality, uniqueness, and significance of their natural and cultural resources. Massachusetts Department of Conservation & Recreation Office of Natural Resources, ACEC Program Overview, *at* *https://www.mass.gov/service-details/acec-program-overview*.

[154] BioMap2 is a Massachusetts framework for classifying ecosystems in order to guide strategic biodiversity conservation in the state. Massachusetts Natural Heritage & Endangered Species Program, *BioMap2: Conserving the Biodiversity of Massachusetts in a Changing World*, *at* https://www.mass.gov/service-details/biomap2-conserving-the-biodiversity-of-massachusetts-in-a-changing-world

[155] BioMap 2 Core Habitat data identify the specific areas needed to promote long-term persistence of Species of Concern, including species listed under the Massachusetts Endangered Species Act, and additional species identified in the State Wildlife Action Plan; exemplary natural communities; and intact ecosystems. Massachusetts Natural Heritage & Endangered Species Program, *BioMap2: Conserving the Biodiversity of Massachusetts in a Changing World*, *at* https://www.mass.gov/service-details/biomap2-conserving-the-biodiversity-of-massachusetts-in-a-changing-world

[156] Massachusetts Plan, p 4-112.

## Table 5: Nature Resource Exposure Table From the Massachusetts Plan

| Name | County | Total Acreage | 1 Percent Annual Chance Flood Event A Zone | | 0.2 Percent Annual Chance Flood Event X500 Zone | |
|---|---|---|---|---|---|---|
| | | | Acres | % of Total | Acres | % of Total |
| Aquatic Buffer | Barnstable | 15,910.8 | 2,310.9 | 14.5 | 3,990.4 | 25.1 |
| Aquatic Buffer | Berkshire | 54,738.6 | 20,313.4 | 37.1 | 1,013.9 | 1.9 |
| Aquatic Buffer | Bristol | 20,468.8 | 9,902.8 | 48.4 | 366.5 | 1.8 |
| Aquatic Buffer | Essex | 32,046.2 | 8,515.8 | 26.6 | 942.0 | 2.9 |
| Aquatic Buffer | Franklin | 48,769.1 | 112.4 | 0.2 | 0.1 | 0.0 |
| Aquatic Buffer | Hampden | 23,192.8 | 10,360.7 | 44.7 | 793.5 | 3.4 |
| Aquatic Buffer | Hampshire | 30,948.9 | 13,229.6 | 42.7 | 767.9 | 2.5 |
| Aquatic Buffer | Middlesex | 16,657.9 | 11,585.3 | 69.5 | 620.2 | 3.7 |
| Aquatic Buffer | Nantucket | 1,578.7 | 197.4 | 12.5 | 64.5 | 4.1 |
| Aquatic Buffer | Norfolk | 10,263.4 | 6,722.3 | 65.5 | 479.9 | 4.7 |
| Aquatic Buffer | Plymouth | 41,381.2 | 18,680.9 | 45.1 | 1,745.0 | 4.2 |
| Aquatic Buffer | Suffolk | 626.3 | 453.2 | 72.4 | 9.0 | 1.4 |
| Aquatic Buffer | Worcester | 60,793.8 | 32,802.1 | 54.0 | 1,526.9 | 2.5 |
| Coastal Adaptation Analysis | Barnstable | 20,054.7 | 14.5 | 0.1 | 34.2 | 0.2 |
| Coastal Adaptation Analysis | Bristol | 8,612.7 | 481.4 | 5.6 | 60.0 | 0.7 |
| Coastal Adaptation Analysis | Essex | 22,326.2 | 377.3 | 1.7 | 28.7 | 0.1 |
| Coastal Adaptation Analysis | Nantucket | 4,365.8 | 279.1 | 6.4 | 227.4 | 5.2 |
| Coastal Adaptation Analysis | Norfolk | 787.1 | 10.8 | 1.4 | 0.6 | 0.1 |
| Coastal Adaptation Analysis | Plymouth | 12,732.9 | 89.6 | 0.7 | 6.5 | 0.1 |
| Landscape Blocks | Barnstable | 82,481.2 | 1,224.2 | 1.5 | 1,457.9 | 1.8 |
| Landscape Blocks | Berkshire | 345,685.3 | 12,986.9 | 3.8 | 1,241.8 | 0.4 |
| Landscape Blocks | Bristol | 85,667.1 | 16,744.0 | 19.5 | 2,665.8 | 3.1 |
| Landscape Blocks | Essex | 41,937.3 | 4,011.7 | 9.6 | 1,320.6 | 3.1 |
| Landscape Blocks | Franklin | 221,827.3 | 135.7 | 0.1 | 0.1 | 0.0 |
| Landscape Blocks | Hampden | 136,833.0 | 6,503.0 | 4.8 | 961.6 | 0.7 |
| Landscape Blocks | Hampshire | 124,440.4 | 11,335.3 | 9.1 | 822.5 | 0.7 |
| Landscape Blocks | Middlesex | 36,866.4 | 3,626.2 | 9.8 | 1,410.9 | 3.8 |
| Landscape Blocks | Nantucket | 11,571.2 | 494.6 | 4.3 | 458.4 | 4.0 |
| Landscape Blocks | Norfolk | 8,250.4 | 521.0 | 6.3 | 751.2 | 9.1 |
| Landscape Blocks | Plymouth | 124,678.0 | 28,414.8 | 22.8 | 2,356.9 | 1.9 |
| Landscape Blocks | Worcester | 204,731.2 | 31,668.0 | 15.5 | 4,630.1 | 2.3 |

*Notes: The table indicates the amount of land in key natural areas vulnerable to 1% annual chance and 0.2% annual chance flood events, respectively, by county. Massachusetts Emergency Management Agency, Massachusetts State Hazard Mitigation and Climate Adaptation Plan, Table 4-11, Natural Resources Exposure — BioMap2 Critical Natural Landscape (2018), available at https://www.mass.gov/files/documents/2018/10/26/SHMCAP-September2018-Full-Plan-web.pdf.*

## Legal

In some cases, state law imposes requirements that may influence the integration of nature-based goals and objectives and identification of natural infrastructure actions and strategies in the state hazard mitigation plan. For example, California SB 379 requires that local jurisdictions review and update their general plan safety elements to address "climate adaptation and resiliency strategies applicable to that city or county."[157] The law requires "the update to include a set of goals, policies, and objectives based on a vulnerability assessment, identifying the risks that climate change poses to the local jurisdiction and the geographic areas at risk from climate change impacts, and specified information from federal, state, regional, and local agencies." This includes the "identification of natural infrastructure that may be used in adaptation projects, where feasible."[158] The law defines natural infrastructure as "the preservation or restoration of ecological systems, or utilization of engineered systems that use ecological processes, to increase resiliency to climate change, manage other environmental hazards, or both. This may include, but is not limited to, floodplain and wetlands restoration or preservation, combining levees with restored natural systems to reduce flood risk, and urban tree planting to mitigate high heat days."[159] The introduction to the state's mitigation goal to "protect the environment" indicates that this law was the driving force behind the development of the goal.

The Massachusetts hazard mitigation plan fulfills FEMA's requirement for a hazard mitigation plan as well as the requirements of the state's Executive Order 569. The Order requires that the Executive Office of Energy and Environmental Affairs (EOEEA) and the Executive Office of Public Safety and Security (EOPSS) "coordinate on efforts to strengthen the resilience of communities, prepare for the impacts of climate change, and proactively plan for and mitigate damage from extreme weather events, including publishing a climate adaptation plan."[160] The Order directs natural hazard resilience planning to wherever possible "employ strategies that conserve and sustainably employ the natural resources of the Commonwealth to enhance climate adaptation, build resilience, and mitigate climate change."[161] Natural resources, open spaces, and nature-based solutions provide multiple services that include resilience benefits, public health services, and contribute to environmental and restoration economies. The mitigation strategy section on Importance of Nature-Based Solutions in Hazard Mitigation and Climate Adaption cites Massachusetts Executive Order 569 as a basis for strong consideration of nature-based solutions over hard infrastructure solutions.[162] In 2018, the state passed a $2.4 billion Environmental Bond Bill that codified key components of the Executive Order.[163] The law emphasizes nature-based strategies and provides funding for investments in environmental protection projects.

It is possible that other states have other legal drivers that influenced the integration of nature-based mitigation strategies in the hazard mitigation plan (e.g., state natural resource laws, state hazard

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[157] California Senate Bill 379, Land use: general plan: safety element (2015), *available at* https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201520160SB379.
[158] *Id.*
[159] *Id.*
[160] Massachusetts Executive Order 569, *Establishing an Integrated Climate Change Strategy for the Commonwealth,* Governor Charlie Baker (Sep. 16, 2016), *available at* https://www.mass.gov/executive-orders/no-569-establishing-an-integrated-climate-change-strategy-for-the-commonwealth.
[161] *Id.*
[162] Massachusetts Plan, p 7-4.
[163] Massachusetts House No. 4835 An Act promoting climate change adaptation, environmental and natural resource protection, and investment in recreational assets and opportunity, 190th Congress (2018), *available at* https://malegislature.gov/Bills/190/H4835.

mitigation laws, etc.). Both of the examples we cite here – the California law and the Massachusetts executive order – are explicitly related to climate change adaptation efforts in the state. Hazard mitigation and climate adaptation address overlapping impacts and often employ the same actions and strategies. Indeed, the Massachusetts Plan is both the state hazard mitigation and climate adaptation plan. The plan is the "fully integrated, innovative, and actionable State Hazard Mitigation and Climate Adaptation Plan."[164] Due to their interagency/collaborative nature, climate adaptation efforts may have led states more quickly to integrate nature-based strategies into hazard mitigation. Looking toward existing climate adaptation efforts may be one opportunity for expanding nature-based hazard mitigation strategies in state plans.

### State Capabilities and Funding

The mitigation strategy section includes an analysis of state capabilities and funding, including "an evaluation of state laws, regulations, policies, and programs related to hazard mitigation as well as to development in hazard-prone areas."[165] This analysis also includes a discussion of state funding capabilities for hazard mitigation projects, including: "1.) a general description of how the state has used its own funds for hazard mitigation projects; and 2.) a general discussion of how the state has used FEMA mitigation programs and funding sources . . ."[166] The capabilities section should demonstrate "the state's commitment to mitigation," identify "a wide range of resources from which to implement mitigation activities," and reveal "areas to target improvements."[167]

The capability section is a real opportunity for states to identify the kind of natural resource programs and capacity that could be tapped to aid in the identification and implementation of nature-based projects. Equally important is the identification of possible funding sources for these projects. We did not review in depth the capabilities sections of the state plans for this report, but we did identify a number of actions that reference other state programs/capabilities or funding sources or call for the state to partner with other state or local agencies or non-profit organizations. We found a number of examples where the funding mechanisms identified in the state capabilities section is reflected in mitigation actions. For example, New Jersey's Shore Protection Fund (2008 PSA 223) for shore protection projects, stabilization, restoration or maintenance of the shore, including monitoring studies and land acquisition,[168] Ohio's action to explore the possibility of using Alternative Stormwater Infrastructure Loan Program to target properties purchased with HMA grants as future green infrastructure project sites,[169] and Oregon's action to "Maintain the Riparian Lands Tax Incentive Program. This program helps reduce sediment and protect stream banks which helps reduce the filling of river and stream channels"[170] are all funding programs that are identified or discussed in the capabilities section. The funding programs provide opportunities to identify resources necessary to implement mitigation actions.

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[164] Massachusetts Plan, p 1-1.
[165] FEMA, *State Mitigation Plan Review Guide,* at p 20 (2015) https://www.fema.gov/sites/default/files/2020-06/fema-state-mitigation-plan-review-guide_03-09-2015.pdf.
[166] *Id.* at p 20.
[167] *Id.* at p 19.
[168] New Jersey Office of Emergency Management, *2019 New Jersey State Hazard Mitigation Plan*, p 6-100 (2019), *available at* http://ready.nj.gov/mitigation/2019-mitigation-plan.shtml [New Jersey Plan].
[169] Ohio Emergency Management Association, *2019 State of Ohio Hazard Mitigation Plan (SOHMP)*, p 3-15 (2019), *available at* https://www.ema.ohio.gov/mip/planning_sohmp.aspx [hereinafter Ohio Plan].
[170] Oregon Plan, p 1038.

The state programs identified in the capabilities section also provide an opportunity to leverage other state natural resource protection partners and programs for the identification and implementation of mitigation actions. Many of these programs are likely identified in the states capability section, even if not tapped for mitigation action. There could be a wealth of untapped resources. For examples, many states have invested significant resources in developing wetland and watershed assessment tools that could be leveraged by hazard planners to identify at-risk areas and possible projects to address the risk. If not happening already, other state agencies and partner organizations could provide valuable information during the planning process that might aid in identifying programs, policies, partners, and funding opportunities with the most promise to address the state's risk.

## Plan Integration

One particularly helpful state capability that could be leveraged by hazard mitigation planners may be the availability of existing conservation plans and initiatives.[171] Many states and local governments have developed tools to prioritize lands for acquisition or restoration for various unrelated conservation or resilience purposes. For example, the New York Department of Environmental Conservation's Open Space Conservation Plan details evaluation and selection criteria that are used to determine spending priorities for the state's open space program. Local comprehensive plans often also include natural resource protection goals that may identify priorities for habitat conservation and restoration. These policies and plans can be informative for the development of nature-based actions that could be integrated into the hazard mitigation plan.[172]

Some of the state hazard mitigation plans include actions that identify specific planning efforts that can be leveraged for hazard mitigation. For example, Maryland's action to "Target Restoration, Preservation, & Mitigation within Special Flood Hazard Areas using the Water Resource Registry,"[173] advocated for the use of existing data to improve targeting. Another action in Vermont tied in a separate conservation plan: "Promote the use of Vermont Fish and Wildlife's Conservation Design Plan to achieve and maintain habitat connectivity and havens for Vermont rare, threatened, and endangered species (aquatic and terrestrial)";[174] they linked the action objective to an existing state program.

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[171] Integration of other state and/or regional planning initiatives (e.g., comprehensive, growth management, economic development, capital improvement, land development, and/or emergency management plans) and FEMA mitigation programs and initiatives that provide guidance to State and regional agencies is required of states with enhanced state mitigation plans. As of September 24, 2020, 14 states earned FEMA approval for their enhanced state mitigation plan. A State with a FEMA approved Enhanced State Mitigation Plan at the time of a disaster declaration is eligible to receive increased funds under the HMGP. The Enhanced State Mitigation Plan must demonstrate that a State has developed a comprehensive mitigation program, that the State effectively uses available mitigation funding, and that it is capable of managing the increased funding. In order for the State to be eligible for the 20 percent HMGP funding, FEMA must have approved the plan within 5 years prior to the disaster declaration. Enhanced State Mitigation Plans 44 CFR § 201.5.

[172] Environmental Law Institute, *Developing Wetland Restoration Priorities for Climate Risk Reduction and Resilience in the MARCO Region* (2016), *available at* https://www.eli.org/sites/default/files/eli-pubs/developing-wetland-restoration-priorities-climate-risk-reduction-and-resilience-marco-region.pdf (ELI's report on priority setting outlines recommendations for policy and process improvements that could improve the ability of states to develop wetland restoration priorities for climate risk reduction and resilience).

[173] Maryland Plan, p 5-41.

[174] Vermont Plan, p 148.

## Partnerships

Involving technical experts in the planning and implementation process can help fill information gaps, aiding in identifying risks and identifying and prioritizing viable nature-based mitigation actions. The hazard mitigation plan must discuss how the state planning team coordinated with other agencies and stakeholders,[175] including from the natural and cultural resources sector, in the planning process. In addition, as discussed above, the capabilities section of the mitigation strategy describes other relevant state programs and efforts that could aid in hazard mitigation efforts.

The plans themselves describe a number of actions that explicitly cite the role of partners. Many of these actions call for the state to engage other organizations to aid in land conservation efforts or other kinds of mitigation actions. For example, "[r]ecruit conservancy agencies to purchase and maintain key undeveloped land in coastal areas"[176] in Texas, "[w]ork with land conservation organizations to include river corridor and floodplain protection provisions, and/or headwater storage in conservation easements"[177] in Vermont, and "[s]upport the Hawai'i Association of Watershed Partnerships" in Hawai'i. The Tennessee Plan sought to bring local non-profit organizations into the development of local plans.

The Wisconsin Plan included an action with background information that acknowledged the role of partners in informing the development of the action. The action was to "Encourage restoration of natural wetland functions."[178] The background of the section describes the participation of Wisconsin Emergency Management in the Wetlands, Wildlife Habitat, and Flood Hazards in the Rock River Basin workshop in May 2011. This workshop was "designed to facilitate greater collaboration between emergency managers and wetland and wildlife conservation managers to strengthen protection of vital wetlands and floodplains." Additionally, the workshop "explored how agencies and organizations can work effectively together to meet multiple goals and identify the information needed and funding sources available for joint projects." The participation of these partners informed the action. The Plan goes on to say "The DNR will use lessons learned from the Wetlands, Wildlife Habitat, and Flood Hazards in the Rock River Basin workshop to identify and restore converted wetland areas."[179]

Partnerships are key to achieving a state's mitigation goals and in advancing nature-based approaches. There are many ways for partners to be involved in the planning process, and in the identification and implementation of mitigation actions, including:

- Natural resource partners can participate with other experts (land use planners, stormwater managers, emergency mangers, etc.) on hazard planning teams to inform the development of the plan itself. FEMA's *Building Community Resilience with Nature-Based Solutions* guide for communities stresses the importance of bringing in partners in planning and implementation of nature-based mitigation actions.[180]

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[175] Standard State Mitigation Plans 44 CFR §§201.4(b) and (c)(1).
[176] Texas Plan, p 296.
[177] Vermont Plan, p 147.
[178] Wisconsin Plan, pp 3-35.
[179] Wisconsin Plan, p 3-35.
[180] FEMA, *Building Community Resilience with Nature-Based Solutions: A Guide for Local Communities* (2020), *available at* https://www.fema.gov/sites/default/files/2020-08/fema_riskmap_nature-based-solutions-guide_2020.pdf.

- Natural resource partners can aid in engaging with other community stakeholders. These groups could educate the public about the environmental, social, and economic co-benefits of nature-based projects and the effectiveness of these projects for addressing the impacts of natural hazards. Gaining community buy-in can be important in ensuring nature-based projects that address community wants and needs are included in the plan, are implemented on the ground, and are maintained over the long term.
- Hazard planners often do not have the experience with the analyses/studies necessary to determine the services provided by natural infrastructure actions. As mentioned above, the GAO's recent report cited lack of technical capacity and complexity of the grant application processes as significant challenges for hazard mitigation grant program applicants.[181] In fact, the challenges associated with the hazard mitigation grant application process was cited by as a reason that states have not spent 35% of the funds that FEMA has allocated under the Hazard Mitigation Assistance program from 1989 through early 2018.[182] Natural resource partners can provide data and expertise for identifying types of, and the geographic location for, natural infrastructure projects that will provide necessary mitigation that will be crucial for the hazard mitigation grant application process.
- Natural resource partners can participate in the planning, designing, and implementing of nature-based projects. Specifically, conservation groups or watershed planners can be instrumental in identifying other relevant plans that could be incorporated or that have identified specific projects that could provide hazard mitigation benefits.
- Natural resource partners can also provide crucial assistance by taking on the maintenance, management, or monitoring responsibilities for projects. An often-overlooked component of any natural infrastructure project is long-term maintenance and management. Partners may provide necessary expertise or willingness to take-on these efforts. Identifying the cost of this component in the mitigation plan so that it could be federally funded is key.

A big challenge in developing these partnerships is the absence of dedicated funding for coordination. It takes time to assemble the right mix of partners, to convene meetings, and push the partnership toward actionable items. A coordinator is also important to help states and municipalities to scope projects and develop funding proposals. State emergency management offices, or FEMA, should consider funding such coordinator positions.

## Conclusion and Recommendations

Most state hazard mitigation plans include at least one nature-based mitigation goal or action. A few states (e.g., Massachusetts, Washington, etc.) have more integrated plans advancing nature-based approaches. We identified many different types of actions across a number of different categories. We did not assess the implementation of these actions, but we were able to gauge the documented commitment to integrating nature-based goals and actions in hazard mitigation plans.

We identified these conclusions:

[181] United States Government Accountability Office, *Disaster Resilience: FEMA Should Take Additional Steps to Streamline Hazard Mitigation Grants and Assess Program Effects* (Feb. 2021), *available at* https://www.gao.gov/assets/720/712172.pdf.
[182] Thomas Frank, *States shun billion in federal aid as climate costs soar,* Climate Wire (Feb. 26, 2021), *available at* https://www.eenews.net/climatewire/stories/1063726077/search?keyword=hazard+mitigation.

- There are many opportunities to integrate nature-based goals and actions into hazard mitigation plans. Many states have done this to some degree, but there are still opportunities to improve, including more comprehensive evaluation of the value of natural systems in the assessment of risk and vulnerability, systematic inclusion of well thought out and specific nature-based hazard mitigation actions, and realistic prioritization and implementation of nature-based strategies.
- Most states had nature-based goals. However, plans with well-developed nature-based goals and objectives were not necessarily the same states that included higher numbers of nature-based actions, and vice versa. Massachusetts had the most actions, and although it did not have goals and objectives with explicit focus on using nature-based solutions, Massachusetts did have a separate section of the plan discussing the importance of nature-based strategies. The Massachusetts plan also extensively discussed the environment in its risk assessment section.
- We identified very few geographically specific projects defined in plans. Most discussions of activities describe general types of actions (such as "use green mitigation techniques such as bio swales, rain gardens, and permeable pavers" or "protect and restore natural floodplain functions"). Although the state plan is linked to local strategies, more specific activities may be found in local hazard mitigation plans. Local plans are more directly tied to community needs and goals and thus may provide an important opportunity for integrating restoration actions.[183] Where it makes sense, state hazard mitigation planners may choose to identify specific projects, and project locations, that can be shown to address a specific risk while continuing to coordinate with local governments to complement the strategies and actions identified in the local plans. Hazard mitigation grants may be available to conduct the studies necessary to identify and plan these kinds of projects. We identified more than 30 Technical and Information actions in the plans, many of which were related to studies that sought to identify future project sites.
- Identifying and integrating nature-based hazard mitigation actions in mitigation plans is an important first step toward advancing and expanding the use of these techniques to address risk associated with natural hazards. Funding, implementing, and monitoring these projects are important next steps. More demonstration projects are needed to show the multiple benefits of nature-based projects.

  We did not review the required sections in the plans that discuss progress on previous actions. However, these sections may provide some information about how well nature-based actions have helped to address risk. There are also other plan sections that could be reviewed to better understand how the state is prioritizing the implementation of nature-based actions versus other types of actions (e.g., the plan's methodology for prioritizing actions).[184]
- It is important to understand some of the challenges in implementing nature-based hazard mitigation strategies, even when they are identified in the hazard mitigation plan. For example, the Benefit-Cost Analysis (BCA) methods (projects must pass benefit-cost in order to be eligible for HMA funding) may present challenges for showing the cost-effectiveness of nature-based strategies. In their recent analysis, the GAO stated that officials in all of the jurisdictions in their study found the BCA for hazard mitigation grants was a challenge due, in part, to the amount of

[183] ELI examined 119 local hazard mitigation plans to identify examples of how states are including natural infrastructure or natural resource protection or restoration as mitigation goals and actions. We found 275 relevant actions. See our report at https://www.eli.org/land-biodiversity/hazard-mitigation-planning

[184] For example, as discussed above, the Massachusetts plan indicates that the prioritization framework the planners "used to rank the action items… includes nature-based approaches specifically designed to conserve and/or employ natural resources as the highest-priority ranking." *See* Massachusetts Plan. p. 7-4

resources and data needed.[185] Calculating "project benefits, such as lost revenue avoided and environmental benefits, can be difficult to calculate and may require hundreds of pages of data or technical project information to support."[186] Also, hiring contractors to conduct these studies can cost thousands of dollars. This may be especially true for nature-based projects as data on ecosystem service values may be less readily available.

Recently, FEMA has made moves to update its BCA Toolkit[187] to reduce barriers to nature-based hazard mitigation projects. For example, FEMA's 2020 policy "Ecosystem Service Benefits in Benefit-Cost Analysis for FEMA's Mitigation Programs Policy" means that nature-based hazard mitigation projects can now be considered cost-effective based on the value of their environmental and social benefits alone. This change will likely reduce the technical and monetary burden on applicants for BCA related to certain project types, especially when they reduce the need for complex modeling (e.g., hydrologic). While this has been an important policy update, challenges remain. FEMA could also make additional tweaks to its BCA Toolkit, for example, in order to further reduce barriers to nature-based solutions, such as creation of additional "pre-calculated benefits" for certain project types. FEMA or state governments could also assist in the collection of data to inform BCA (e.g., data needed to estimate the savings from other benefits such as avoided soil loss, mass wasting or landslides, and the role that healthy, intact floodplains and wetlands play in preventing those types of catastrophes). FEMA should also invest in more guidance and decision support tools that help communities consider nature-based project types, especially things like upper watershed projects and reach-scale schemes.

A related challenge is a dearth of nature-based project "case studies" that have been successfully funded by FEMA, which could help to demonstrate to other applicants that such projects are possible. This challenge is being partially addressed by FEMA's Mitigation Action Portfolio (and other efforts),[188] and the situation will presumably improve as more nature-based projects are approved through BRIC and HMGP over time.

We have identified a series of steps states can take to improve integration of nature-based goals and actions into their plans.

1. Identify and include natural resource protection and restoration experts as key members of the planning team (such experts could include state agency staff, NGOs, watershed groups,

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[185] United States Government Accountability Office, *Disaster Resilience: FEMA Should Take Additional Steps to Streamline Hazard Mitigation Grants and Assess Program Effects* (Feb. 2021), *available at* https://www.gao.gov/assets/720/712172.pdf.

[186] *Id.*

[187] FEMA, *Ecosystem Service Benefits in Benefit-Cost Analysis for FEMA's Mitigation Programs Policy*, FEMA Policy FP-108-024-02 (Sept. 2020), *available at* https://www.fema.gov/sites/default/files/2020-09/fema_ecosystem-service-benefits_policy_september-2020.pdf; Thomas Frank, *FEMA ends policy favoring flood walls over green protections,* Climate Wire (Oct. 15, 2020), *available at* https://www.eenews.net/stories/1063716253/print.

[188] FEMA, *Hazard Mitigation Assistance Mitigation Action Portfolio* (Aug. 2020), *available at* https://www.fema.gov/sites/default/files/2020-08/fema_mitigation-action-portfolio-support-document_08-01-2020_0.pdf; The Naturally Resilient Communities website (http://nrcsolutions.org/), which includes "case studies of successful projects from across the country to help communities learn more and identify which nature-based solutions might work for them," is another good resource. Another good resource is Glick, P., E. Powell, S. Schlesinger, J. Ritter, B.A. Stein, and A. Fuller. *The Protective Value of Nature: A Review of the Effectiveness of Natural Infrastructure for Hazard Risk Reduction.* (2020) Washington, DC: National Wildlife Federation, *available at https://www.nwf.org/-/media/Documents/PDFs/NWF-Reports/2020/The-Protective-Value-of-Nature.ashx?la=en&hash=A75F59611475502BEE58723F8B3C58423417E579*

academics, etc.). Natural resources experts are essential to provide the knowledge that is needed to integrate natural resource information throughout the plan, including the risk assessment and mitigation strategy. As a first step, state planners may wish to draw from the programs already identified in the capabilities section of the hazard mitigation plan to identify potential partners and team members.

The planning team should also examine the mitigation plan process itself to identify opportunities to focus on the value of natural systems and the benefits of integrating nature-based hazard mitigation strategies (e.g., dedicate at least one planning meeting to nature-based actions, ensure nature-based actions are thoughtfully discussed at community outreach meetings, etc.).

2. Conduct an explicit review of legal barriers or opportunities to integrating nature-based strategies in hazard mitigation planning. State law and policy may be an important driver for integrating natural resource protection and identification of nature-based hazard mitigation strategies. Looking toward existing climate adaptation law and planning efforts may be an opportunity. It may be equally important to identify any legal barriers that could be addressed in order to facilitate the identification and implementation of nature-based strategies for hazard mitigation.

3. Systematically evaluate the risk to natural systems and how the loss and degradation of natural habitats contributes to increased risk from hazards in the risk and vulnerability assessment. To be most effective, this would go beyond a short description of the potential impacts to the environment in each hazard profile to also include how the loss or degradation of natural systems affects vulnerability. Experts on the planning team can help to identify sources of data and other analyses that can help with evaluation of risk and vulnerability. For example, it is important for hydrologic assessments to be part of the risk assessment in order to most effectively address flood risks (e.g., determining which risks are associated with altered hydrology and disconnected floodplains and wetlands).

4. Develop and include goals that not only focus on how to protect the environment from natural hazards but also reflect the state's priority and commitment to use nature-based strategies to mitigate the state's risk. A good straightforward example is "Encourage hazard mitigation measures that promote and enhance nature-based solutions, natural processes, and ecosystem benefits while minimizing adverse impacts to the environment" from the California Plan. The companion spreadsheet for this report could serve as a resource for reviewing examples of goals and objectives from other state plans.[189]

5. Develop and integrate nature-based actions in the mitigation strategy. Both broad and specific actions could be useful. Broad actions communicate the state's commitment to pursuing nature-based projects and the flexibility to pursue federal funds when opportunities arise. More specific actions can give some weight to a given project that has been developed to address a specific risk or vulnerability. Identifying partners in these actions would also be useful. At the state level, Technical and Information actions may be especially valuable as the information collected can then feed back into the evaluation of risk and identification of mitigation actions, as well as into other resilience efforts.

[189] The companion spreadsheet is available at https://www.eli.org/land-biodiversity/hazard-mitigation-planning.

The companion spreadsheet for this report could serve as a resource for reviewing examples of actions from other state plans.[190] The action categories that we suggest here (Agency Coordination, Education and Awareness, Funding and Programmatic etc.) could be used as a guide for formulating, organizing, and reviewing actions. This frame might help states identify gaps in the types of actions they have and/or spur new ideas.

The capabilities section of the mitigation strategy is another opportunity to identify existing resources, programs, and partners that can be leveraged as mitigation actions. The natural resource experts on the planning team are an important resource for developing the capabilities section. Further, linking to or making reference to completed and ongoing efforts to prioritize habitat restoration projects or other climate adaptation planning efforts outside of the hazard mitigation planning process could help secure funds to implement those priority projects. Then as those prioritizations are updated (perhaps more frequently than the 5-year mitigation plans) they effectively help the mitigation plan stay current.

6. Invest in monitoring and assessment of nature-based hazard mitigation projects. Performance data will help planners communicate the success and value of nature-based projects to the public. Monitoring data can help convince local stakeholders that nature-based strategies will work in their specific case and offer numerical evidence that nature-based projects have positive environmental and mitigation effects. Monitoring data can also help planners design more effective nature-based hazard mitigation strategies in the future.

Finally, we have identified recommendations for FEMA to improve integration of nature-based goals and actions into hazard mitigation plans.

1. Examine FEMA's Hazard Mitigation Planning guidance documents to find opportunities to promote partnerships with natural resource experts and provide more information on how to identify and integrate appropriate nature-based actions. For example, FEMA's State Mitigation Planning Key Topics Bulletins (on the Mitigation Strategy, Mitigation Capabilities, Planning Process, and Risk Assessment) inform states on how to meet the regulatory and policy requirements for hazard mitigation planning.[191] Although natural resources are mentioned, these brief guides could be updated to highlight key approaches and resources that could be leveraged to better integrate natural system protection and nature-based strategies in hazard mitigation.

   In addition to the actions cataloged in this report, FEMA's (2013) Mitigation Ideas - A Resource for Reducing Risk to Natural Hazards includes many valuable examples of natural systems protection mitigation actions.[192] This document (as well as the actions identified in this report) could serve as a starting point for conversations among the planning team as it seeks to identify and integrate appropriate nature-based actions into the plan.

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[190] The companion spreadsheet is available at https://www.eli.org/land-biodiversity/hazard-mitigation-planning.
[191] FEMA, *State Mitigation Planning Key Topis Bulletin: Mitigation Strategy* (Oct. 2016), *available at* https://www.fema.gov/sites/default/files/2020-06/fema-state-mitigation-strategy-planning-bulletin_10-26-2016_0.pdf.
[192] FEMA, *Mitigation Ideas - A Resource for Reducing Risk to Natural Hazards* (Jan 2013), *available at* https://www.fema.gov/sites/default/files/2020-06/fema-mitigation-ideas_02-13-2013.pdf.

2. Examine the Benefit-Cost Analysis. As discussed above, FEMA has made a number of recent changes to the BCA to make it easier for nature-based strategies to pass. However, FEMA could make additional changes that would result in further improvement. For example, FEMA could make changes to the BCA Toolkit in order to further reduce barriers to nature-based solutions, such as creation of additional "pre-calculated benefits" for certain project types. FEMA could also aid in data collection on project benefits, such as lost revenue avoided and environmental benefits associated with nature-based projects.

3. Invest in more "case studies" of nature-based projects that have been successfully funded by FEMA that could help to demonstrate to other applicants that such projects are possible. FEMA's Mitigation Action Portfolio[193] is a good start. Other resources such as the case studies on the Naturally Resilient Communities website may also be valuable. We have also created two new case studies of successful projects.[194]

4. Invest in partnerships with natural resource agencies and organizations. As discussed above, partnerships with natural-resource experts are crucial for identifying projects, completing grant applications, and implementing nature-based hazard mitigation strategies. In addition to promoting such partnerships in the hazard mitigation planning guidance as a way to better integrate nature resource actions, FEMA should consider investing in coordinator positions to help states assemble the right mix of partners and push the partnership to scope nature-based projects and develop funding proposals.

[193] FEMA, *Hazard Mitigation Assistance Mitigation Action Portfolio* (Aug. 2020), *available at* https://www.fema.gov/sites/default/files/2020-08/fema_mitigation-action-portfolio-support-document_08-01-2020_0.pdf.

[194] The case studies are posted at https://www.eli.org/land-biodiversity/hazard-mitigation-planning

## Appendix 1: State and Tribal Plan Links, Dates, Agencies

| State | Year | Lead Agency | Other Agencies |
|---|---|---|---|
| Alabama | 2018 | Alabama Emergency Management Agency | Hagerty Consulting |
| Alaska | 2018 | State of Alaska, Division of Homeland Security and Emergency Management | AECOM |
| Arizona | 2018 | Arizona Department of Emergency and Military Affairs – Planning Branch (DEMA) | JE Fuller |
| Arkansas | 2018 | Arkansas Division of Emergency Management (ADEM) | BOLDplanning |
| California | 2018 | California Governor's Office of Emergency Services (Cal OES) | Cal Poly State University Support Team |
| Colorado | 2018 | Division of Homeland Security and Emergency Management; Colorado Department of Public Safety | Michael Baker International and Wood Environment & Infrastructure Solutions, Inc. |
| Connecticut | 2019 | Connecticut Department of Emergency Services and Public Protection (DESPPS)/Division of Emergency Management and Homeland Security (DEMHS) and Department of Energy and Environmental Protection (DEEP) | Dewberry and subcontractors Tetra Tech and Milone & MacBroom |
| Delaware | 2018 | Delaware Emergency Management Agency | Collaborative Planning Team |
| Florida | 2018 | Florida Division of Emergency Management | Dewberry, Florida Gateway College, Integrated Solutions Consulting, Lakeland Regional Health, Langton Consulting, Pegasus Engineering |
| Georgia | 2019 | Georgia Emergency Management and Homeland Security Agency (GEMA/HS) | University of Georgia, Carl Vinson Institute of Government, Information Technology Outreach Services (ITOS) |
| Hawai'i | 2018 | Hawai'i Emergency Management Agency | Tetra Tech |
| Idaho | 2018 | Idaho Office of Emergency Management | Tetra Tech, Inc. |
| Illinois | 2018 | Illinois Emergency Management Agency (IEMA) | State Planning Team |
| Indiana | 2019 | Indiana Department of Homeland Security | The Polis Center, Indiana University-Purdue |
| Iowa | 2018 | Iowa Homeland Security and Emergency Management | State Hazard Mitigation Team |
| Kansas | 2018 | Kansas Division of Emergency Management | Kansas Hazard Mitigation Team |
| Kentucky | 2018 | Kentucky Emergency Management (KYEM) | University of Kentucky Hazard Mitigation Grants Program Office (UK-HMGP) |

| State | Year | Lead Agency | Other Agencies |
|---|---|---|---|
| Klamath Tribes | 2017 | Klamath Tribal staff, planners, and tribal members | Bridgeview Consulting, LLC, Planning Team |
| Lac du Flambeau | 2019 | Emergency Management Department for the Lac du Flambeau Tribe | Bullock & Haddow LLC, Adaptation International, GLISA NOAA RISA |
| Louisiana | 2019 | Louisiana Governor's Office of Homeland Security | Department of Georgaphy and Anthropology; Department of Construction Management, Louisiana State University; University of New Orleans Center for Hazards Assessment, Response & Technology |
| Maine | 2019 | Maine Emergency Management Agency<br>Prepared by MEMA State Hazard Mitigation Officer & Natural Hazards Planner | Multiple partners participated, including The River Flow Advisory Commission, Drought Task Force, Climate Adaptation Workgroup, and 16 County Emergency Managers |
| Maryland | 2016 | Maryland Emergency Management Agency (MEMA) | Maryland Resiliency Partnership Group, Mitigation Advisory Council |
| Massachusetts | 2018 | Massachusetts Emergency Management Agency (MEMA) of the Executive Office of Public<br>Safety and Security, in partnership with the Executive Office of Energy and Environmental<br>Affairs (EOEEA) | AECOM Consulting |
| Michigan | 2019 | Emergency Management and Homeland Security Division, Michigan Department of State Police, and Michigan Citizen-Community emergency Response Coordinating Council | Various stakeholders |
| Minnesota | 2019 | Minnesota Department of Public Safety, Division of Homeland Security and Emergency Management | University of Minnesota Duluth |
| Mississippi | 2018 | Mississippi Emergency Management Agency | Mississippi Hazard Mitigation Council |
| Missouri | 2018 | Missouri State Emergency Management Agency | Wood Environment and Infrastructure Solutions (Wood E&IS), Inc. |
| Montana | 2018 | Montana Department of Military Affairs Disaster and Emergency Services | Tetra Tech |
| Nebraska | 2019 | Nebraska Emergency Management Agency (NEMA) Recovery Section staff; IEM | Members of the Governor's Task Force for Disaster Recovery, with<br>staff assistance from member agencies, including NEMA and NeDNR |

| State | Year | Lead Agency | Other Agencies |
|---|---|---|---|
| Nevada | 2018 | Nevada Division of Emergency Management | Nevada Hazard Mitigation Planning Committee |
| New Hampshire | 2018 | New Hampshire Homeland Security Emergency Management | State Hazard Mitigation Planning Committee |
| New Jersey | 2019 | New Jersey Office of Emergency Management | Michael Baker International |
| New Mexico | 2018 | New Mexico Department of Homeland Security and Emergency Management | Planning Team |
| New York | 2019 | New York State Division of Homeland Security and Emergency Services | State University of New York's Research Foundation & Albany Visualization and Informatics Lab (AVAIL) |
| North Carolina | 2018 | North Carolina Emergency Management | ESP Associates and Atkins |
| North Dakota | 2018 | North Dakota Department of Emergency Services (NDDES) | Hagerty Consulting, Inc. |
| Ohio | 2019 | Ohio Emergency Management Association | State Hazard Mitigation Team |
| Oklahoma | 2019 | Oklahoma Department of Emergency Management | State Hazard Mitigation Team and Officer |
| Oneida Nation | 2016 | Oneida Nation Pre-Disaster Mitigation Plan Steering Committee | Bay-Lake Regional Planning Commission |
| Oregon | 2015 | Oregon Office of Emergency Management | Department of Land Conservation and Development |
| Pennsylvania | 2018 | Pennsylvania Emergency Management Agency | Michael Baker International |
| Rhode Island | 2018 | Rhode Island Emergency Management Agency | Hagerty Consulting |
| South Carolina | 2018 | South Carolina Emergency Management Division | Team |
| South Dakota | 2019 | South Dakota Office of Emergency Management | Wood Environmental & Infrastructure Solutions |
| Tennessee | 2018 | TN Department of Military, Tennessee Emergency Management Agency | BOLD Planning Solutions |
| Texas | 2018 | Texas Division of Emergency Management | State Hazard Mitigation Team |
| Utah | 2019 | Utah Division of Emergency Management | Team of Organizations, Departments, Agencies |
| Vermont | 2018 | Vermont Division of Emergency Management | Team |
| Virginia | 2018 | Virginia Department of Emergency Management | Witt O'brien's |
| Washington | 2018 | Washington Emergency Management Division | Multi-Agency Hazard Mitigation Workgroup |
| West Virginia | 2018 | West Virginia Military Authority & West Virginia Emergency Management | Mitigation Planning Team |
| Wisconsin | 2017 | Wisconsin Emergency Management, Department of Military Affairs | State Hazard Mitigation Team |

| State | Year | Lead Agency | Other Agencies |
|---|---|---|---|
| Wyoming | 2016 | Wyoming Office of Homeland Security | Senior Advisory Committee, Mitigation Sub-Committee |

## Appendix 2: State and Tribal Nature-Based Hazard Mitigation Goals

| State | Goals | Goal Category |
|---|---|---|
| Alabama | Goal 2: Reduce the State of Alabama's vulnerability and increase resilience to hazards to protect people, property, and natural resources.<br>Objective 2.6 Promote hazard mitigation policies that reduce risk to people and property and protect the environment. | Broad goal that mentions protecting the environment in addition to protecting other state aspects |
| Alaska | -- | No relevant goals |
| Arizona | -- | No relevant goals |
| Arkansas | Goal 2: Promote sustainable and disaster resilient development within Arkansas and its communities.<br>Objective 2.2: Promote sustainable development and "smart growth" initiatives through coordination with state agencies and non-profit organizations. | Goal specifically focuses on natural infrastructure/nature-based solutions |
| California | Goal 3: Protect the environment;<br>Objective 1: Provide guidance to all levels of government about mitigation planning and project compliance with the California Environmental Quality Act (CEQA) and all other applicable environmental laws, and facilitate alignment of federal and state regulations across agencies to strengthen mitigation, response, and recovery efforts. (Modified)<br>Objective 2: Encourage hazard mitigation measures that promote and enhance nature-based solutions, natural processes, and ecosystem benefits while minimizing adverse impacts to the environment;<br>Objective 3: Encourage mitigation planning programs at all levels of government to protect the environment and promote enforcement of sustainable mitigation actions;<br>Objective 4: Coordinate and implement integrated and adaptive hazard mitigation, and watershed and habitat protection strategies, through public and private partnerships;<br>Objective 5: Coordinate hazard mitigation planning with state and federal programs designed to minimize the release and movement of toxic and hazardous substances in the environment. | Goal specifically focuses on the environment;<br><br>Goal specifically focuses on natural infrastructure/nature-based solutions |
| Colorado | Support mitigation initiatives and policies that promote disaster resiliency, nature-based solutions, cultural resources and historic preservation, and climate adaptation strategies; | Goal specifically focuses on natural infrastructure/nature-based solutions |

| State | Goals | Goal Category |
|---|---|---|
| Connecticut | Goal 1: Promote implementation of sound floodplain management and other natural hazard mitigation principles on a state and local level;<br>Strategy 1.6: Encourage less development in risk zones, statewide, by promoting the Community Rating System (CRS) and by encouraging open space planning. Also encourage low impact development tools and techniques, low-intensity uses of existing open space in risk areas, and the incorporation of floodplain resource management best management practices into local floodplain programs. | Goal specifically focuses on natural infrastructure/nature-based solutions |
| Delaware | -- | No relevant goals |
| Florida | Goal 4: Support mitigation initiatives and policies that protect the state's cultural, economic, and natural resources;<br>Objective 4-1: Support land acquisition programs that reduce or eliminate potential future losses due to natural hazards and that are compatible with the protection of natural or cultural resources;<br>Objective 4-2: Support restoration and conservation of natural resources wherever possible.<br>Objective 4.6: Coordinate effective partnerships between state agencies for floodplain management. | Broad goal that mentions protecting the environment in addition to protecting other state aspects; Goal specifically focuses on natural infrastructure/nature-based solutions |
| Georgia | -- | No relevant goals |
| Hawai'i | Goal 1: Reduce the long-term vulnerability of Hawaii's people, property and jurisdictions, including state-owned or operated buildings, infrastructure and critical facilities, to natural hazards while conserving the State's natural, historical, and cultural assets. This includes high risk properties such as repetitive loss (RL) and severe repetitive loss (SRL) properties. | Broad goal that mentions protecting the environment in addition to protecting other state aspects |
| Idaho | Goal 2: Reduce the adverse economic and environmental impacts of natural, technological, and human-caused hazard events. | Broad goal that mentions protecting the environment in addition to protecting other state aspects |
| Illinois | -- | No relevant goals |
| Indiana | -- | No relevant goals |

| State | Goals | Goal Category |
|---|---|---|
| Iowa | Goal 1: Protect the health, safety, and quality of life for Iowa citizens while reducing or eliminating property losses, economic costs, and damage to the natural environment caused by a disaster;<br>Objective 1: Establish regulatory measures or processes that reduce the number and severity of all hazard risks in order to alleviate death, injuries, environmental impact, and property losses.<br>Objective 2 (combined): Encourage property protection measures and construction projects to prevent and reduce structure and other property damage, and promote the health, safety and welfare of citizens, and protect the environment.<br>Objective 4: Build support, capacity, and commitment to prevent or reduce risks from all hazards for protection of Iowa's citizens, property, and natural resources. | Broad goal that mentions protecting the environment in addition to protecting other state aspects |
| Kansas | Goal 1: Minimize the vulnerability of the people, property, environment, and economy of Kansas and its communities to the impacts of natural and manmade hazards. | Broad goal that mentions protecting the environment in addition to protecting other state aspects |
| Kentucky | -- | No relevant goals |
| Klamath Tribes | Goal 1—Reduce or prevent future hazard-related injuries and losses of life, property damage, and environmental impact.<br>Goal 3—Encourage the development and implementation of long-term, cost-effective and environmentally sound mitigation projects.<br>Objective 7 – Establish a partnership among the Tribal Government and Tribal business leaders with surrounding area government and business community to improve and implement methods to protect life, property, and the environment, while preserving the cultural integrity of the Klamath Tribes.<br>Objective 12 - Encourage hazard mitigation measures that result in the least adverse effect on the natural environment and that use natural processes, while preserving and maintaining the cultural elements of the Klamath Tribes. | Goal specifically focuses on the environment;<br><br>Goal specifically focuses on natural infrastructure/nature-based solutions |

| State | Goals | Goal Category |
|---|---|---|
| Lac du Flambeau | Goal 2: The goal of these hazard mitigations actions is to reduce the risk and extent of loss of critical natural resources (plant and animal species) and the spread of invasive species on individuals, families, and the community as a whole. Implementation of these actions will help ensure the health and wellness of the community, as well as decrease the incidence of other man-made hazards.<br>Goal 9: The goal of these hazard mitigations actions is to protect people and the natural environment from adverse effects of hazardous materials incident. | Goal specifically focuses on the environment |
| Louisiana | Goal 1: Protect the people, property, and natural resources of Louisiana, by promoting strategies and policies that increase resiliency, and minimize vulnerability to natural hazards.<br>Objective 1.5: Establish and coordinate effective partnerships between state agencies for floodplain and watershed management and development. | Broad goal that mentions protecting the environment in addition to protecting other state aspects |
| Maine | Goals: To reduce the risk of loss to life and property from flooding through state level agency coordination and support.<br>Objective 4: Watershed management. Minimize increased downstream flooding caused by runoff from upstream development. | Broad goal that mentions protecting the environment in addition to protecting other state aspects |
| Maryland | Maryland Hazard Mitigation Plan Goal - To protect life, property, and the environment from hazard events through: Promote actions that protect natural resources, while enhancing hazard mitigation and community resiliency. | Goal specifically focuses on the environment |
| Massachusetts | Goal 4: Increase the resilience of State and local government, people, natural systems, the built environment, and the economy by investing in performance-based solutions. (Plus section 7.3 Importance of Nature-Based Solutions in Hazard Mitigation and Climate Adaption) | Broad goal that mentions protecting the environment in addition to protecting other state aspects |
| Michigan | Goal 2: Reduce Property Damage: Incorporate hazard mitigation considerations into land use planning, resource management, land development processes, and disaster-resistant structures.<br>Goal 3: Build Alliances: Forge partnerships with other public safety agencies and organizations to enhance and improve the safety and wellbeing of all Michigan communities.<br>Objective 3.1: Promote urban forestry and vegetation management programs and initiatives to develop more resilient woodlands, streetscapes, and landscapes in communities throughout Michigan. | Goal specifically focuses on natural infrastructure/nature-based solutions |

| State | Goals | Goal Category |
|---|---|---|
| Minnesota | Drought Goal: Reduce economic loss and environmental impacts due to drought (MN has 2 plan goals and then goals for each hazard) | Broad goal that mentions protecting the environment in addition to protecting other state aspects |
| Mississippi | Goal 1: Minimize loss of life, injury, and damage to property, the economy, and the environment from natural hazards; Preserve, create, and restore natural systems to serve as natural mitigation functions.<br>Objective 1.6 Preserve, create, and restore natural systems to serve as natural mitigation functions | Broad goal that mentions protecting the environment in addition to protecting other state aspects<br><br>Goal specifically focuses on natural infrastructure/nature-based solutions |
| Missouri | Goal 4: Implement mitigation actions that improve the protection of community tranquility from the adverse effects of disasters<br>Objective 4.2: Consider sustainability issues (ecologically sound, economically viable, socially just, and humane) when developing or reviewing mitigation projects and plans. | Goal specifically focuses on the environment |
| Montana | Goal 2: Reduce Impacts of Wildland and Rangeland Fires<br>Objective 2.4: Implement Natural Resource Protection Projects to Reduce Impacts from Wildfire.<br>Goal 3: Mitigate the Potential Loss of Life and Property from Flooding<br>Objective 3.3: Implement Natural Resource Protection Projects to Reduce Impacts from Flooding.<br>Goal 5: Reduce the Impacts from Drought<br>Objective 5.3: Support Natural Resource Protection Efforts to Reduce Impacts from Drought<br>Goal 8: Minimize Impacts from Disease Outbreaks<br>Objective 8.3: Implement Natural Resource Protection Projects to Reduce Impacts from Disease | Goal specifically focuses on natural infrastructure/nature-based solutions |

| State | Goals | Goal Category |
|---|---|---|
| Nebraska | GOAL 4: Encourage the development and implementation of long-term, cost effective, and resilient mitigation projects that preserve or restore the functions of natural systems.<br>Objective 4.1: Encourage the use of green and natural infrastructure for mitigation projects, when applicable.<br>Objective 4.2: Provide technical assistance to communities and stakeholders in the application and implementation of mitigation projects that preserve or restore natural systems.<br>Objective 4.3: Maintain and encourage ongoing relationships between state and local agencies and federal partners to play an active and vital role in identifying appropriate preservation and restoration of vulnerable natural systems.<br>Objective 4.4: Promote the continued use of natural systems and features, and open space preservation, in land use planning and development by local jurisdictions. | Goal specifically focuses on natural infrastructure/nature-based solutions |
| Nevada | -- | No relevant goals |
| New Hampshire | Overarching Goal: Minimize loss and disruption of human life, property, the environment, and the economy due to natural, technological, and human-caused hazards through a coordinated and collaborative effort between federal, State, and local authorities to implement appropriate hazard mitigation measures;<br>Natural Hazard Objectives:<br>-Ensure mitigation strategies consider the protection and resiliency of natural, historical, and cultural resources | Broad goal that mentions protecting the environment in addition to protecting other state aspects |
| New Jersey | Goal 2: Protect Property<br>Objective 2.3: Implement hazard mitigation policies to protect environmental resources that serve a natural hazard mitigation function;<br>Objective 2.4: Encourage cost-effective and environmentally-sound development and land use. | Goal specifically focuses on natural infrastructure/nature-based solutions |
| New Mexico | Goal 5: Shorten recovery time for both community function and the natural environment after natural hazard events. | Broad goal that mentions protecting the environment in addition to protecting other state aspects |

| State | Goals | Goal Category |
|---|---|---|
| New York | Goal 1: Promote a comprehensive state hazard mitigation policy framework for effective mitigation programs that includes coordination among federal, state, and local organizations for planning and programs.<br>Objective 1.1: Promote integrated land use planning and development to encourage resilience and sustainability through statewide programs that address zoning, building codes, smart growth, capital improvement programs, open space preservation, critical infrastructure siting, and storm water management regulations;<br>Goal 2: Protect existing property including public, historic, private structures, state-owned/operated buildings, and critical facilities and infrastructure.<br>Objective 2.3: Encourage resilient and sustainable structural practices that reduce vulnerabilities and encourage the use of green and natural infrastructure;<br>Objective 2.4: Promote the continued use of natural systems and features, open space preservation, and land use development planning within local jurisdictions;<br>Goal 4: Preserve or Restore Natural Systems: Encourage the development and implementation of long-term, cost effective, and resilient mitigation projects to preserve or restore the functions of natural systems;<br>Objective 4.1: Encourage the use of green and natural infrastructure;<br>Objective 4.2: Provide technical assistance to communities and stakeholders in the application and implementation of mitigation projects that preserve or restore natural systems;<br>Objective 4.3: Maintain and encourage ongoing relationships between state agencies and partners to play an active and vital role in preservation and restoration of vulnerable natural systems;<br>Objective 4.4: Facilitate, encourage, and manage retreat where appropriate. | Broad goal that mentions protecting the environment in addition to protecting other state aspects<br><br>Goal specifically focuses on natural infrastructure/nature-based solutions |
| North Carolina | To reduce the State's vulnerability and increase resilience to natural hazards, in order to protect people, property and natural resources. | Broad goal that mentions protecting the environment in addition to protecting other state aspects |

| State | Goals | Goal Category |
|---|---|---|
| North Dakota | Purpose: Minimize the vulnerability of the public, property, infrastructure, environment, and economy of North Dakota and its communities to the impacts of natural and technological hazards as well as adversarial threats;<br>Goal 4: Preserve/protect people, property, and natural and cultural resources from the impacts of hazards and threats. Ensure that communities are resilient to the impacts of hazards and threats.<br>Objective 4.1: Within five years, starting in 2019, reduce the vulnerability of people, property, and natural and cultural resources to hazards and threats. | Broad goal that mentions protecting the environment in addition to protecting other state aspects |
| Ohio | -- | No relevant goals |
| Oklahoma | Goal 3: To protect the environment. | Goal specifically focuses on the environment |
| Oneida Nation | Goal 1: Minimize human, economic, and environmental disruption from natural hazards<br>Goal 5: Promote and enhance the sue of natural resource protection measures as a means to reduce the impact if natural hazards on people and property. | Broad goal that mentions protecting the environment in addition to protecting other state aspects<br><br>Goal specifically focuses on natural infrastructure/nature-based solutions |
| Oregon | Goal 4: Minimize the impact of natural hazards while protecting, restoring, and sustaining environmental processes; | Goal specifically focuses on the environment |
| Pennsylvania | Goal 1: Protect lives, property, environmental quality, and resources of the Commonwealth, including RL and SRL properties.<br>Objective 1-13: Promote Natural Systems Protection mitigation in the Commonwealth between 2019 and 2023. | Broad goal that mentions protecting the environment in addition to protecting other state aspects<br><br>Goal specifically focuses on natural infrastructure/nature-based solutions |
| Rhode Island | Goal 5: The built environment, infrastructure, people, natural environment, and economy are resilient to the impacts of natural, technological, and human-caused hazards under current and future conditions (including repetitive loss [RL] and severe repetitive loss [SRL]). | Broad goal that mentions protecting the environment in addition to protecting other state aspects |
| South Carolina | Goal #7: Enhance and encourage the use of natural resource protection measures as a means to reduce the impacts of hazards on people and property. | Goal specifically focuses on natural infrastructure/nature-based solutions |

| State | Goals | Goal Category |
|---|---|---|
| South Dakota | Goal 4: Reduce impacts to the economy, the environment, and cultural resources from hazards;<br>Objective 4.1: Reduce loss to natural resources (i.e. forest and watershed health).<br>Drought Goal: Reduce drought impacts to South Dakota's economy, people, state assets, cultural resources, and environment; Reduce losses to natural resources (i.e., forest and watershed health) | Broad goal that mentions protecting the environment in addition to protecting other state aspects; Goal specifically focuses on the environment |
| Tennessee | -- | No relevant goals |
| Texas | Goal 5: Reducing adverse environmental, natural resource, and economic impacts from natural, technological, and human-caused hazard events. | Broad goal that mentions protecting the environment in addition to protecting other state aspects |
| Utah | Goal 8: Preserve, protect, and/or restore natural systems, natural resources, and other environmental conditions against hazard events; Combine hazard loss reduction efforts with other environmental, social, and economic needs of the state.<br>Goal 9. Combine hazard loss reduction efforts with other environmental, social, and economic needs of the state | Goal specifically focuses on the environment |
| Vermont | Mission: To protect life, property, natural resources and quality of life in Vermont by reducing our vulnerability to climate change and natural disasters;<br>Goal: Protect, restore and enhance Vermont's natural resources to promote healthy, resilient ecosystems;<br>Goal: Develop and implement plans and policies that create resilient natural systems, built environments, and communities. | Broad goal that mentions protecting the environment in addition to protecting other state aspects<br><br>Goal specifically focuses on natural infrastructure/nature-based solutions |
| Virginia | Vision: It is the Commonwealth's vision to promote resiliency and reduce the long-term impacts of hazards on human, economic, and natural resources throughout the state. | Broad goal that mentions protecting the environment in addition to protecting other state aspects |
| Washington | -- | No relevant goals |
| West Virginia | Vision: It is the vision of the State of West Virginia to promote resiliency and reduce the long-term effects of on the population, infrastructure, economy, and natural resources of the state. | Broad goal that mentions protecting the environment in addition to protecting other state aspects |

| State | Goals | Goal Category |
|---|---|---|
| Wisconsin | Goal 1: Minimize human, economic, and environmental disruption from natural, technological, and manmade hazards. | Broad goal that mentions protecting the environment in addition to protecting other state aspects |
| Wyoming | -- | No relevant goals |

## Appendix 3: State and Tribal Nature-Based Hazard Mitigation Actions

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Alaska** | FL Action 1.4.1: Encourage the State and communities to purchase flood-prone property and convert to open space for perpetuity. | Land Use | Multi-hazard |
| **Alaska** | Encourage non-structural mitigation and preparedness activities. | Policy and Law | Multi-hazard (EQ Action 4.1.1 |
| **Alaska** | Encourage developing erosion damaged embankment restoration projects that use natural vegetation to stabilize and fortify high risk coastal and riverine erosion damaged locations. | Restoration | Flood |
| **Alabama** | 76. Create technical bulletin that educates local floodplain managers about the benefit of evaluating the hazard posed by the encroachment of non-native plant species into floodways. | Education and Awareness | Flood |
| **Alabama** | 77. Create technical bulletin that educates local floodplain managers to account for and incorporate wetland protection and mitigation sites into the planning process when preparing new studies for watercourses. | Education and Awareness | Flood |
| **Alabama** | 112. Create a state program to promote the planting of indigenous trees that are more resilient to high wind events. | Funding and Programmatic | Wind |
| **Alabama** | 79. Reduce the flooding risk to communities by acquiring property located in the 100- year floodplain and return it to open space. | Land Use | Flood |
| **Alabama** | 75. Develop regulations that preserve and rehabilitate natural systems to serve natural hazard mitigation functions (i.e., floodplains, wetlands, watersheds, and urban interface areas) | Policy and Law | Flood |
| **Arizona** | -- | -- | - |
| **Arkansas** | 16. Use green mitigation techniques such as bio swales, rain gardens, and permeable pavers | Green Infrastructure | |
| **California** | Coordinate the activities of state agencies to improve air and water quality; protect natural resources and agricultural lands | Agency Coordination | |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **California** | Provide funding to local agencies in the Sacramento San Joaquin for levee maintenance and improvement and for habitat mitigation and enhancement | Funding and Programmatic | |
| **Colorado** | HH-1: Implement fuels reduction and forest health projects. | Conservation/ Preservation/ Management | Wildfire |
| **Colorado** | FHP 2.1: Enhance the natural and beneficial functions of floodplains by promoting an increased awareness of stream ecosystem function and its benefits to flood hazard mitigation. | Education and Awareness | Flood |
| **Colorado** | DMRP 6.7: River restoration for streams that are most vulnerable to drought impacts. | Restoration | Drought |
| **Connecticut** | 59. Increase support for state-level cultural and natural resources initiatives to increase resiliency of cultural and natural resources from disasters. Expand SHPO resiliency focused technical assistance project completed in 2018 to northern four counties. | Funding and Programmatic | |
| **Connecticut** | 60. Increase support for state-level cultural and natural resources initiatives to increase resiliency of cultural and natural resources from disasters. Expand SHPO resiliency focused technical assistance project completed in 2018 to northern four counties. | Funding and Programmatic | |
| **Connecticut** | 16. Conduct phragmites control/invasive plant control (herbicide and mowing) on state owned land tidal and freshwater marshes to reduce fuel load and wildfire risk in tidal areas for three-year period to control this invasive species. Reduce phragmites by 50% in year one; 40% in year two; 10% in year three with 100% reduction after three years. | Restoration | |
| **Connecticut** | 28. Encourage municipalities and COGs to conduct watershed-based hydrologic and hydraulic studies to evaluate potential flood mitigation alternatives along river and stream corridors. | Technical and Information | |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Connecticut** | 34. Continue to identify head-of-tide habitat within Connecticut and monitor the change in this habitat due to climate change through sentinel monitoring in order to determine those communities that may endure increased risk from coastal storms and associated flooding. LWRD is currently funding multiple monitoring and data synthesis projects in support of this activity | Technical and Information | |
| **Connecticut** | 35. Identify and map the locations of headwater, main stem and coastal dams, culverts, bridges, and other structures or land modifications that contribute to flood damage and act as barriers to habitat connectivity and assess the feasibility of removal or modification of these structures. | Technical and Information | |
| **Delaware** | 26. Encourage the acquisition of land in flood-prone areas. | Conservation/ Preservation/ Management | Flood |
| **Delaware** | 6. Encourage greenways "zoning" along river corridors | Land Use | Flood |
| **Delaware** | 5. Strongly encourage riparian buffer requirements. Recommend environmentally sensitive development such as greenways and trails as opposed to commercial and residential development. | Policy and Law | Flood |
| **Florida** | -- | -- | |
| **Georgia** | 27. Minimize damage to natural resources through the use of and compliance with greenspace, stream buffers, zoning ordinances as actions to protect Georgia communities | Land Use | All Hazards |
| **Georgia** | 88. Ensure there are no adverse effects of any proposed mitigation projects on Georgia's natural resources and/or threatened or endangered species | Policy and Law | All hazards |
| **Georgia** | 28. Create and maintain state wide map layer that identifies important natural and cultural resources | Technical and Information | All Hazards |
| **Hawai'i** | 2018-046—Green Infrastructure Study and Plan | Green Infrastructure | |
| **Hawai'i** | 2018-019—Support the Hawai'i Association of Watershed Partnerships | Partnerships | |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Hawai'i** | 2018-026—Assess, identify, and implement state nursery improvements needed to provide native plants for green breaks | Technical and Information | |
| **Hawai'i** | 2018-047—Report Assessing the Feasibility and Implications of Managed Retreat Strategies for Vulnerable Coastal Areas in Hawai'i | Technical and Information | |
| **Idaho** | -- | -- | |
| **Illinois** | Action 2.6.4.1. Work in developing and maintaining a database on all protected lands, identifying possible partners in the acquisition and maintenance of hazard prone lands contiguous to protected lands. | Technical and Information | |
| **Indiana** | 1. Develop an outreach program to educate communities on green infrastructure and provide opportunities for them to seek additional training | Education and Awareness | Flood |
| **Indiana** | 30. Retrofit state facilities to provide adequate capabilities in the event of disasters. Include green infrastructure to reduce unnecessary strain on water resources | Green Infrastructure | Winter Storm, Drought, Extreme Temps, Wildfire, Disease Outbreak, Fluvial Erosion Hazard |
| **Iowa** | 2.12 Encourage and implement green infrastructure practices to create healthier urban environments and manage storm water in cities. Practices include mechanisms that prevent soil erosion or provide flood protection, habitat, and cleaner air and water (riparian forest buffers, infiltration including bioswales, wet detention systems, storm water wetlands, vegetated swales, permeable pavement, and green roofs). | Green Infrastructure | |
| **Iowa** | 2.14 Use a comprehensive approach to address problems with water washing over or threatening public roads, and with public bridges and culverts that do not meet flow requirements. A comprehensive approach could simply mean elevation, replacement, or retrofit, OR it could be systemwide with a collection of projects/changes that might include green infrastructure, basins, and increased capacity of soil to retain water. | Green Infrastructure | |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Iowa** | 2.4 Acquire more flood prone properties (with priority for repetitive loss and SRL properties) and convert to open space/green space; or elevate to or at least one foot above base flood elevation. | Land Use | |
| **Iowa** | 1.4 Promulgate (and develop if necessary) a handbook explaining options and methods for communities to deal with property acquired from flood buyouts. | Restoration | |
| **Iowa** | 2.5 Implement floodplain and streambank restoration/channel improvement projects that reduce peak flow during flood events. | Restoration | |
| **Iowa** | 4.3 Minimize damage and also preserve/restore the functions of natural systems by establishing vegetated buffers and strategically-placed wetlands that capture runoff and drainage waters before they can negatively impact the surrounding environment. | Restoration | |
| **Kansas** | 33 Assess benefits from the restoration of flow, habitat, and flood storage in urban waterways. | Technical and Information | Flood |
| **Kentucky** | L4 Manage Vegetation, Wetlands | Conservation/ Preservation/ Management | Flooding |
| **Kentucky** | L10 Maintain Creek Banks | Conservation/ Preservation/ Management | Flooding |
| **Kentucky** | D22. Promote, develop Green Infrastructure/Low-Impact Development Projects | Green Infrastructure | Flooding/Landslides |
| **Kentucky** | L13 Realign Streams | Restoration | Flooding |
| **Kentucky** | Flood Action: Protect and restore natural floodplain functions | Restoration | |
| **Klamath Tribes** | Consider planting standards in wildland buffer areas to require fire-resistant plants with loose branching habits, non-resinous woody material, high moisture content leaves and limited seasonal accumulation of dead vegetation | Policy and Law | |
| **Klamath Tribes** | Continue working with Oregon Watershed Enhancement Board for various watershed improvement activities | Partnerships | |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Klamath Tribes** | Continue working on the Legacy Road Reconstruction program for projects such as: decommissioning/vacating of roadways of high negative impact to natural resources; road upgrades; surface drainage improvements; road stabilization, and culvert replacement for fish passage | Funding and Programmatic | |
| **Lac du Flambeau** | Work with Federal partners to preserve or restore wetlands ecosystems in buffer zones along rivers and lakes for flood control and water quality management. Re-assess buffer zone setbacks | Conservation/ Preservation/ Management | Severe Thunderstorms / Lightning / Hail |
| **Lac du Flambeau** | Protect and mitigate existing impacts to the forests along the wetlands and riparian areas, and within the wetlands system. Monitor vegetation changes in watersheds though ground cover surveys, aerial photography or by relying on the research from local conservation groups and universities; | Conservation/ Preservation/ Management Restoration | Severe Thunderstorms / Lightning / Hail |
| **Lac du Flambeau** | Expand opportunities to engage the community in nature preservation projects and efforts | Education and Awareness | Severe Thunderstorms / Lightning / Hail |
| **Lac du Flambeau** | Conduct education and outreach about green infrastructure to help control runoff, capture stormwater and reduce water demand. Some common green infrastructure practices include bioretention areas (rain gardens), low impact development methods, green roofs, swales (depressions to capture water) and the use of vegetation or pervious materials instead of impervious surfaces. | Education and Awareness Green Infrastructure | Severe Thunderstorms / Lightning / Hail |
| **Lac du Flambeau** | Expand programs working to protect sensitive land from development using land acquisition through purchase | Funding and Programmatic | Flood |
| **Lac du Flambeau** | Invest in and utilize green infrastructure to help control runoff, capture stormwater, and reduce water demand. Some common green infrastructure practices include bioretention areas (rain gardens), low impact development methods, green roofs, swales (depressions to capture water) and the use of vegetation or pervious materials instead of impervious surfaces | Green Infrastructure | Severe Thunderstorms / Lightning / Hail |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Lac du Flambeau** | Expand work with utility companies to reduce sediment and nutrient inputs into source water bodies, regulate runoff (construction site) and streamflow, buffer against flooding (e.g., wetlands) | Partnerships | Severe Thunderstorms / Lightning / Hail |
| **Lac du Flambeau** | Integrate policies into existing plans that protect, maintain, and enhance tree canopy in urban settings to reduce heat. | Policy and Law | Extreme Heat |
| **Lac du Flambeau** | Work with Federal partners to take action through existing authorities to ensure enforcement of water quality standards | Policy and Law | Severe Thunderstorms / Lightning / Hail |
| **Lac du Flambeau** | Ensure that the Conservation Code committee continue to meet periodically to discuss issues and recommend projects. | Policy and Law | Flood |
| **Lac du Flambeau** | Enhance existing ordinances which manage riparian buffers along rivers, streams, lakes and other water bodies; | Policy and Law | Flood |
| **Lac du Flambeau** | Develop flood management systems that better utilize natural floodplain processes | Technical and Information | Flood |
| **Louisiana** | No actions like other states, but a technical appendix describing a number of mitigation strategies. | | |
| **Maine** | -- | -- | |
| **Maryland** | #34 – Target Restoration, Preservation, & Mitigation within Special Flood Hazard Areas using the Water Resource Registry | Conservation/ Preservation/ Management Restoration | |
| **Maryland** | #18 - Increase opportunities for communication about adaptation planning in Maryland, facilitate the exchange of ideas between Chesapeake Bay watershed partners, and pilot green/grey infrastructure to prepare for and respond to climate impacts to vulnerable populations. | Education and Awareness Green Infrastructure | |
| **Maryland** | #15 – Coastal Restoration to Mitigate Hazards for Vulnerable Communities | Restoration | |
| **Massachusetts** | EOEEA: Review habitat management, land stewardship, coastal zone management, agricultural and invasive species programs and policies to develop strategies that promote coordination among agencies and support climate change adaptation and mitigation goals. | Agency Coordination | Precipitation Changes, Sea Level Rise, Rising Temperatures, Extreme Weather |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Massachusetts** | MassWildlife: In partnership with CZM, improve management of beach nourishment projects and other shoreline protection strategies and incorporate habitat considerations into coastal storm disaster response habitat and infrastructure on barrier beaches. | Conservation/ Preservation/ Management | Precipitation Changes, Sea Level Rise, Rising Temperatures, Extreme Weather |
| **Massachusetts** | MassDOT: Pilot Deerfield Watershed Stream Crossing Resilience Project. This project will produce GIS layers and a web viewer ranking the vulnerability of culverts and wildlife to climate change. The final report will document the methods used in the project. Next steps will include an evaluation of how to transfer the methods to the remaining watersheds in Massachusetts. | Technical and Information | Precipitation Changes, Sea Level Rise, Rising Temperatures, Extreme Weather |
| **Massachusetts** | DCR: Update the State Forest Action Plan to enhance climate change mitigation and adaptation strategies. Update State Forest Action Plan to incorporate strategies to deal with future conditions presented by a warming planet. These concepts will be incorporated into the 2020 update of the Plan | Funding and Programmatic | Precipitation Changes, Sea Level Rise, Rising Temperatures, Extreme Weather, Earthquake |
| **Massachusetts** | DER: Develop a prioritization and implementation strategy for barrier removal on cold water streams most impacted by warming temperatures. DER will work with federal, state, and local organizations and property owners to identify, prioritize, design, permit, and guide the removal of dams and replacement of culverts for the benefit of cold water habitat, public safety, and municipal infrastructure resilience. Removing barriers results in-stream temperatures decreasing and connectivity increasing for sensitive species in cold water streams, while also improving the safety of roadways, infrastructure and residents living in close proximity to dams and culverts. | Funding and Programmatic | Precipitation Changes, Rising Temperatures, Extreme Weather |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Massachusetts** | DER: Develop an implementation plan to build municipal capacity to replace undersized, deteriorated culverts with larger, safer structures that are resilient to extreme storms and provide passage for fish and wildlife. | Funding and Programmatic | Precipitation Changes, Rising Temperatures, Extreme Weather |
| **Massachusetts** | DER: Develop an implementation strategy and updated prioritization scheme to work with federal, state, and local partners and non-profit organizations to remove unwanted state-owned dams to reduce risk, increase resilience to extreme weather and climate change, and restore aquatic habitat. | Funding and Programmatic | Precipitation Changes, Rising Temperatures, Extreme Weather, Earthquake |
| **Massachusetts** | EOEEA: Based on results of vulnerability assessment for EOEEA properties and vulnerability assessments from other agencies, use climate change projections to develop stormwater management actions and projects. EOEEA properties held by agencies including DCR and MassWildlife such as parkways, parking lots, and other facilities may have opportunities for decreased stormwater runoff through the use of green techniques or traditional methods. Similarly, protected green space held by agencies may be able to buffer neighboring infrastructure held by others. EOEEA will work with its agencies to examine areas with the highest potential for best practice stormwater management projects, and develop a plan to implement these management actions. | Funding and Programmatic | Precipitation Changes |
| **Massachusetts** | DEP: Implement Updated Stream crossing culvert replacement guidance. DEP has an updated stream crossing / culvert replacement guidance to protect wildlife habitat and reduce flooding impacts. The agency will continuing to partner with the Department of Fish and Game, the Division of Ecological Restoration and others to secure funding for culvert replacement projects that will improve the resiliency of new structures, protect habitat and reduce flood damage. | Funding and Programmatic | Precipitation Changes, Sea Level Rise, Rising Temperatures, Extreme Weather |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Massachusetts** | EOEEA: Reassess and develop a climate change resiliency framework and criteria for all EOEEA agency land acquisition and grant funding for land acquisition to support natural resource conservation, wildlife, human health and public safety. While EOEEA has incorporated resiliency criteria into its land acquisition grant programs and agencies address it in their agency prioritization schemes, the overall natural land protection program should be reviewed, assessed and reprioritized to ensure protection of multiple resiliency goals including protecting critical ecosystem services, ensuring connectivity of wildlife, protecting climate-sensitive areas, avoiding repeat loss of infrastructure and property, increasing human health and safety, and preserving habitats of climate-sensitive species. | Funding and Programmatic | Precipitation Changes, Sea Level Rise, Rising Temperatures, Extreme Weather |
| **Massachusetts** | DER: Develop an implementation plan to reprioritize and accelerate tidal wetland restoration for climate adaptation and habitat restoration. DER will work with towns and private property owners as well as federal, state, and local organizations to identify, design, permit, and guide the construction of salt marsh restoration projects that benefit public safety, build resilience to extreme weather and sea level rise, and restore coastal habitat. Coastal wetlands provide benefits to people and communities such as flood reduction, protection from coastal storms, water quality improvement, and recreation. | Funding and Programmatic Restoration | Severe Thunderstorms / Lightning / Hail |
| **Massachusetts** | DER: Develop an implementation strategy for retired cranberry bog restoration for climate adaptation and habitat restoration by working with landowners, federal, state, and local partners and non-profit partners for climate resiliency, habitat quality, flood and water quality protection, and wildlife. | Funding and Programmatic Restoration | Precipitation Changes, Sea Level Rise, Rising Temperatures, Extreme Weather |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Massachusetts** | DER: Develop an implementation plan to complete priority water quality restoration projects for climate adaptation and habitat restoration. DER will work with partners to identify, prioritize, plan and complete projects that improve water quality and increase community resilience to water quality impacts stemming from climate change. Projects may include green infrastructure stormwater treatments; enhancing local and regional capacity for data collection, analysis, and leading restoration projects; restoration of riparian buffer functions and values; and support to communities developing ordinances and stormwater utilities. | Funding and Programmatic Restoration Green Infrastructure | Precipitation Changes, Rising Temperatures |
| **Massachusetts** | DER: In support of EOEEA's efforts on MVP, build the capacity of regional organizations to implement climate adaptation and habitat restoration at the local level.DER will partner with and support up to five regional organizations that help municipalities identify, develop, and implement projects that provide climate change adaptation and improved public safety for communities and habitat restoration benefits for fish and wildlife. DER will facilitate regional solutions at the watershed, river corridor, or coastline scale, which may cross municipal boundaries. | Partnerships | Precipitation Changes, Sea Level Rise, Rising Temperatures, Extreme Weather |
| **Massachusetts** | EOEEA: Review, evaluate, and implement revisions as needed to environmental and energy policies, regulations, and plans.: Review, evaluate, conduct outreach with stakeholders, and implement revisions that may be needed to key state environmental and energy policies, regulations and plans maintained by EOEEA and its agencies. This action has cross-cutting impact on risk reduction across the administration. | Policy and Law | Precipitation Changes, Sea Level Rise, Rising Temperatures, Extreme Weather |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Massachusetts** | DEP: Promulgate wetlands regulations to establish performance standards for work in land subject to coastal storm flowage. Promulgate wetlands regulations to establish performance standards for work in Land Subject to Coastal Zone Flowage. DEP Wetlands Protection Program is working to propose draft regulations that will establish performance standards for work in Land Subject to Coastal Zone Flowage. This resource area is critical for reducing coastal impacts from Storm event. DEP intends to align any proposed standards with FEMA mapping and the state building code for these areas. | Policy and Law | Precipitation Changes, Sea Level Rise, Rising Temperatures, Extreme Weather |
| **Massachusetts** | DER: Restore streamflow to flow-stressed rivers to increase resiliency for aquatic ecosystems and for water supplies. DER works to restore natural streamflow (the amount of water that flows through streams and rivers) in Massachusetts. DER works with partners to collect streamflow data and manages restoration projects aimed at restoring natural flow. Streamflow restoration projects increase community resilience to drought and improve aquatic habitats. | Restoration | Precipitation Changes, Rising Temperatures |
| **Massachusetts** | MassWildlife: Dam removals at the Merrill Ponds Wildlife Management Area. | Restoration | Precipitation Changes, Extreme Weather, Earthquake |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Massachusetts** | MassWildlife: Great Marsh Pilot Ditch Remediation Project. Because of the significance of the marsh, cost-effective experimental pilot projects are warranted to assess the feasibility of larger-scale interventions in the future. Marsh ditching during the past century has led to partial drying and lowering of the marsh bed. In cooperation with The Trustees of Reservations (TTOR), researchers at University of New Hampshire, and other partners, we propose to fill select ditches on MassWildlife and TTOR properties with organic material and measure the effects on marsh elevation and rates of sediment trapping. Preliminary indications are that this technique may prevent further subsidence, reduce the rate of marsh loss, and possibly even gradually elevate the marsh bed through sediment trapping. | Restoration | Precipitation Changes, Sea Level Rise, Rising Temperatures |
| **Massachusetts** | DER: Update and share a dam removal decision support tool that directly incorporates new climate change projections, climate adaptation benefits and helps municipalities and others prioritize dams for removal. Municipalities, federal, state, and local agencies and non-profit organizations want to remove outdated dams to reduce risk, improve public safety, and restore habitat. With more than 3,000 dams and limited resources, it is important to select the projects that will yield the greatest environmental and risk reduction benefits. DER has developed and published a web-based tool that evaluates dams for removal based on the expected ecological benefit. DER will update and publish the web-based tool to include risk reduction and climate adaptation benefits. | Technical and Information | Precipitation Changes, Rising Temperatures, Extreme Weather |
| **Massachusetts** | DEP: Update precipitation data used by wetlands program. Update Precipitation projections (models) used by the wetlands program to condition work in wetland resource areas and design stormwater controls. | Technical and Information | Precipitation Changes, Sea Level Rise, Rising Temperatures, Extreme Weather |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Massachusetts** | DEP: Regional water quality monitoring initiative. DEP is participating in a regional surface water quality monitoring initiative with the other New England states, EPA Regional offices, and tribes in the Northeast, Mid-Atlantic and Southeast. This effort monitors freshwater streams to detect climate-related changes related to temporal trends in biological, thermal, hydrologic, habitat and water chemistry data, and to gather information on response and recovery of organisms to extreme weather events. | Technical and Information | Precipitation Changes, Sea Level Rise, Rising Temperatures, Extreme Weather |
| **Massachusetts** | MassWildlife: Evaluation of climate change impacts on common species. MassWildlife is largely funded through the purchase of fishing and hunting licenses. Common species (e.g., yellow perch, pumpkinseed, chain pickerel, wild turkey, deer, bear,) provide recreational opportunities to the broadest number of anglers and hunters and yet little work has focused on understanding how these species will respond to climate change in Massachusetts. Climate change is likely to shift habitats that support common species as well as angler and hunter behavior. Understanding the direct and indirect effects of climate change on common species and angler/hunter behavior will allow the Division to foresee how management strategies may need adjustment to provide recreational opportunities to Commonwealth citizens into the future. | Technical and Information | Precipitation Changes, Sea Level Rise, Rising Temperatures, Extreme Weather |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Massachusetts** | MassWildlife: Updates to BioMap2. In 2010, the MassWildlife's Natural Heritage and Endangered Species Program completed a rigorous analysis of the status and location of rare species and natural communities in collaboration with The Nature Conservancy. The resulting document, BioMap2, identified areas where conservation efforts should be focused in order to protect plant and wildlife biodiversity in Massachusetts. For example, the document has been used to identify where land acquisition is likely to benefit the protection of rare species. Since completion of the document newer and finer-scaled climate change predictions have become available. Incorporation of the newer predictions as well as more recent species and habitat data can help the Division prioritize and tailor effective management actions. | Technical and Information | Precipitation Changes, Sea Level Rise, Rising Temperatures, Extreme Weather |
| **Massachusetts** | MassWildlife: Work with MassDOT to incorporate habitat and cold water fisheries considerations into MassDOT climate vulnerability assessments, adaptation projects, and community planning tools. | Technical and Information | Precipitation Changes, Sea Level Rise, Rising Temperatures, Extreme Weather |
| **Massachusetts** | MassWildlife: Evaluation of shifts in habitats and species distributions. Species habitats and distributions are expected to shift with changing environmental conditions, resulting in changes to the function and structure of ecosystems. The Division of Fisheries and Wildlife will need to understand the rate and extent of changes to ecosystems over different timescales in order to effectively manage resources. The Division is already considering these shifts in management decisions. For instance, emphasis has fallen away from purchasing areas that will likely be lost to sea level rise (e.g., salt marshes). However, comprehensive spatially-explicit analysis (where, how) of impacts to ecosystems and vulnerable species and habitats has not been completed. | Technical and Information | Precipitation Changes, Sea Level Rise, Rising Temperatures, Extreme Weather |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Massachusetts** | MassWildlife: Study impact of climate change on fish hatcheries held by MassWildlife. | Technical and Information | Precipitation Changes, Sea Level Rise, Rising Temperatures, Extreme Weather |
| **Massachusetts** | MassWildlife: Identification of areas with high native aquatic biodiversity to help prioritize aquatic adaptation actions as the climate changes. The Division of Fisheries and Wildlife is responsible for the conservation of freshwater fishes and wildlife throughout Massachusetts. Efforts (i.e. BioMap2) have been made to rigorously analyze and map rare species and natural community data in terrestrial ecosystems. These efforts identified lands critical for protecting and maintaining wildlife and plant biodiversity in Massachusetts. However, similar efforts have not been completed for the river and streams providing habitat to aquatic species (e.g., fishes, freshwater mussels) managed by MassWildlife. Identification of water bodies with high native aquatic biodiversity would provide critical information necessary for effective management and conservation of aquatic species in the state. | Technical and Information | Precipitation Changes, Rising Temperatures, Extreme Weather |
| **Massachusetts** | MassWildlife: Identification of cold water climate refugia and transitional waters for protections of CFRs. | Technical and Information | Precipitation Changes, Rising Temperatures, Extreme Weather |
| **Massachusetts** | MassWildlife: Mapping and control of invasive plant species. | Technical and Information | Precipitation Changes, Sea Level Rise, Rising Temperatures, Extreme Weather |
| **Michigan** | Conduct periodic educational programs on creating and maintaining a storm-resistant urban forest, targeted at urban forestry programs and local public works agencies, making their areas more resistant to severe winds, fires, lightning, ice storms, and invasive species. | Education and Awareness | |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Michigan** | Promote coordination and provide technical support for local urban forestry programs (professional guidance, training, and education; tree selection, planting, and maintenance; local tree ordinance development; public awareness and education; street and park tree management and planning; community climate adaptation planning; utility vegetation management, awareness, and safety; recognition/certification). | Partnerships | |
| **Minnesota** | Promote collective action between state agencies to address the stability of natural systems in the built environment by providing sufficient water storage, reducing volume, slowing velocity, and promoting practices to stabilize soils and maintain the diversity of native plant communities | Agency Coordination | |
| **Minnesota** | Flood goal: Stream corridor protection projects and restoration and soil erosion control projects will be used to prevent or reduce risks and increase the protection of natural resources from flooding. | Conservation/ Preservation/ Management Restoration | |
| **Minnesota** | Extreme Temperature Goal: Reduce Urban Heat Island Effect. Increase tree plantings around buildings to shade parking lots and along public rights-of-way. Encourage installation of green roofs and cool roofing products that reflect sunlight and heat away from a building. | Green Infrastructure | |
| **Minnesota** | Flood goal: #4 Require incorporation of water-sensitive infrastructure – such as protection of natural areas, development of green infrastructure, and minimization of impervious areas to treat both water quality and quantity – in all comprehensive plans and watershed plans. | Policy and Law<br><br>Green Infrastructure | |
| **Mississippi** | Preserve, create, and restore natural systems | Conservation/ Preservation/ Management Restoration | Hurricane |
| **Missouri** | -- | -- | |
| **Montana** | Project 5.4.2 - Encourage passive water storage where it will enhance natural function and increase water supply security. | Conservation/ Preservation/ Management | Drought |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Montana** | Project 1.5.1 - Continually update planning and zoning guidelines and model regulations (including growth policies, subdivision regulations, floodplain regulations, design standards for open space, setbacks and vegetative buffers) which recognize the risk from natural and manmade hazards and offer recommendations on best practices and smart growth solutions. | Land use | All hazards |
| **Montana** | Project 3.3.1 - Encourage appropriate entities to obtain conservation easements for land in the floodplain. | Partnerships | Flood |
| **Montana** | Project 5.3.1 - Continue to implement angling restrictions and closures to reduce drought impacts on Montana fisheries. | Policy and Law | Drought |
| **Montana** | Project 5.3.2 - Continue to administer Fish, Wildlife, and Parks' Water Rights and Water Reservations to protect instream flows during drought for the benefit of fish and wildlife | Policy and Law | Drought |
| **Montana** | Project 8.3.1 - Encourage water saving measures and institute fishing restrictions during drought to reduce stress on fish, which can make them more susceptible to disease. | Policy and Law | Disease Outbreaks |
| **Montana** | Project 3.4.5 - Encourage Natural Channel Design (NCD) techniques for stream restoration and bank restoration/stabilization projects to increase flood resiliency. | Restoration | Flood |
| **Montana** | Project 3.4.6 - Encourage projects that will increase stream length to regain natural function and reduce impact of flooding. | Restoration | Flood |
| **Montana** | Project 5.4.4 - Encourage removal of abandoned structures to improve stream connectivity. | Restoration | |
| **Nebraska** | Establish Floodplain Management Program for Channel Migration – A floodplain management program for channel migration should be implemented with the philosophy that infrastructure should work with the natural hydrology instead of changing the waterways to meet existing infrastructure, and emphasize nature-based solutions | Funding and Programmatic | Flood |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Nevada** | Provide native and accepted introduced seed species through the Nevada State seed bank program | Conservation/ Preservation/ Management | Wildfire |
| **Nevada** | Supply resources for rehabilitation efforts through the State Tree Nurseries in Las Vegas and Washoe Valley, and the Nevada State seed bank programs. | Funding and Programmatic | Wildfire |
| **Nevada** | Restore native and adapted vegetation and work to prevent areas being impacted by non-native or undesirable species conversions through collaborative efforts. | Restoration | Wildfire |
| **New Hampshire** | 58. Continue the development of local and regional river corridor stewardship programs such as the Rivers Management and Protection Program. | Funding and Programmatic | Inland Flooding |
| **New Hampshire** | 34. Promote funding and resources for land acquisition, conservation planning, land management programs, and land stewardship in areas at risk of loss or degradation due to sea level rise. | Funding and Programmatic | Coastal Flooding/Inland Flooding |
| **New Hampshire** | 47.Recommend a comprehensive planning and zoning policy such as development setbacks and limits on density and infrastructure in coastal and transitional zones to consider vulnerability to sea level rise and saltwater intrusion. | Land Use | Coastal Flooding/Inland Flooding |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **New Hampshire** | 43.Continue to develop and maintain GIS layers as a multi-agency collaborative effort to capture data, including but not limited to: • NH DES-NHGS: Stream Crossing Initiative geodatabase. • NH DNCR-DHR: Sensitive natural and cultural resources and historical and archeological properties, and incorporation of archeological site data in the new Electronic Mapping and Management Information Tool (EMMIT) and promote use by municipalities, local heritage commissions, historical societies, and preservation professionals. • NH DNCR-DFL: LANDFIRE data layers (used to determine statistical probabilities of wildland fires). • NH DES Coastal Program: Coastal hazards (maximum flooding extent, nuisance flooding extent, etc.), locations of natural and manmade protective systems and barriers (salt marshes, seawalls, etc.), ongoing study locations, and others. Data collected in partnership with NH Fish and Game, UNH Sea Grant, and GRANIT. • NH HSEM: Maintain Hazard Mitigation Assistance (HMA)Program funded project layer. | Technical and Information | All Hazards |
| **New Jersey** | 2008 PSA 223 Continue the nonlapsing Shore Protection Fund for shore protection projects, stabilization, restoration or maintenance of the shore, including monitoring studies and land acquisition. | Funding and Programmatic | |
| **New Mexico** | 6. Implement Actions to Improve Forest and Watershed Health | Restoration | Drought, Flood, Wildfire |
| **New York** | Land Acquisition: Continue to purchase land & explore enhancement options that may prevent development encroachment into hazardous areas. Identifying alternate funding sources for land acquisition resulting in open space or some sort of development prevention in a hazard area is a fundamental form of hazard mitigation. | Conservation/ Preservation/ Management | Coastal Hazards \| Hurricane \| Flooding |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **New York** | Sustainable Shoreline Project: Development of guidance for communities on the tradeoffs among management options for controlling shoreline erosion, including relative costs, impacts on habitat functions, and resilience to storms and sea level rise. The project included a series of green shoreline demonstration projects including the design of two ecologically-enhanced (or green") shoreline treatments to control erosion on shorelines in Cold Springs and Nyack." | Education and Awareness | Coastal Hazards |
| **New York** | Hudson Estuary Watershed Resilience Project: The Estuary Program is funding Cornell Cooperative Extension staff in Columbia, Dutchess, Greene, Orange and Putnam counties to conduct outreach to municipal and landowner audiences in target watersheds on flood resiliency. This effort will address the need for communities to enhance their understanding of stream dynamics, floodplain function and watershed planning to enhance their vulnerability to floods. The project will also evaluate the capacity of communities to respond to floods in a manner that ensures the long-term viability of stream systems and reduces future flooding impacts. | Education and Awareness | Flooding \| Coastal Hazards |
| **New York** | Green Infrastructure to Reduce Localized Flooding: Green infrastructure practices can reduce storm water runoff through infiltration. By strategically implementing appropriate green infrastructure practices, especially as retrofits, localized flooding problems can be reduced. Implementation can be site-specific or within a particular sub watershed to improve storm water management during storms. While many potential sites have already been identified, a component of this project could be a plan to identify the most strategic locations to specifically reduce flooding problems. | Green Infrastructure | Flooding \| Coastal Hazards |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **New York** | Targeted Dam Removal Hudson Estuary Watershed: Dam infrastructure is aging, while precipitation is predicted to become more intense. These two factors increase the future risk of catastrophic, and unplanned, dam failures. Dams can also create upstream flooding around the impoundment. A regional program that identifies the highest risk dams to downstream flooding as well as those contributing to upstream flooding, will be identified, and dam removal will be pursued with willing dam owners to permanently eliminate dam related flood risks. | Restoration | Flooding |
| **New York** | Jones Beach State Park - Dune Creation Project: While most of Jones Beach State Park is buffered from coastal storms by natural dunes, there are no coastal dunes in front of the park,Äôs most developed section which includes the West Bathhouse, Central Mall, Boardwalk, and the East Bathhouse. These areas experienced significant damage during Hurricane Sandy. This project will construct a protective dune system as a natural protection measure for park facilities. | Restoration | Coastal Hazards |
| **New York** | Orient Beach State Park ,Äì Shoreline Protection: Most the entrance road to Orient Beach State Park has been stabilized with a rock revetment, but roughly 1,700 linear feet of the access road still requires protection. The roadway and nearby utility lines were damaged during many number of coastal storms, including Hurricane Sandy. | Restoration | Coastal Hazards |
| **New York** | Bayswater Park Project: Located on a Jamaica Bay historic estate, the park has lost most of its structured bulkhead to salt marsh grasses. This project will establish a natural, storm-resilient shoreline using native plantings by creating tidal wetlands and dunes. | Restoration | Coastal Hazards \| Flooding \| Hurricane |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **New York** | Lake Kanawauke and Lake Sebago Project: The stream corridor that connects Lake Kanawauke and Lake Sebago was heavily damaged by flooding during Tropical Storm Irene. The stream passes through several culverts and pipes witn insufficient capacity for major flood events. This project will remedy the capacity problems and restore the stream to natural conditions, removing a potential impoundment hazard that is vulnerable to failure and increases risk to Lake Sebago dam and downstream communities. | Restoration | Flooding |
| **New York** | Fire Island Stabilization Project part of FIMP: Rebuild dunes to 15,Äô and beach re-nourishment; may involve property acquisition to allow new alignment | Restoration | Hurricane \| Coastal Hazards |
| **New York** | Integrating SLAMM results and stakeholder priorities to define marsh adaptation strategies: Building on the previous SLAMM project, this project will better incorporate roads and infrastructure into the analysis, better visualize marsh migration pathways, and develop a decision-support tool that will assist decision makers in planning adaptation strategies for marsh conservation and coastal community resiliency. The study area will consist of NYC, Westchester County, and Nassau County. | Technical and Information | Flooding \| Hurricane \| Coastal Hazards |
| **New York** | Assessing Flooding Risks and Mitigation Options from a Watershed Perspective: Use a watershed-based approach to study rivers and streams to determine flooding risks and mitigation options. The study will use watershed delineation, GIS mapping data, and hydraulic modeling to determine the most effective mitigation methods that can be locally implemented. | Technical and Information | Flooding \| Coastal Hazards |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **New York** | Conduct a Climate Vulnerability and Economic Assessment for AtRisk Transportation Infrastructure in the Lake Champlain Basin: Prioritize road-stream crossings (culverts) and road segments that are most vulnerable to climate change impacts, and have significant safety and ecological roles; develop engineering-based design adaptation options; incorporate the benefits and costs of adaptation options. The study is also supporting the development of the USGS StreamStats tool for NYS, which will be expanded to allow projecting trends. | Technical and Information | Flooding \| Coastal Hazards |
| **New York** | Oakwood Beach Natural Infrastructure Feasibility Study: Mini-feasibility study to see if wetlands can be added to USACE project for South Shore of Staten Island Feasibility Study | Technical and Information | Hurricane \| Coastal Hazards |
| **New York** | Habitat Corridor Mapping in the Hudson Valley: Cornell University is working with the Estuary Program to develop a landscape-scale habitat connectivity map based on changes in species distribution caused by climate change. This will help to prioritize land conservation for north-south corridors to allow wildlife migration as the climate changes (plants, animals, and ecosystems). | Technical and Information | Flooding \| Coastal Hazards |
| **New York** | SLAMM Modeling in the Hudson Estuary: Cornell University and Scenic Hudson using the SLAMM (Sea Level Rise Affecting Marshes Model) to model potential marsh migration in the Hudson Estuary to develop shoreline conservation priorities and assess the need for barrier removal to facilitate the landward migration of tidal wetlands as sea level rises. Loss of tidal wetlands can impact water quality especially in drought or heat extremes. | Technical and Information | Flooding \| Coastal Hazards |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **New York** | Marsh Migration Modeling with SLAMM: This project predicts how wetlands along New York State's coastlines may move and change due to sea-level rise. The results will help land-use planners identify appropriate adaptation strategies for these marshes and nearby areas. | Technical and Information | Hurricane \| Flooding \| Coastal Hazards |
| **North Carolina** | The state will provide training and publications to local governments, state agencies, and other organizations on emergency management and mitigation. Encompassed in this, the state will develop and implement an outreach program to receive feedback on mitigation programs and policies. These efforts may include:<br>-Conduct direct outreach on non-structural mitigation measures at Local, Tribal, and State agencies as well as with citizens. | Education and Awareness | All Hazards |
| **North Carolina** | Carry out projects that qualify under the most current version of Unified Hazard Mitigation Assistance program to protect/mitigate risk to people and personal property such as residences and businesses. Where possible, a primary focus of these programs will be on repetitive loss and severe repetitive loss properties. Project types that fall under this action could include, but are not limited to:<br>-Provide funds for purchase of conservation easements or purchase of land within floodplain<br>-Identify properties to be acquired that will support mitigation by coordinating with other entities (such as the Clean Water Task Force) to leverage other funding sources for acquisition to support additional state mandated goals.<br>-Develop funding source (with hazard funds) targeted to areas most vulnerable to earthquakes, sinkholes, and landslide/geochemistry for acquisition and/or conservation easements. | Funding and Programmatic | All Hazards |
| **North Dakota** | -- | -- | |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Ohio** | Explore the possibility of using Alternative Stormwater Infrastructure Loan Program to target properties purchased with HMA grants as future green infrastructure project sites. | Funding and Programmatic Green Infrastructure | |
| **Oklahoma** | -- | -- | |
| **Oneida Nation** | Maintain a stormwater management plan that includes such remediation techniques as surface detention basins, in-street detention units, and rain gardens | Green Infrastructure | |
| **Oregon** | 115. Maintain the Riparian Lands Tax Incentive Program. This program helps reduce sediment and protect stream banks which helps reduce the filling of river and stream channels | Funding and Programmatic | |
| **Oregon** | 26. Incorporate text addressing hazard mitigation into natural resource agencies' guidance and process documents focusing on environmental quality to ensure that natural resources are protected in the design and construction of hazard mitigation projects | Funding and Programmatic | |
| **Pennsylvania** | Action 1-13a. Identify cooperative funding opportunities for natural system protection projects. Obtain hazard mitigation funds for a stream corridor restoration or wetland restoration project associated with flooding. | Funding and Programmatic | |
| **Rhode Island** | 2019-48: Beach Ecosystem Preservation - Preserve the dynamic nature of beaches and barriers in future management of these critical natural systems. Differentiation between developed and undeveloped systems is necessary when considering management approaches. New development should be minimized in undeveloped beach and dune areas and retreat incentivized as a coastal adaptation strategy where possible. Offshore sand sources suitable for beach replenishment should be identified and beaches should be prioritized for re-nourishment. | Conservation/ Preservation/ Management | |
| **Rhode Island** | 2019-36: Green Stormwater Infrastructure: Enhance the capacity of traditional stormwater systems through the use of green infrastructure. | Green Infrastructure | |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Rhode Island** | 2019-50: Coastal Wetland Habitat Preservation: Monitor and assess coastal wetland habitats and management practices to evaluate and prioritize future actions. Statewide models, such as the SLAMM, should be updated to identify opportunities for restoration and assist in planning for future marsh migration. To minimize loss and preserve the benefits of coastal wetland habitats, conservation and management must be approached at multiple scales and timeframes. State agencies and their partners should continue to work with municipalities to identify opportunities for retreat, removal of derelict infrastructure, and enhancement of natural shoreline areas. Where possible, retreat rather than fortification should be emphasized as a coastal adaptation strategy. | Technical and Information | |
| **South Carolina** | Maintain healthy beach profile. | Conservation/ Preservation/ Management | |
| **South Carolina** | Fund the Beach Restoration and Improvement Trust Fund; Establish timely release of Beach Renourishment Trust Fund. | Funding and Programmatic | |
| **South Carolina** | Support Dune Restoration Efforts | Restoration | |
| **South Dakota** | -- | -- | |
| **Tennessee** | 4. Develop a strategy for empowering non-profit groups such as environment or watershed protection organizations to support local hazard mitigation planning by October 2021 | Partnerships | All Hazards |
| **Texas** | Restore and protect coastal wetlands and marshes. Coastal wetlands are transitional areas of vegetation and soils located between uplands and open marine water environments that are typically saturated or periodically inundated by tidal waters. | Conservation/ Preservation/ Management Restoration | Coastal Erosion |
| **Texas** | Encourage local communities to enforce above-minimum floodplain compliance. These include zero rise, 18 inch curb, fees for open space conversion, and freeboard ordinances on coastal properties | Land Use | Flood |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Texas** | Recruit conservancy agencies to purchase and maintain key undeveloped land in coastal areas. The National Fish and Wildlife Foundation (NFWF) administers and monitors the $2.544 billion Gulf Environmental Benefit Fund arising from the 2010 Deepwater Horizon explosion and oil spill in the Gulf of Mexico. The Fund will provide $203 million for natural resource projects in Texas. The NFWF, a Congressionally-chartered non-profit, is one of the largest private funders of conservation projects in the United States. | Partnerships | Hurricane/Storm Surge |
| **Texas** | Restore natural beach and dune system through beach nourishment and dune restoration | Restoration | Coastal Erosion |
| **Utah** | 3. Construct debris basins, flood retention ponds, bioswales & energy flow dissipaters in an effort to control the flow and release of flood waters. | Green Infrastructure | Flood |
| **Utah** | 6. River Restoration: Ogden City has lead the way in restoring a section of Ogden City and using FEMA grants to restore a section of the Weber river | Restoration | Flood |
| **Utah** | 7. Watershed Restoration: These projects would apply to drought, wildfire and erosion. Would include projects that address watershed protection and restoration, such as beaver dams, reseeding, fuel reduction, etc.. | Restoration | Flood, Drought, Wildfire, Erosion |
| **Vermont** | Conserve land identified in the critical headwater storage inventory through landowner outreach and existing conservation programs. | Conservation/ Preservation/ Management | Inundation; Fluvial Erosion |
| **Vermont** | Strategy: Connect water quality, flood resilience and native habitat connectivity through co-benefits. Action: Promote the use of Vermont Fish and Wildlife's Conservation Design Plan to achieve and maintain habitat connectivity and havens for Vermont rare, threatened, and endangered species (aquatic and terrestrial). | Conservation/ Preservation/ Management | Inundation; Fluvial Erosion |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Vermont** | Strategy: Connect water quality, flood resilience and native habitat connectivity through co-benefits Action: Promote the use of Vermont Fish and Wildlife's Conservation Design Plan to achieve and maintain habitat connectivity and havens for Vermont rare, threatened, and endangered species (aquatic and terrestrial). | Conservation/ Preservation/ Management | Invasive Species; Inundation; Fluvial Erosion |
| **Vermont** | Strategy: Improve flood resilience of agricultural lands Action: Expand use of USDA conservation programs to plant riparian buffers and flood chute grassed waterways to reduce future flood damage to farm fields, attenuate flood-borne sediment and debris, and reduce downstream flooding. | Funding and Programmatic | Inundation; Fluvial Erosion |
| **Vermont** | Strategy: Connect water quality, flood resilience and native habitat connectivity through co-benefits. Action: Create a "Reconnect Vermont Rivers" initiative (or similar State planning, prioritization, and tracking mechanism) to enhance the funding eligibility and incentives for flood resilience, water quality, and habitat projects as co-benefits. | Funding and Programmatic | Inundation; Fluvial Erosion |
| **Vermont** | Strategy: Establish a statewide conservation and buyout program. Action: Create a dedicated State fund to support the purchase or local match of hazard-prone properties and the purchase of easements to conserve river corridors, floodplains, and wetlands identified as key flood attenuation areas. | Funding and Programmatic | Inundation; Fluvial Erosion; Landslide |
| **Vermont** | Expand the eligibility criteria and increase funding for VHCB's conservation and buyout program, to address any flood-vulnerable structures. | Funding and Programmatic | Inundation; Fluvial Erosion |
| **Vermont** | Strategy: Promote land management standards for State and private lands Action: Work with land conservation organizations to include river corridor and floodplain protection provisions, and/or headwater storage in conservation easements. | Partnerships | Inundation; Fluvial Erosion |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Vermont** | Strategy: Improve headwater storage Action: Complete a pilot project in a strategic watershed, using the above inventory, to prioritize land conservation and determine the cost of averted flood damage. | Technical and Information | Inundation; Fluvial Erosion |
| **Vermont** | Strategy: Improve headwater storage Action: Develop an inventory of critical headwater and floodplain storage areas that would result in a measurable abatement of flooding. | Technical and Information | Inundation; Fluvial Erosion |
| **Vermont** | Identify critical headwater storage areas enrolled in the Current Use program and conduct outreach to inform landowners of the value of protecting these areas during harvesting operations. | Technical and Information | Inundation; Fluvial Erosion |
| **Vermont** | Identify stormwater-impaired headwater storage areas where stormwater treatment and stream restoration would result in hazard mitigation co-benefits. | Technical and Information | Inundation; Fluvial Erosion |
| **Vermont** | Strategy: Connect water quality, flood resilience and native habitat connectivity through co-benefits. Action: Develop hydraulic and stream power models for a range of flood frequencies to analyze and define valley areas supporting essential floodplains and river corridor functions that would increase the storage of flood flows, sediments, and nutrients. | Technical and Information | Inundation; Fluvial Erosion |
| **Virginia** | -- | -- | |
| **Washington** | Reduce the Conversion of Ecologically Important Lands for Development - Reducing development impacts on ecologically important lands and enhance the ecosystem services those lands provide. | Conservation/ Preservation/ Management | Coastal Hazards Flood Climate Change |
| **Washington** | Pest Program - Protect the agriculture, environment and natural resources of Washington State by preventing the introduction and spread of high risk invasive insects, terrestrial snails, plant diseases and noxious weeds. | Conservation/ Preservation/ Management | Agricultural Disease |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Washington** | Flood Control Assistance Account Program - To promote flood risk reduction throughout the state. This fund enables communities to do flood risk reduction planning and projects that can include house elevations and buyouts, levee work, and ecosystem improvements. Creation of comprehensive flood hazard management plans is a central goal of the program. Creation of comprehensive flood hazard management plans is a central goal of the program. | Funding and Programmatic | Flood |
| **Washington** | Shoreline Armoring Implementation Strategy - Increase the health of Puget Sound shores while ensuring people and their property are safe and able to continue enjoying Puget Sound beaches. Sustaining shoreline processes provides habitat necessary to support a diverse and resilient marine food web, and also provides opportunity for adaptation to sea level rise and climate-driven changes. A functioning nearshore provides recreation and a natural buffer that protects waterfront properties. | Funding and Programmatic | Coastal Hazards Flood Climate Change |
| **Washington** | Voluntary Stewardship Program - All 27 counties that opted into the Voluntary Stewardship Program have approved work plans that protect and enhance critical areas (wetlands, areas with a critical recharging effect on aquifers used for potable water, frequently flooded areas, geologically hazardous areas, and fish and wildlife habitat conservation areas) while maintain the viability of agriculture. | Funding and Programmatic | Flood Earthquake Landslide |
| **Washington** | Incorporate Hazard Mitigation and Disaster Recovery into Comprehensive Plans - Improve community resilience through better guidance and technical assistance to local government for comprehensive planning and Critical Areas Ordinance updates and through coordination between Commerce and EMD. Locally adopted comprehensive plans, development regulations and capital improvement plans (programs) consider the impacts of disasters on the natural and build | Funding and Programmatic | Earthquake Landslide Flood Goal 1 |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| | environments to ensure actionable local strategies are developed and, when adequately resourced, implemented. | | |
| **Washington** | Floodplains by Design: Further flood safety, floodplain ecological restoration, and support agriculture in floodplains around the state; Restoration | Partnerships | Flood |
| **Washington** | Critical Areas Ordinance/Hazard Mitigation Planning Coordination - COM and EMD will develop a process to coordinate on planning, guidance, and local-jurisdiction technical assistance to better align comprehensive plans, Critical Areas Ordinances and hazard mitigation plans with the aim of producing more effective, more accurate plans that better reduce long-term vulnerability and include more local stakeholders. | Policy and Law | Flood Landslide Earthquake Tsunami |
| **Washington** | Address Chronic Environmental Deficiencies (mitigate using nature-based solutions)- Chronic Environmental Deficiency sites (CEDs) are locations along the state highway system where recent, frequent, and chronic maintenance repairs to the state transportation system are causing impacts to fish and fish habitat. Address areas of repeated maintenance and include them in the Transportation Asset Management Plan. Mitigate using nature-based solutions that are resilient to climate hazards.; | Restoration | |
| **Washington** | Chehalis Basin Flood Reduction - In 2016, the Washington State Legislature created the Office of Chehalis Basin to "aggressively pursue implementation of an integrated strategy and administer funding for long-term flood damage reduction and aquatic species restoration in the Chehalis River Basin." | Restoration | Flood |
| **Washington** | Replace Undersized Culverts (mentions green infrastructure) - Remove and replace 30 barriers to fish migration, statewide, each year, currently funded to build 11-15 (depending on individual project costs).; | Restoration | |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Washington** | Coastal Resilience Technical Assistance - Avoid or minimize the existing and future impacts of coastal hazards on communities and natural resources. | Technical and Information | Flood Landslide Tsunami Coastal Hazards |
| **Washington** | Floodplain Management Technical Assistance - Reduce flood damage and support ecosystem recovery in floodplains. | Technical and Information | Flood |
| **West Virginia** | -- | -- | |
| **Wisconsin** | 2.1 Action: Encourage communities to sign up for and participate in the Conservation Reserve Enhancement Program (CREP) to reduce crop losses. | Conservation/ Preservation/ Management | |
| **Wisconsin** | 1.7 Action: Coordinate and incorporate hazard mitigation planning concepts in future updates to the State Guide on Developing the Natural Resources Element of the Comprehensive Planning Guides | Funding and Programmatic | |
| **Wisconsin** | 3.1 Action: Give extra points to communities applying for DNR Stewardship programs if their proposal includes mitigation elements. DNR's Stewardship grant program allocates additional points for projects that acquire, enhance, or protect natural areas that provide water quality and water quality benefits. Many of these projects often also serve as flood mitigation measures. Adding specific mitigation actions, such as increasing floodwater storage capacity, to the project ranking criteria would help conserve natural resources while reducing flood losses. | Funding and Programmatic | |
| **Wisconsin** | 3.18 Action: Implement the Municipal Flood Control and Riparian Restoration (MFC) grant program. Grants are available biennially, typically in the spring of even years, for projects that reduce flood risk. Projects shall minimize harm to existing beneficial functions of water bodies and wetlands, maintain natural aquatic and riparian environments, use stormwater detention and retention structures and natural storage to the greatest extent possible, and provide opportunities for public access to water bodies and to the floodplain. | Funding and Programmatic | |

| State | Action | Action Category | Action Hazard |
|---|---|---|---|
| **Wisconsin** | 9.2 Action: Integrate hazard mitigation concepts into UW-Extension programs for community development, lake and watershed management, farm management, and housing. | Funding and Programmatic | |
| **Wisconsin** | 10.29 Action: Incorporate Climate Resilient Mitigation Activities (CRMAs) as defined by FEMA (including Aquifer Storage and Recovery; Floodplain and Stream Restoration; Flood Diversion and Storage; and Green Infrastructure) into WEM's scoring system for preapplications. | Funding and Programmatic | |
| **Wisconsin** | 3.6 Action: Provide workshops and distribute informational materials to improve understanding and enforcement of floodplain, coastal, shoreline, and wetland regulations, including mitigation techniques. | Policy and Law | |
| **Wisconsin** | 3.5 Action: Encourage restoration of natural wetland functions. Wetlands provide natural flood storage areas. Restoring the natural function of these areas can reduce the flooding potential of other areas in the watershed. For many years, the DNR has been working with NRCS, USFWS, and other entities interested in wetland restoration to streamline the regulatory processes of these activities. Efficient spending of federal funds promotes access to future funding opportunities. The DNR has worked with partners on enabling legislation to develop a permitting process for certain classes of federally-funded and -designed wetland restoration projects; to develop a general permitting process; and to train staff from impacted agencies. | Restoration | |
| **Wyoming** | Action #9 Implement Flood Mitigation Projects - Promote utilizing natural systems protections to protect and restore natural floodplain functions, such as stream restoration, forest management, conservation easements, and wetland preservation. | Conservation/ Preservation/ Management Restoration | |

## Appendix 4: State Risk Assessment and Vulnerability Assessment

| State | Risk Assessment and Vulnerability Assessment |
|---|---|
| Alabama | Little to no discussion of natural systems/environment in risk assessment. |
| Alaska | Little to no discussion of natural systems/environment in risk assessment. |
| Arizona | Each hazard profile has a description of environmental/cultural impacts for each hazard. Each hazard profile describes several categories of potential consequences and impacts and one of the categories is environmental/cultural. The discussion is generally very cursory. There is little information on habitats or ecosystems. More of the discussion is focused on human health. |
| Arkansas | Each hazard profile covers impacts to the environment in an impacts table. But the analysis is cursory (e.g., "The impact to the environment could be severe.") |
| California | California has an entire section on natural environment under the section on state assets at risk. This includes a short section on ecosystems at risk. There is more in-depth assessment of effects on the natural environment in the profile on wildfire. |
| Colorado | Each hazard has an impact summary table that includes an assessment of impacts to the environment. This is fairly cursory, but some more in-depth discussion. |
| Connecticut | Each hazard profile describes primary and secondary impacts, including impacts to natural infrastructure. Relatively little discussion of ecosystems/natural infrastructure in these sections. More discussion on at risk habitats in the section on sea level rise. |
| Delaware | Little to no discussion of natural systems/environment in risk assessment. |
| Florida | Each hazard profile includes a hazard impact analysis that includes impacts that are possible due to the hazard occurring in the state. This includes impacts affecting the environment. Impacts are bulleted lists under each category. The analysis is cursory. The Coastal Erosion hazard profile's vulnerability assessment includes an analysis of the Florida's critically eroded managed shoreline by region. |
| Georgia | Little to no discussion of natural systems/environment in risk assessment. |
| Hawai'i | Each hazard protocol has an exposure analysis (climate change and sea level rise, chronic coastal flood, dam failure, earthquake, event-based flood, hurricane, landslide and rockfall, tsunami, volcanic hazards, and wildfire) or qualitative analysis (drought, hazardous materials, health risks, and high windstorms) for environmental resources. The exposure analysis tables show the total extent and percent of total area environmental resources located in the hazard areas. The environmental assets included are critical habitat, wetlands, and parks are reserves (and reefs). |
| Idaho | Each hazard profile has a section on environmental impacts that goes into some depth on impacts, but there was no exposure analysis or vulnerability assessment. |
| Illinois | Little to no discussion of natural systems/environment in risk assessment. |
| Indiana | Little to no discussion of natural systems/environment in risk assessment. |
| Iowa | We were unable to obtain the 2018 risk assessment |

| State | Risk Assessment and Vulnerability Assessment |
|---|---|
| Kansas | Each hazard profile includes a consequence analysis (table) that includes the impact of each hazard on the environment. Each analysis includes a ranking (minimal to severe) and description of impacts. The description is not in depth (e.g., "The impact to the environment could be severe."). |
| Kentucky | Little to no discussion of natural systems/environment in risk assessment. |
| Louisiana | Little to no discussion of natural systems/environment in risk assessment. |
| Maine | Little to no discussion of natural systems/environment in risk assessment. |
| Maryland | Each hazard profile has a consequence analysis table that includes impacts to the environment. The discussion is minimal, "Floods impact the environment by spreading pollution; overloading water and wastewater treatment plants; carrying silt and debris; and disturbing wildlife and the natural area." |
| Massachusetts | Natural Resources and Environment are one of the sectors assessed for each hazard in the risk assessment. They define natural resources as "These are components of natural systems that exist without human involvement. For the purpose of this survey, key natural resource categories include forested ecosystems, aquatic ecosystems, coastal ecosystems, wetland ecosystems, and old field ecosystems. Each hazard profile has a table that discusses each sector assessed, including natural resources and the environment. Each profile also has a more in-depth discussion of impacts to natural resources and the environment (some hazards have more discussion than others). For example, the section on inland flooding includes a table on Natural Resources Exposure – Areas of Critical Environmental Concern (Table 4.9) that details the amount of critical habitat in the 1 percent annual chance flood event and 0.2 percent annual change flood event zones. Further Table 4.10 lists the Natural Resources Exposure from the Massachusetts BioMap2 Core Habitat analysis (including priority natural communities, species of conservation concern, vernal pools, wetlands, etc.). Again, this table details the amount of critical habitat in the 1 percent annual chance flood event and 0.2 percent annual change flood event zones. The sections on coastal flooding and hurricanes include similar tables. |
| Michigan | The risk analysis includes a Hazard Analysis Summary Table that includes a numerical risk rating for a number of considerations, including the environment (p. 41). No additional discussion. |
| Minnesota | No systematic/consistent discussion of risk/vulnerability/impacts to the environment or natural resources. There is a discussion of climate change in each hazard profile. |
| Mississippi | Some hazard profiles (dam failure, hurricane, winter storm) include a discussion of vulnerability of natural resources. The hurricane profile has a more detailed discussion on barrier island loss. |
| Missouri | Natural resources discussed in exposure analysis – including discussion of natural and beneficial functions and special status species. |
| Montana | No systematic treatment of risk/vulnerability to natural environment in the risk assessment section or hazard profiles. Short discussion in the hazard profile on drought. |
| Nebraska | Each hazard profile has an Impact/Consequences Summary table that describes impacts across categories, including the environment. Discussion is cursory – |

| State | Risk Assessment and Vulnerability Assessment |
|---|---|
| | "The environment in the inundated areas will be severely impacted with contaminates, erosion, and debris." The drought profile includes some discussion of impact to plants and wildlife. The flood profile includes a discussion of non-structural mitigation approaches. |
| Nevada | No systematic treatment of risk/vulnerability to natural environment in the risk assessment section or hazard profiles. The flood profile includes a discussion of "Reducing Flood Damage in Areas of High Flood Probability" which highlights a number of mitigation activities, that include non-structure projects. Nevada also profiles invasive species (Infestations) as a hazard. |
| New Hampshire | There is no consistent treatment of natural infrastructure in the hazard profiles (e.g., no tables). However, several of the hazard profiles include discussion of impacts to natural resources as well as how the loss of natural infrastructure can aggravate the hazard (drought, inland flooding, and coastal flooding, wildfire, climate change). |
| New Jersey | There is a section on environmental impacts in most hazard profiles (coastal erosion, dam and levee failure, drought, earthquake, hurricane and coastal storm, etc.). The section goes into some depth on impacts. The drought profile has more information on impacts to the environment, including habitats. |
| New Mexico | Discussion of the drought-wildfire-flood cycle in the hazard identification/risk assessment section, and the impact of ecosystem change on this cycle and the effect of the cycle on ecosystems. Each hazard profile has a table of impacts that includes environmental impacts. |
| New York | The risk assessment section describes "Critical and Environmental Infrastructure—the ability of critical and environmental infrastructure to recover from events—components may include water and sewage, transportation, power, communications, and natural infrastructure" as one of four critical dimensions of a consistent system of resilience indicators or measures. The risk assessment section online does not contain hazard profiles. |
| North Carolina | Each hazard description has a section on impacts, several of the profiles include impacts to the environment (e.g., drought). The vulnerability assessment includes a short section on environmental vulnerability. Each hazard vulnerability assessment profile includes a table on risk and consequence analysis. This includes an analysis of consequences for the environment. This includes analysis of damage to sensitive habitats. |
| North Dakota | Environment is one of the risk assessment categories. Each hazard profile includes a consequence analysis that includes impacts to the environment. |
| Ohio | No consistent analysis of environmental impacts/vulnerabilities. The climate change section includes some information on biodiversity and ecosystems. |
| Oklahoma | Little to no discussion of natural systems/environment in risk assessment. |
| Oregon | No consistent analysis of environmental impacts/vulnerabilities. The drought hazard profile has a small section on environmental impacts. Some discussion of impacts to forest assets and riparian importance (in terms of terrestrial and aquatic habitat values, water quality and quantity, and other ecological functions) in the section on wildfire vulnerability. |
| Pennsylvania | Each hazard profile has a section on environmental impacts, including impacts to wetlands and other habitats. The sections are fairly short (approx. 1 |

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| | paragraph). The consequence analysis has a short section on the environment that references the hazard profiles. |
| Rhode Island | Each hazard profile includes an analysis of risk and vulnerability to the environment (about 1 paragraph). Each hazard profile has a table that includes probable hazard magnitude to people, critical infrastructure, property, state operations, and the environment. |
| South Carolina | No consistent analysis of environmental impacts/vulnerabilities. Some discussion of habitat degradation in the drought profile. |
| South Dakota | Some discussion of impacts to plants and wildlife from drought. Each hazard consequence summary includes impacts to the environment. |
| Tennessee | Little to no discussion of natural systems/environment in risk assessment. |
| Texas | No consistent analysis of environmental impacts/vulnerabilities. Some discussion on loss of coastal habitat in the sections on coastal erosion, inland erosion, and subsidence. |
| Utah | The Hazard Consequence and Impact Analysis Matrix includes impact on the environment for each hazard. Each hazard was evaluated for vulnerability factor for each item in the matrix, including the environment (low, moderate, high, catastrophic). No consistent discussion of impacts to the environment in the hazard profiles. Some discussion in the drought, flood, and fire profiles. |
| Vermont | Potential impact on the environment is part of the hazard assessment. Table 16 evaluates each hazard across a number of potential impacts, including impacts to the environment. Each potential impact is ranked 1 – 4 (by frequency of occurrence and potential impact). Each hazard has a final score which is calculated by multiplying probability by average potential impact. Each hazard profile has a similar table. There is some discussion of impact to environment/habitat in several of the hazard profiles, but no consistent treatment except for the table. |
| Virginia | Each hazard profile has an emergency management accreditation program analysis of detrimental impacts, including the environment. None of the profiles includes an in-depth analysis of impacts to the environment. |
| Washington | Each hazard profile has a section on environmental impacts. |
| West Virginia | Little to no discussion of natural systems/environment in risk assessment. |
| Wisconsin | Hazard profiles have a risk analysis that includes impacts to the environment from the hazard. Each section on the environment includes a few bullet points. |
| Wyoming | Little to no discussion of natural systems/environment in risk assessment. |


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