The Role of Land Protection in Mitigating Freshwater Flooding Hazard: Strategies to Increase Land Trust Engagement
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Purpose of this Report

This report is a synthesis of extensive research conducted to clarify the role that land protection can play in mitigating flood hazard. The report describes promising approaches and tools and identifies barriers that need to be overcome to expand and support land trust involvement in this work.

Our findings have relevance for 1) directing land protection for flood hazard mitigation, 2) targeting funding to achieve flood mitigation, and 3) supporting the education, planning, and outreach land trusts need to effectively advance this work.

The report describes the role of land protection for flood mitigation, summarizes five strategies where land protection could play critical role in flood mitigation, and then identifies opportunities and barriers to land trust engagement. The last section of the report recommends opportunities for conservation groups to identify and protect lands vulnerable to flooding, restore ecological function in degraded floodplains, and support complementary planning and policy that increases flood resilience. Appendix B chronicles examples of programs, tools, and science that conservation organizations are using to implement strategies to mitigate freshwater flood risk.

This research was conducted with a grant from the Jane’s Trust Foundation with the primary intention of informing Open Space Institute’s (OSI) own Appalachian Landscape Protection Fund. We anticipate that the findings will direct our education and outreach work with land trusts and could inform future capital grant criteria. The initial geographic focus of this report was northern New England and has since broadened to the eastern U.S. We have included our detailed review of flood mitigation work in the three states of that region within Appendix D.

We hope this work also serves as a resource to other funders and organizations who support and direct conservation at various scales.

A Role for Land Protection in Flood Mitigation

Over the course of several days in 2011, Tropical Storm Irene dropped 11 inches of rain in parts of Vermont, claiming six lives and destroying 500 miles of roads, 1,000 culverts, 200 bridges, and 1,600 homes across the state. Stream gauges that captured the flow of water during the storm tell a surprising story. Discharge from the Otter Creek registered at peak flow in Rutland, Vermont had dissipated by nearly half the volume 30 miles downstream in Middlebury, Vermont, where flow might be expected to have increased given its location in the watershed.

High levels of protected land within the large forest and wetland complex between the two points slowed and attenuated the flood waters before they reached downtown Middlebury. Researchers at the University of Vermont estimate that intact floodplains and wetlands along the Otter Creek reduced flood damages in Middlebury by 84 to 90 percent during Irene and saved the town as much as $1.8 million (Watson et al. 2016).

Inland, or freshwater flooding is the most common type of natural disaster in the United States and among the most damaging to human lives and property.

In the past three decades, inland floods in the United States were responsible for an average of $8.2 billion in annual damages, with yearly totals increasing over the course of this period (Wing et al. 2018).
An analysis of trends in river flooding across the US from the 1920s to 2008 found the biggest increase in flood magnitude in the Midwest and the Northeast regions (Peterson et al. 2013) (Figure 1).

Figure 1. Trends in Flood Magnitude, 1920 - 2008

Source: Peterson et al. 2013, as adapted for the Third National Climate Survey (Melillo et al. 2014).

As many as 40.8 million Americans currently reside in areas at risk for severe freshwater flooding (Wing et al. 2018). Looking to the future, inland flood risk will likely be exacerbated by climate change in regions like the Northeast that are projected to experience more frequent heavy downpours and extreme weather events like hurricanes and tropical storms (Melillo et al. 2014). Even where drought is anticipated in southern regions of the U.S., rain will be delivered in larger storm events that result in less infiltration and significant flood impacts. Furthermore, continued development of natural land within floodplains projected in the coming decades will increase exposure to flood risk (Johnson et al. 2019).

Intact headwaters, floodplains, and wetlands reduce flood impacts by attenuating or slowing water when rivers overflow their banks and storing the excess until flood waters recede. Land protection preserves the natural buffering capacity of these resources, directs development away from flood-prone areas, and helps to avert future damage. A recent study found that every dollar spent on floodplain protection saves at least five dollars in potential future damages from floods (Johnson et al. 2019).

Importantly, the same lands that provide flood storage supply some of the highest conservation values in a landscape. These resources offer the greatest water quality benefits, serve as important habitat migration corridors, provide local climate variation, and store more carbon than upland areas due to greater nutrient and water availability (Dybala et al. 2019).

However, as our research shows, flood hazard mitigation has not been a significant focus of land trust work to date. The barriers for greater land trust engagement in this work are many. Among these challenges are complex science, and the lack of affordable, easy to use tools to help practitioners prioritize land protection for flood mitigation. Furthermore, this work often calls for specialized skills, expertise, and relationships that land trusts may not currently have. And while some land trusts may be able to tap into dedicated funding streams for flood hazard mitigation to protect land, the complexity of administering grants from federal funding programs is a significant deterrent.
Yet many land trusts possess relevant skills, from transactional expertise, to experience with ecological restoration, planning, and land management, and capacity for long-term stewardship that could make them valued partners in advancing land-based approaches to flood hazard mitigation.

Whether it is acknowledged or not, much of the land protection accomplished by land trusts in flood-prone areas already has benefits for flood resiliency. Yet without more intentional, science-driven approaches to targeting protection, land trusts may be missing opportunities to 1) maximize the flood hazard mitigation benefits of conservation projects, 2) access funding sources available for land protection that mitigates flood risk, and 3) communicate about how their work contributes to flood resilience.

At the same time, so long as land trusts remain at the fringes of this work, local, state and federal flood mitigation programs are missing a valuable set of partners who could support project implementation and improve long-term outcomes from their investments.
Section 1: Flood Risk Mitigation Strategies

Here we present five land protection and policy strategies that conservation organizations are using to mitigate inland flooding. A summary table for each strategy outlines the potential role for land trusts, highlighting the opportunity as well as some challenges to successful implementation. For a synthesis of related research, case studies, and examples of how the strategy has been implemented, see Appendix B at the end of the report.

PERMANENT PROTECTION

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Potential Land Trust Role</th>
<th>Positives</th>
<th>Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permanent Protection</td>
<td>Strategically acquire fee title or conservation easements in floodplains, river corridors, or flood storage areas for the purpose of increasing flood resilience.</td>
<td>Applies tools and approaches already familiar to most land trusts to what may be a new target</td>
<td>Land trusts may lack the tools, data, and knowledge to effectively target the protection of properties that will mitigate flood hazard.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Proactive acquisition of undeveloped floodplains can save lives, by keeping people out of the most flood-prone areas and buffering flood impacts on development downstream.</td>
<td>River corridors are dynamic landscape features that pose novel transactional, legal, and stewardship challenges for land trusts accustomed to terrestrial protection projects.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Acquisition is more cost effective than buyouts of properties with structures that experience repeat flood damages.</td>
<td>It may be challenging to transport a successful program or tool from one geography to another without reproducing the supportive infrastructure of dedicated state funding and technical assistance.</td>
</tr>
</tbody>
</table>

Retaining and permanently protecting wetlands and floodplain forests that absorb and attenuate flow during high water episodes is a cost-effective approach to mitigating flood hazard with an array of additional benefits such as water filtration, carbon sequestration, habitat, and recreational values. Protection of undeveloped floodplains through acquisition of an easement or fee simple interest keeps people and assets out of the path of dangerous floodwaters and may reduce damages incurred by communities during disasters.

Specialized legal tools, such as river corridor easements and riparian buffer agreements provide options for conservation entities looking to ensure protection of dynamic riverine landscapes.
## CONSERVATION PLANNING AND ANALYSIS

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Potential Land Trust Role</th>
<th>Positives</th>
<th>Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conservation Planning and Analysis</td>
<td>Integrate flood hazard or flood storage areas into strategic conservation plans to inform land protection targets. Participate in community planning processes, including flood hazard planning, as an advisor, stakeholder, or technical assistance provider to ensure open space and comprehensive plans address floodplain protection, and advocate for the inclusion of land protection as a flood hazard mitigation strategy in watershed plans and other guidance documents.</td>
<td>Conservation planning provides the basis for a strategic and science-based approach to land protection. Integration of land protection into state or local hazard mitigation planning could provide a source of funding for targeted land protection. Detailed local analysis of flood risk provides a screen for project prioritization and evaluation to maximize the hazard reduction benefit of conservation investments. Understanding the flood resilience benefits of protecting specific properties can help land trusts engage project partners and secure funding available for flood hazard mitigation.</td>
<td>Most conservation plans do not have regulatory teeth, and require willing implementers and financial resources to impact work on the ground. Finding flood hazard data appropriate for targeting conservation can be challenging. Publicly available FEMA flood hazard maps have limited coverage, are outdated in many locations, and do not account for climate change. Detailed local analyses and high-resolution flood hazard models are expensive to produce. Land trusts will likely need access to technical support, education, and funding to understand and incorporate flood resilience into their conservation strategies.</td>
</tr>
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</table>
# VOLUNTARY FLOODPLAIN BUYOUTS

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Potential Land Trust Role</th>
<th>Positives</th>
<th>Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voluntary Floodplain Buyouts</td>
<td>Partner with municipalities on flood buyout projects to increase the likelihood that acquisitions will contribute additional ecological and social benefits including water quality protection, wildlife habitat, or recreation.</td>
<td>Land trusts are well-positioned to add value to the buyout process by virtue of their expertise and capacity to steward open space long-term, allaying some of the burden faced by municipalities with few resources to manage buyout properties. Buyouts permanently remove people and vulnerable infrastructure from flood-prone areas, and often reduce hazard to remaining structures. The buyout process can help landowners who have suffered flood losses recover the appraised value of damaged structures.</td>
<td>Buyouts are expensive compared to protecting land before it is developed. Land trusts may not have the expertise to handle all aspects of the buyout process. Demolition and restoration often involve handling hazardous materials, and disaster recovery has complex social and emotional dynamics for many communities. Engaging in this work will require land trusts to partner with organizations and agencies that bring these skills. Federal disaster relief program applications are challenging and time consuming to complete and administer. There are often significant time lags before funding is secured, and programs operate on a reimbursement structure, requiring NGOs to have access to capital to complete the buyouts. FEMA’s Hazard Mitigation Grant Program can be used for proactive buyouts of properties vulnerable to flooding, as well as post-disaster buyouts, but NGOs are only eligible to apply for the post-disaster funds.</td>
</tr>
<tr>
<td></td>
<td>Accept fee or conservation easement interest in buyout properties. FEMA programs allow municipalities to transfer title to buyout properties to non-profit conservation organizations. By taking over management of lands acquired through buyouts, land trusts can reduce financial burdens on municipalities and ensure that high standards of stewardship are maintained. Land trusts can also accept conservation easements on buyout properties. Provide technical assistance for restoration or stewardship of acquired properties. Assist with fundraising for projects or partner on grants to cover costs for ecological restoration or recreational infrastructure like trail building to create a public amenity. Lead applications for post-disaster FEMA funds through the Hazard Mitigation Grant Program. Work with municipalities to develop a strategic plan for floodplain buyouts to proactively identify top opportunities to acquire properties from willing landowners based on best practices such as clustering and connecting buyouts to existing open space.</td>
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Properties subject to significant repeat flood damage may be candidates for flood buyout programs that work with willing landowners to purchase flood-prone parcels at fair market value, demolish or relocate...
built structures, and return the land to an open space condition. Development on buyout properties is typically prohibited through a deed restriction. Moving property and assets out of the floodplain through buyouts lowers a community’s exposure to flood risk and cuts down on expenses associated with disaster recovery.

FLOODPLAIN REGULATIONS

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Potential Land Trust Role</th>
<th>Positives</th>
<th>Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floodplain Regulations</td>
<td>Partner with local or regional planners to review and propose changes to municipal code that support flood resilience by adding additional protections to sensitive river areas, or regulating development in floodplains</td>
<td>Local regulations play a significant role in determining how and where development occurs in a community, so efforts that embed higher floodplain standards into ordinances or bylaws can have far-reaching impact on reducing reduce flood vulnerability and losses. Regulations can also help to incentivize floodplain protection.</td>
<td>Land trusts may lack the expertise, relationships, and trust needed to effectively influence local land use regulations. For this reason, it is important to collaborate with trusted intermediaries such as regional planning authorities who have specialized knowledge and close working relationships with municipalities. Local regulations do not offer permanent protections or restrictions and can be amended or replaced under certain circumstances.</td>
</tr>
</tbody>
</table>

Adjustments to a community’s floodplain regulations can bolster flood resilience by dictating where and how development can occur and strengthening protection for sensitive natural areas. Floodplain regulations can be integrated into municipal code in a variety of ways, but are most often included in zoning ordinances, building codes, or standalone floodplain management ordinances.

Communities that participate in the National Flood Insurance Program must adopt and enforce minimum federal regulatory standards for new and improved structures in Special Flood Hazard Areas. Communities that voluntarily adopt higher floodplain standards can reduce their vulnerability to flood hazard and qualify for reductions in their flood insurance premiums through the Community Rating System (described in the following section of this report).
## Community Rating System

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Potential Land Trust Role</th>
<th>Positives</th>
<th>Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community Rating System (CRS)</td>
<td>Identify towns where CRS enrollment would be cost effective.</td>
<td>CRS provides a financial incentive to communities that take actions that reduce flood hazard and increase resiliency and makes flood insurance more affordable for residents in participating communities.</td>
<td>Enrolling and maintaining active status in the CRS requires a significant time investment that can be a deterrent to municipalities with staffing and budgetary constraints.</td>
</tr>
<tr>
<td></td>
<td>Educate municipalities about the cost-saving benefits of CRS and the credits available for open space protection. Help municipalities document qualifying land protection and encourage proactive protection of vulnerable floodplain lands as a flood hazard mitigation strategy.</td>
<td>Open Space Preservation is one of the activities that can garner participants the most points within the CRS program.</td>
<td>Communities need to see that the benefits of participation outweigh the costs. This strategy may therefore only be relevant in places where flood insurance premiums and flood frequency are relatively high. A high proportion of the communities currently enrolled in the CRS are affected by coastal flooding.</td>
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</table>

The Community Rating System (CRS) is a voluntary incentive program that provides an insurance premium benefit to communities that reduce flood hazard and increase resiliency by taking actions that exceed minimum standards set by the National Flood Insurance Program (FEMA, 2015). Communities can earn points and qualify for lower flood insurance premiums (up to a 45% reduction) by completing and documenting approved activities related to floodplain management, public information, and hazard mitigation, including open space protection, floodplain mapping, and adopting higher floodplain regulatory standards.
Section 2: Opportunities, Challenges, and Recommendations

In the United States today, flood risk management relies heavily on engineered and structural approaches to protect assets in the floodplain. Comparatively, land protection has been underutilized as a strategy for flood hazard mitigation. Here we offer a high-level summary of our findings, that underscores compelling reasons to incorporate land protection into the flood risk management toolkit and points to the challenges of harnessing land protection to mitigate flood hazard. This is followed by a set of recommendations that could help advance the land trust community’s ability to contribute to flood hazard mitigation.

Opportunities

1. Land protection is an effective and cost-efficient approach to mitigating some flood risk, returning $5 in reduced flood impacts for every $1 invested, on average.

2. Land protection is particularly effective as a strategy to mitigate flood hazard in places where intact floodplains or headwaters threatened by conversion are situated upstream from vulnerable communities. Protection can also add value where land management practices compromise the floodplain’s natural capacity to absorb and attenuate flood waters, such as farming in a floodplain with insufficient riparian buffers.

3. In addition to flood hazard mitigation, floodplain protection delivers some of the greatest conservation benefit per acre as a result of its contribution to drinking water quality, habitat resilience, carbon sequestration and other values.

4. A majority of federally funded floodplain buyouts wind up as vacant lots, with mowed grass or bare mineral soil. Land trusts and other conservation organizations could play a valuable role in facilitating pre- and post-flood buyouts by bringing critical expertise and resources to ensure that buyouts achieve multiple ecological and social benefits. Land trust involvement can help ensure that buyout properties are restored to functioning ecological systems and stewarded long-term.

5. Current and projected increases in flood exposure due to climate change and future development of floodplains make flood impacts a growing concern in many parts of the country. This presents an opportunity to work with people on projects that benefit their communities as well as the natural world.

Challenges

1. Freshwater flood occurrence is episodic and flood vulnerability is governed by a complex set of factors. The relative impact of flooding on communities varies greatly from town to town and from state to state, and in many places, the response is more reactive than proactive. For these reasons, freshwater flood hazard has more salience and visibility in some geographies than others.

2. By comparison, we found more highly developed state responses, programs, and tools available to address coastal flooding, including the impacts of sea level rise, which poses an immediate and sustained threat to lives and property in coastal communities.

3. The relative emphasis of land protection as a flood hazard mitigation strategy varies substantially among state natural resource agencies, and there is a lack of consistent approaches at the state level.
4. Few land trusts are currently targeting their work for flood hazard mitigation. A notable exception to this can be found in Vermont, where several land trusts are taking a leading role in addressing flood hazard through targeted land protection, riparian corridor easements, and floodplain buyouts.

5. A lack of dedicated funding to support targeted land protection for flood resilience poses a barrier for conservationists in many geographies. The intensive application and management processes required to access hazard mitigation funding available from state or federal programs serves as a deterrent to prospective applicants.

6. Nationally, flood hazard data is highly uneven. The publicly available hazard dataset from the Federal Emergency Management Agency (FEMA) has incomplete coverage and is outdated in many places. Higher-resolution data that covers smaller catchments, and detailed local analyses are not widely available and are expensive to produce. This makes fine-grained targeting of protection to mitigate flood risk challenging.

7. Where advanced tools have been developed, such as models that predict impacts associated with changing land cover, they tend to focus on restoration, despite the relevance of the science to targeting land protection for flood hazard mitigation.

**Recommendations**

Our recommendations span a range of approaches that are relevant to a diverse set of audiences. These include land trusts and land trust associations interested in increasing the flood mitigation value of their land protection work, state land protection programs looking to integrate flood hazard mitigation as a co-benefit of their funding, as well as mitigation programs looking to better support land protection as a strategy to achieve their goals.

The recommendations exist on a spectrum from relatively simple efforts that can be advanced within current conditions and constraints, to more complex proposals that would require deeper structural changes and dedicated support to overcome significant obstacles. Additional work is needed to assess the feasibility of implementing these recommendations.

**Target the Investment**

1) **Target vulnerable watersheds.** Identify geographies where freshwater flood hazard can be effectively addressed through land protection, and where increases in flooding are anticipated. Understand the types of flood hazard that affect a given location to determine which strategies will be most effective. Some approaches will be more relevant for addressing inundation, while others can address hazards from flood-related erosion.

**Outreach and Communication**

2) **Focus outreach.** Provide education and technical assistance to land trusts that serve areas where freshwater flood hazard is most salient.

3) **Share best practices from leading states and land trusts.** Disseminate examples of model language and easement terms that address flood hazard and replicable approaches for identifying land protection priorities.

4) **Support education of local officials.** Fund land trust efforts to educate municipalities on the role of land protection in mitigating flood hazard and engage in local planning and policy matters.
5) **Articulate co-benefits.** Support land trusts in understanding their role in mitigating freshwater flood hazard (both the range of strategies and best practices, and how to communicate about co-benefits of work they already do, with respect to flood management).

**Tools and Capacity Building**

6) **Invest in decision support tools for practitioners and hazard mitigation planning.** Land trusts and flood hazard plans would benefit from clear, easy to use datasets and analytic tools to support targeting land protection for flood hazard mitigation.

7) **Facilitate science-based conservation planning.** Provide technical assistance and training to help land trusts integrate flood hazard data into strategic conservation plans.

8) **Strengthen capacity for buyouts.** Develop training and materials to help land trusts partner effectively with communities to support voluntary floodplain buyouts.

**Funding**

9) **Align funding.** Establish grant fund evaluation criteria that incentivize land protection projects with flood hazard mitigation benefits and explore opportunities to leverage the state and private funding programs that land trusts already utilize to attain flood resilience benefits.
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Appendix A: Background and Key Terms

To provide context for the strategies reviewed in this report, we present a brief primer on some of the terms and core concepts used throughout.

Types of Inland Floods

Inland flooding includes precipitation-driven flooding (responsible for most “flash floods” and urban flooding) and riverine flooding, which is influenced by multiple watershed-specific factors in addition to rainfall (Table A1).

Table A1. Types and Characteristics of Inland Floods

<table>
<thead>
<tr>
<th>Inland Flood Type</th>
<th>Description</th>
<th>Where they occur</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash Flooding</td>
<td>Rapidly developing floods often caused by intense short-duration precipitation, dam or levee failures, or break up of debris or ice jams.</td>
<td>Small, steep watersheds</td>
</tr>
<tr>
<td>Urban Flooding</td>
<td>Intense short-duration precipitation events in watersheds with high levels of impervious cover generate excessive runoff that overwhelms drainage and stormwater management infrastructure.</td>
<td>Watersheds with high proportion of impervious cover</td>
</tr>
<tr>
<td>Riverine Flooding</td>
<td>Often the result of multiple heavy precipitation events (which may be combined with snowmelt) over an extended period that drains excess water into rivers, causing them to overtop their banks and inundate low-lying areas.</td>
<td>Large watersheds and rivers. Basin-specific factors like topography and soil moisture impact where river flooding is most likely to occur.</td>
</tr>
</tbody>
</table>

Adapted from the Third National Climate Assessment (Melillo et al. 2014)

This report does not directly address coastal flooding related to sea-level rise or storm surge, however coastal storms such as hurricanes or tropical cyclones often cause flooding inland when they make landfall.
Flood-Proneness

An area’s susceptibility to flooding is influenced by a variety of factors specific to a river’s drainage basin, including soils, topography, vegetation cover, that interact with climatic variables such as ground temperature, rainfall, and snowpack (USGS, n.d. (a), see box). Soils with high porosity, such as sand, allow for higher rates of rainwater infiltration, and are therefore associated with fewer flood losses. Steep terrain is generally associated with higher flood losses, as steep slopes can concentrate rainfall and contribute to rapid stream peaks and increased mean annual flow (Brody & Highfield, 2013). Human activities, including settlement patterns, and the alteration of land cover and river morphology also play a role. In their natural and unaltered state, rivers and their floodplains are part of a single dynamic system that evolves and migrates over time through the processes of erosion and accretion. In many communities, the encroachment of development and agriculture into floodplains has whittled away the natural flood storage capacity of riparian forests and wetlands, exposing homes, businesses, and public infrastructure to flood damage.

Communities in flood-prone areas have historically relied on engineered structures such as dams, reservoirs, flood walls, and levees to hold back flood waters, or modified stream channels to divert flow and protect assets in the floodplain. These interventions have been somewhat effective at reducing flood damage, but at significant cost and often with unintended consequences. In some cases, flood risk is reduced locally, but exacerbated in downstream communities. River channels that have been straightened to remove meanders, or deepened through dredging or berming flow faster, erode at higher rates, and do not attenuate as readily during flood events. Engineered floodworks can provide a false sense of security, enabling development in high flood risk areas, and exposing people and property to dangerous conditions when control structures fail. As flood control infrastructure ages, replacing and upgrading it to withstand record-breaking storms will come with a hefty price tag.

The probability of flood occurrence in a given location can be predicted based on historic data on rainfall and streamflow. The recurrence interval or return period represents a long-term statistical average of the number of years between floods of a specified magnitude. Hydrologists tend to cite the Annual Exceedance Probability (AEP), which represents the percent chance of flood occurrence occurring in any year (United States Geologic Survey, n.d. (b))

<table>
<thead>
<tr>
<th>Recurrence Interval (Years)</th>
<th>Annual Exceedance Probability (Percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>50</td>
</tr>
<tr>
<td>5</td>
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<tr>
<td>200</td>
<td>0.5</td>
</tr>
<tr>
<td>500</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Factors Influencing Flood Occurrence
Adapted from United States Geologic Survey, n.d (a)

- The amount of rainfall occurring on a realtime basis.
- The rate of change in river stage on a realtime basis, which can help indicate the severity and immediacy of the threat.
- Duration, intensity and areal extent of the storm, which can be valuable for determining possible severity of the flooding.
- Characteristics of a river’s drainage basin, such as soil-moisture conditions, ground temperature, snowpack, topography, vegetation cover, and impermeable land area, which can help to predict how extensive and damaging a flood might become.
“100-Year Flood”

A “100-year flood” has a 1% chance of being equaled or exceeded in a given year and is said to have a 100-year recurrence interval. The United States Federal Emergency Management Agency (FEMA) uses the 100-year flood as its “base flood” and standard for the National Flood Insurance Program. Today, many experts disfavor the 100-year flood terminology, as it commonly leads to misinterpretation by the public, and prefer the term “1% annual chance flood” to convey that floods of this magnitude can occur more frequently than once every 100 hundred years.

Appendix B. Flood Risk Mitigation Strategies – Expanded Content

Strategy 1. PERMANENT PROTECTION

Retaining and permanently protecting wetlands and floodplain forests that absorb and attenuate flow during high water episodes is a cost-effective approach to mitigating flood hazard with an array of additional benefits such as water filtration, carbon sequestration, habitat, and recreational values. Protection of undeveloped floodplains through acquisition of an easement or fee simple interest keeps people and assets out of the path of dangerous floodwaters and may reduce damages incurred by communities during disasters.

Approach: Targeted Land Protection Programs

The following examples highlight conservation organizations and public agencies working together to bring resources and capacity to protect land for flood resilience.

Program: Streamside Acquisition Program – New York

The Streamside Acquisition Program (SAP) is a partnership between the Catskill Center, a land trust based in Arkville, NY and the New York City Department of Environmental Protection (NYCDEP) that permanently protects streamside lands and floodplains from willing landowners in the Schoharie River Basin, primarily through fee simple acquisition (Catskill Center, n.d.). The program, which is operated by the Catskill Center and funded by NYCDEP, targets acquisition of properties with specific water resources to protect water quality, reduce streambank erosion, and mitigate flood hazard. The Catskill Center leads all aspects of project solicitation and design, oversees negotiations with landowners, and executes contracts for purchase, before transferring the fee interest or easement to NYCDEP. When acquiring land in fee, NYCDEP conveys an easement to the state Department of Environmental Conservation (Catskill Center, 2019).

The Streamside Acquisition Program is one prong of New York City’s source water protection strategy and effort to maintain EPA-issued Filtration Avoidance Determination that waives filtration requirements in the Catskill/Delaware Water Supply (New York City Department of Environmental Protection, 2018). SAP complements NYCDEP’s existing land acquisition program by targeting projects that secure critical lands around watercourses, but that are considerably smaller than those typically solicited by the agency (Catskill Center, 2003), often less than 10 acres. As of mid-2020, SAP had closed 17 projects totaling 120 acres.

The requirements for projects that can be funded through SAP follow guidance laid out in the 2010 Water Supply Permit issued by the New York State Department of Environmental Conservation. To be
eligible for the program, at least a portion of the property must be located within 1,000 feet of a reservoir, within a FEMA 100-year floodplain, or within 300 ft of an eligible watercourse, or contain qualifying wetland area.

The program’s focus on wet, small acreage properties presents some transactional challenges. An 8-acre parcel along a stream with no road frontage is generally considered low development risk and will typically garner low valuation by an appraiser. At times, the fair market value determined by appraisers is barely enough to cover fixed transactional costs incurred by the landowner, which make up a higher percentage of the purchase price on small projects. To encourage the owners of properties with particularly a high proportion of surface water features or low fair market value to participate in the program, SAP has been authorized to offer sellers incentive payments early in the contract period, following completion of survey and title work (NYCDEP 2019).

Program: Greenseams—Milwaukee, Wisconsin
Greenseams is a partnership between The Conservation Fund and the Milwaukee Metropolitan Sewerage District that purchases land and conservation easements from willing landowners in the Milwaukee, Menomonee, Oak Creek, and Root River watersheds where suburban development threat is high. When selecting properties for protection, the program considers the presence of water features like floodplains and wetlands, soil types that absorb water, and additional benefits such as recreation potential. The program has conserved 111 properties and 3,689 acres since it was founded in 2001, reducing flood risk for 1.57 million people living in 28 communities in the greater Milwaukee area (The Conservation Fund, n.d.).

Tool: Specialized Conservation Easements
In some geographies, specialized easements have been developed for the purposes of restoring floodplain function, reducing flood risk, and protecting water quality.
Example: River Corridor Easements, Vermont
The Vermont Agency of Natural Resources promotes the use of river corridor easements as a tool to reduce flood hazard and restore ecological values in stream reaches identified as important flood and sediment attenuation areas (Kline 2010). A distinct feature of the easement is the transfer of river channel management rights within a “meander belt” that contains sensitive lands prone to erosion through sale or donation of an easement to a land trust. This approach restricts the landowner from implementing erosion and channel adjustments or developing new structures within the river corridor, but typically allows for agriculture and silvicultural management outside of the riparian buffer. Landowners are required to maintain a riparian buffer comprised of native woody vegetation with a minimum width of 50 feet that moves location with the river.

As the river location changes, landowners may seek permission from the easement holder to modify or recover an allowable land use within the river corridor. The Vermont DEC acts as an “intended third party beneficiary” of the grant and can help the grantee determine whether proposed activities are consistent with the purpose of the easement, supply technical assistance, and assist with enforcement. Channel management rights can be purchased through a stand-alone easement, or as an amendment to other types of conservation easements.

The tool is often used in conjunction with restoration or other conservation approaches. Vermont land trusts can seek funding for river corridor easements from the Vermont Clean Water Fund, which was created in 2015 through State Act 64. Notably, the Clean Water Fund was established as part of the
state’s commitment to the Environmental Protection Agency to reduce pollutant loads in Vermont waterways through a revised total maximum daily load (TMDL) plan.

According to state leaders, the river corridor easement program has been successful, and demand has exceeded available state funding. As of 2018, the majority of river corridor easements funded by the Clean Water Initiative Program had been completed by the Vermont River Conservancy and the statewide Vermont Land Trust (Vermont Agency of Natural Resources, 2019). The Vermont DEC has developed a river corridor easement template that could serve as a model for easements in other states, but without dedicated funding and technical support from a state agency, and land trusts in other could find the additional complexity of implementing and enforcing this tool to be a barrier.

**Example: Model Riparian Buffer Protection Agreement—Pennsylvania**

The Pennsylvania Land Trust Association (PALTA) developed a Model Riparian Buffer Protection Agreement (Pregmon & Loza, 2017), as a conservation easement designed specifically for the permanent protection of a riparian buffer along a waterway. Although this tool is not tailored expressly for flood hazard mitigation, mitigating erosion and downstream flooding is listed as a possible conservation objective along with others, including improving the quality of water resources and biological resources, preventing soil loss, and providing other ecosystem services. The model easement contains commentary that lays out key issues and alternatives with an explanation of implications for taxes, monitoring, stewardship, and enforcement.

A critical consideration in the design of the easement is whether the location of the conservation area will be defined as fixed or shifting with the position of the waterway. A shifting conservation area ensures that water resources will be protected, even if the waterway moves over time, but could affect the potential for a donated easement to qualify for a federal tax deduction. In either the fixed or shifting scenario, the easement specifies a minimum buffer width measured from the top of the banks of the waterway as part of the conservation area. The model also allows for the protection of areas of present and future woodland.

A notable difference between the PALTA model easement and the Vermont river corridor easement is the stance regarding stream bank modifications. The PALTA easement permits streambank stabilization for habitat enhancement, subject to review, while the Vermont easement expressly prohibits any erosion control or stream channel adjustments.

**Strategy 2. CONSERVATION PLANNING AND ANALYSIS**

The following examples showcase approaches used to identify flood vulnerability and prioritize properties where open space protection could play a role in mitigating flood risk.

**Approach: River Corridor Planning**

**Method: Geomorphic Assessment**

The Vermont Agency of Natural Resources provides funding support for the development of reach-scale river corridor plans that draw on geomorphic assessments to describe departures from a river’s “equilibrium” point and recommend strategies to limit future encroachment of river corridors and priority actions for removing or retrofitting problematic structures.
Vermont’s geomorphic assessment protocol has three phases that grow in intensity of effort from remote sensing to rapid field assessment to survey-level field assessments that measure the physical characteristics of rivers and stream channels and beds, and identify sites where change is occurring (Vermont Agency of Natural Resources, n.d.).

The resulting plans identify stream reaches suitable for protection or restoration and can inform the design and implementation of river corridor easements. Between the years of 2016-2018, 219 miles of stream were assessed for river corridor plans using geomorphic assessments (Vermont Agency of Administration 2020). The Vermont river corridor planning model has garnered interest from other states. At least two watershed plans for portions of the Exeter River commissioned by the New Hampshire Department of Environmental Conservation utilized the Vermont geomorphic assessment protocols to propose specific sites for land protection and restoration (Bear Creek Environmental and Fitzgerald Environmental Associates 2009; 2010).

**Case Study: Vermont River Sensitivity Coarse Screen**

To inform their use of land protection as a flood resilience strategy, the Vermont Land Trust (VLT) commissioned a statewide study of stream erosion and deposition potential. This effort resulted in the creation of a series of maps, and a GIS-based tool called the “Vermont River Sensitivity Coarse Screen” (Schiff et al. 2015). The map scores stream reaches for erosion and deposition potential based on their location within a valley, and color codes segments red, yellow, or green to indicate whether excessive erosion or deposition is likely, possible, or not likely. Further interpretation is needed to determine the factors contributing to the designation, which may include stream power, topography, or channel confinement from development or natural features.

Variables scored by the tool provide some insight into the flood hazard mitigation value that land protection could provide in a given location. Sites with high deposition risk, broad unconfined floodplains, a higher percentage of land in natural vegetation, high river to road ratio (indicating risk to infrastructure), and sites in headwaters are among those that could contribute to flood resiliency if conserved.

VLT uses the coarse screen as an initial assessment tool before field verification when considering locations for river corridor protection projects. The tool provides basic information about river condition and processes, and is particularly useful where finer-scale data not exist. The tool is often used in conjunction with other data available in Vermont, including river corridor plans and maps, FEMA flood insurance maps, and field-based and site-specific stream geomorphic data.
Figure B1. A screenshot showing sample erosion scores and sub-variables generated by the Vermont River Sensitivity Coarse Screen. Segments that appear in red score “high” for erosion while yellow and green segments score moderate or low, respectively. Similar rankings are available for deposition (deposits of sediment) (Schiff et al. 2015).

Approach: Strategic Conservation Planning for Flood Resilience

Example: Strategic Conservation Plan, Stowe Land Trust, Stowe, VT

The Stowe Land Trust in Stowe, Vermont identified sections along the main stem of the Little River as a priority for protection in their 2016 Strategic Conservation Plan. The plan illustrates how land protection can work alongside other tools, like land use zoning, to achieve the goal of long-term river stability and flood resilience for the town and surrounding region. Development is already restricted along the West Branch of the Little River by a Fluvial Erosion Hazard Zone. In reaches along the main stem, which are not subject to the restriction, the land trust proposed working with willing landowners to purchase river corridor easements with funding from the Vermont Department of Environmental Conservation.
**Approach: Local Flood Analysis**

**Method: Hydraulic Modeling**

Following Tropical Storm Irene in 2011, the New York City Department of Environmental Protection launched the Local Flood Analysis (LFA) Program to help communities in the New York City West of Hudson Watersheds identify long-term, cost-effective projects to mitigate flood hazards and safeguard water quality (Catskill Streams, 2014). The LFA is a town-specific engineering feasibility analysis based on hydraulic assessment of historic and predicted future inundation levels. The analysis identifies sites and structures that are vulnerable to repeat flood damage and evaluates the costs and benefits of possible mitigation strategies. Recommendations are site-specific and may include floodplain enhancement and restoration, floodplain buyouts and demolitions, flood-proofing structures, and other strategies. Several funding programs enable municipalities to implement strategies identified through the LFA process. A significant number of properties acquired through the New York City-Funded Flood Buyout Program originate from LFA recommendations.

**Case Study: Land Conservation Priorities for the Protection of Coastal Water Resources**

Led by The Nature Conservancy in New Hampshire, a group of conservation organizations authored “Land Conservation Priorities for the Protection of Coastal Water Resources,” (Steckler, Glode, and Flanagan, 2016) to elucidate conservation targets within the state’s coastal watersheds. The plan included a Flood Storage and Risk Mitigation analysis that identified areas with high flood storage potential where land protection could serve to reduce vulnerability to flooding. To model areas capable of storing flood waters beyond wetland and riparian area boundaries, analysts used...
LiDAR-derived high-resolution topographic data to map the extent of “low flats,” flood-prone lands next to wetlands. They then calculated the flood storage volume of the low flats and classified the areas into tiers of priority based on their capacity and flood mitigation potential due to location upstream of development and infrastructure. Buffer Options for the Bay, an initiative promoting the protection and restoration of vegetated buffers around water resources in New Hampshire’s Great Bay region, used the flood storage and risk mitigation data developed by The Nature Conservancy to produce maps for each of the 42 towns in the Great Bay Watershed (Buffer Options for the Bay, 2018).

Figure B3. Map created by The Nature Conservancy for Brentwood, NH showing flood storage and risk mitigation opportunity areas (Buffer Options for the Bay, 2018)

Spotlight on Data: Mapping Flood Hazard and Conservation Priority

Here we profile several flood hazard and riparian resource datasets with national coverage that could be integrated into conservation planning that seeks to address flood hazard.

FEMA Flood Hazard Maps

Flood hazard data for the United States is publicly available through the Federal Emergency Management Agency (FEMA) in support of the National Flood Insurance Program (NFIP). FEMA Flood
Insurance Rate Map (FIRM) maps delineate a community’s flood hazard zones and dictate insurance rates and building regulations in the regulated floodway (FEMA 2016). The highest level of FEMA flood hazard, referred to as the Special Flood Hazard Area, identifies locations where flooding would be expected to occur during a 100-year flood. Within this zone, purchase of flood insurance is mandatory, and other floodplain management regulations must be enforced. While mapping of Special Flood Hazard Areas in coastal areas is nearly complete, coverage of rainfall-driven and riverine flooding is spotty, particularly in small catchments, and of varying age and quality (Wing et al. 2018). FEMA flood hazard data captures risk of catastrophic flooding, but does not include smaller, more frequent floods, and does not account for the likelihood of increased flooding in the future due to climate change. Despite these limitations, FEMA data should be used in projects where the regulatory floodway is relevant, such as efforts to identify projects that qualify for credits through the Community Rating System. On its own, FEMA flood hazard data may be insufficient for prioritizing land protection, but this data can be effectively integrated into conservation plans if detailed flood hazard models are not available for the area of interest.

**Fathom Flood Hazard Models**

The UK-based flood analytics company Fathom developed a two-dimensional hydrodynamic flood risk model of the conterminous United States at 30-meter resolution, using topography data from the United States Geological Survey (USGS), data from the U.S. Army Corps of Engineers National Levee Database to represent known flood defenses, and global regionalized flood frequency analysis to estimate rainfall and return period discharges (Wing et al. 2017). The model simulates fluvial flooding to 50 km and pluvial flooding in all catchments, providing the most spatially detailed flood exposure estimates to date for this geography. When validated against FEMA Special Flood Hazard Area maps and local hydraulic models from the USGS, the Fathom US Flood Model matched the accuracy of detailed local models between 86 to 92%. Using Fathom’s US Flood Model, Wing et al. (2018) found that over three times as many Americans (41 million) are exposed to serious flooding hazard than previously estimated using FEMA maps (13 million). These high-resolution models are expensive to produce and update, and have high commercial value for insurance risk assessment. Fathom charges an annual license fee for the use of its flood hazard models, but has made the data available to some academic research institutions and non-profit organizations for non-commercial use.

Fathom has partnered with The Nature Conservancy on several projects that demonstrate the potential for this data to inform land protection priorities. The Nature Conservancy’s Floodplain Prioritization Tool for the Mississippi River Basin integrates Fathom’s flood hazard models, along with data on habitat, water quality, and social vulnerability, to identify places where land protection or restoration could mitigate flood vulnerability and advance other co-benefits (The Nature Conservancy, 2019a).

**Active River Area**

The Active River Area (ARA), conceived by scientists at The Nature Conservancy and the environmental engineering firm Milone & MacBroom, is a spatially explicit conservation framework and dataset that encompasses the river channel and key natural features within surrounding lands where the physical and ecological processes of river systems occur (Smith et al. 2008). The ARA is comprised of five components that create the varied habitats and ecologically rich zone of the river and surrounding lands: 1) material contribution areas, 2) meander belts, 3) floodplains, 4) terraces, and 5) riparian wetlands. Unlike a classic riparian buffer, ARA is not a zone of fixed width or a standardized setback from a waterbody. The extent of the ARA can be wider or narrower in a given location as needed to account for dynamic river processes, according to site-specific characteristics such as valley setting, watershed position, and stream geomorphology. While not a flood hazard layer, ARA data, which is
available from The Nature Conservancy’s Conservation Gateway, can be used in conservation planning to prioritize targets for protection (The Nature Conservancy, 2018). Preserving the active river area can help retain natural features that absorb and attenuate flood waters and lessen flood-related erosion. As a composite layer, or separated out into its component parts, ARA can aid the design of freshwater protection areas that capture critical river processes. The ARA could supplement or enhance existing policies and programs related to riparian area management by bringing a spectrum of ecological values into consideration.

**Strategy 3. VOLUNTARY FLOODPLAIN BUYOUTS**

Properties subject to significant repeat flood damage may be candidates for flood buyout programs that work with willing landowners to purchase flood-prone parcels at fair market value, demolish or relocate built structures, and return the land to an open space condition. Development on buyout properties is typically prohibited through a deed restriction. Moving property and assets out of the floodplain through buyouts lowers a community’s exposure to flood risk and cuts down on expenses associated with disaster recovery.

The Federal Emergency Management Agency (FEMA) has increasingly promoted voluntary buyouts as a component of its national flood mitigation strategy and has funded the acquisition of over 55,000 properties damaged by floods since 1993 (Salveson et al. 2018). FEMA funded buyout projects require that the land be maintained in perpetuity for “uses compatible with open space, recreational or wetland management practices,” however the funding can only be applied to certain project costs including appraisals, acquisition, building demolition, and land clearing. Restoration, ongoing stewardship, and capital investments that may be needed to transition buyout properties to public parks, wildlife refuges, or other uses are typically not eligible for FEMA funding. Communities that lack the capacity, budget, or expertise to maintain acquired land may miss opportunities to derive multiple ecological and social benefits from buyouts. A study of FEMA-funded buyouts between 1993-2000 found that the most common category of land use for buyout properties was “vacant lots,” characterized by bare mineral soil or mowed grass (Zavar & Hagelman, 2016). Such outcomes squander the potential for the reclaimed properties to contribute to water quality protection, habitat, carbon sequestration, and other conservation values.

A strategic approach to floodplain buyouts can reduce the cost burden of dealing with acquired properties and amplify public benefits. The Environmental Law Institute and the University of North Carolina’s Institute for the Environment (2017) recommend designing acquisition plans around multiple contiguous properties, ideally adding acreage to existing open space to decrease the odds that the land will remain vacant. A study conducted by The Nature Conservancy in partnership with Texas A&M University found that this “clustering” approach was just as cost effective as the scattered and reactive acquisitions that typically occur after disasters, however clustered lots were more readily repurposed as public amenities or restored to ecologically functioning floodplains (The Nature Conservancy, 2019 b).

**Federal Funding for Buyouts**

States that receive a Presidential Major Disaster Declaration are eligible to apply for federal post-disaster assistance. The primary federal programs used to fund buyouts are the FEMA Hazard Mitigation Grant Program (HMGP) and the Housing and Urban Development Community Development Block Grant Disaster Recovery (CDBG-DR) program. Detailed descriptions of these two funding programs are provided in Appendix C.
Case Study—Vermont State Buyout Program Post-Irene

Following severe flooding during the spring of 2011 and again in August associated with Tropical Storm Irene, the State of Vermont secured funding from the FEMA Hazard Mitigation Grant Program (HMGP) and the Housing and Urban Development Community Development Block Grant Disaster Recovery program (CDBG-DR) for voluntary buyouts of damaged structures.

The Two Rivers-Ottauquechee Regional Commission (TRORC), which serves 30 communities in east central Vermont, coordinated the state buyout program, liaising between municipal, state, and federal partners, administering the federal grants, and providing direct assistance to communities and property owners. To date, the program has purchased and removed 150 residences and businesses in 40 towns across the state. By bringing together funding from the two federal grant programs and $2 million dollars in state match from the Vermont Housing and Conservation Board, the program was able to offer owners 100% of the pre-disaster value in the buyout.

The commission’s ability to document damages to structures, home values, and costs in the immediate aftermath of the disaster proved critical in securing the federal funds for the buyout program. TRORC hired a designated staff person to oversee the buyout program, and worked closely with local partners, including a social services team, to provide support to community members affected by the disaster (Antioch University New England, 2019). Most of the buyout properties were retained by municipalities, though some transferred to conservation organizations, including the Vermont River Conservancy. Twelve of the buyouts managed by TRORC have become parks or public river access sites (Vermont Association of Planning and Development Agencies, 2019).

Case Study—Bettis Autoland Buyout and River Corridor Easement, Vermont River Conservancy

Tropical Storm Irene hit hard in the community of Hancock, Vermont, causing an estimated $1.57 million in damages in the town of fewer than 800 residents in the heart of the Green Mountain National Forest (Town of Hancock, 2015). Among the properties inundated when the White River overflowed its banks was the Bettis Autoland salvage yard, a 5.5-acre parcel within the 100-year floodplain. It wasn’t the first time this location had flooded over the years. The site, which held over 100 junk cars and scrap metal, had been flagged in previous watershed plans as high priority for restoration, given its flood proneness and the risk to water quality when floodwaters transported toxins from the ground into the waterway. (Vermont River Conservancy, n.d.).

Federal mitigation funds available to the state after Irene created an opening to buy out the property. The Vermont River Conservancy (VRC), a statewide land trust that specializes in protection of waterways for recreation, habitat, and flood mitigation, initially pursued a FEMA post-hazard mitigation fund grant to buy out the Bettis property, but the application was ultimately denied because portions of the project fell outside of FEMA’s mapped floodplain. The project was ultimately completed with the help of a Housing and Urban Development Community Development Block Grant obtained from The Two-Rivers Ottauquechee Regional Commission (TRORC), the regional planning agency tasked with administering Vermont’s buyout program following Irene.

VRC Executive Director Steve Libby credits the essential role that TRORC played in facilitating the complex transaction. “In Vermont, regional planning commissions have been a key partner in the buyout process, Libby stated. “They know the federal programs well and brought expertise in remediation of brownfields and hazardous areas that was essential for this project. The land trust didn’t need to know everything because we had strong partners.”
The federal grant, along with additional support from the Vermont Housing and Conservation Board and the White River Partnership, enabled VRC to buy out the property, remove 150 junk cars and other detritus from the former salvage yard, remediate hazards on the site, and create a public recreation area with a parking lot, trail, and river access (Vermont River Conservancy, n.d.). As per the requirements of the buyout program, the site will remain as open space in perpetuity, and will be protected by a river corridor easement held by VRC. The current landowner, Vermont Riverlands LLC, plans to convey the property to the Town of Hancock.

By bringing its land protection and restoration expertise to bear in management of this project, the land trust helped buck the national trend that sees the majority of federally funded buyouts wind up as vacant lots with bare mineral soil or mowed grass. Today, a site that was once cause for environmental concern each time the river overflowed its banks, is a recreational asset and a step towards greater flood resilience for the community.

**Case Study—Conway, South Carolina**

Following severe flooding associated with Hurricane Matthew in 2016, the city of Conway, South Carolina applied for FEMA Hazard Mitigation Grant Program funding to buy out homes subject to repeat flood damage. By the time the funding came through nearly two years later, many of the homeowners the city had originally lined up for the acquisitions had backed out, having rebuilt or moved on over the course of the intervening months. Shortly thereafter in the fall of 2018, Hurricane Florence made landfall in South Carolina, flooding many of the same properties once more. With unspent hazard mitigation funds from the previous disaster declaration in hand, Conway was able to reengage homeowners and close on a significant number of buyout properties.

Busy with a full slate of buyout projects, the city opted not to apply for post-disaster funds for damages incurred from Hurricane Florence. A group of conservation organizations collaborating through the Upper Waccamaw Task Force identified a block of 26 properties along the Waccamaw River adjacent to Waccamaw National Wildlife Refuge and well-suited for buyouts through the FEMA program. Led by Ducks Unlimited, task force members American Rivers, Winyah Rivers Association, and the Open Space Institute worked together to prepare the grant application on behalf of Conway. The group later learned from the state Hazard Mitigation Office that this portion of the Waccamaw River was not included in statewide priorities for post-disaster funds, which gave the project a low likelihood of getting funded.

This story illustrates some of the challenges of accessing federally funded buyout programs, including a time-intensive application process, high administrative costs, prolonged project timelines, and the need to align projects with statewide priorities. However, it also demonstrates the potential for non-profit conservation organizations to bring much needed capacity and value to the municipal flood buyout process.

**Strategy 4. FLOODPLAIN REGULATIONS**

Adjustments to a community’s floodplain regulations can bolster flood resilience by dictating where and how development can occur and strengthening protection for sensitive natural areas. Floodplain regulations can be integrated into municipal code in a variety of ways, but are most often included in zoning ordinances, building codes, or standalone floodplain management ordinances.

Communities that participate in the National Flood Insurance Program must adopt and enforce minimum federal regulatory standards for new and improved structures in Special Flood Hazard Areas. Communities that voluntarily adopt higher floodplain standards can reduce their vulnerability to flood
hazard and qualify for reductions in their flood insurance premiums through the Community Rating System (described in the following section of this report).

**Approach: Higher Floodplain Regulation Standards for Floodplain Management Ordinances**

The New Hampshire Floodplain Management Program produced a Menu of Higher Floodplain Regulation Standards for New Hampshire Communities (New Hampshire Office of Strategic Initiatives, 2018) that details a range of regulations that exceed minimum federal standards required for participation in the National Flood Insurance Program that communities can incorporate into a flood management ordinance. The menu describes the benefit offered by each standard, provides sample ordinance language from New Hampshire communities that have adopted it, and indicates where communities can earn credits for implementing the standard through the Community Rating System.

*Table B1. A Sample of Higher Floodplain Standards, Adapted from the Menu of Higher Floodplain Regulation Standards for New Hampshire Communities (New Hampshire Office of Strategic Initiatives, 2018)*

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Space Preservation Regulations</td>
<td>Measures that keep certain areas open and free of development</td>
<td>Buffer or setback rules, deed restrictions, cluster development requirements, low-density zoning</td>
</tr>
<tr>
<td>Overlay Districts</td>
<td>Specialized zoning categories that allow communities to enforce regulations in flood-prone areas outside of the Special Flood Hazard Areas designated on FEMA maps.</td>
<td>River corridor protection areas</td>
</tr>
<tr>
<td>Floodplain Development Limitations</td>
<td>Regulations that prohibit and permit certain uses or building practices in the floodway or the FEMA Special Flood Hazard Area.</td>
<td>Prohibitions against new buildings or storage of hazardous materials, Permitting only certain land uses such as recreational, agricultural, or open space</td>
</tr>
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**Tool: Supplemental Zoning Districts**

*Example: River Corridor Protection Areas, Vermont*

In Vermont, River Corridor Protection Areas are zoning overlays often used in riparian areas vulnerable to erosion. The approach can limit development within a designated protection zone or require development to meet certain specifications so that the river can meander.

The town of Lyndon, Vermont passed a flood hazard bylaw that is enforced within River Corridors mapped by the Vermont Agency of Natural Resources, and the FEMA Special Flood Hazard Area. The bylaw prohibits certain activities within the hazard area, and sets minimum standards for development, stating “the hazard areas are not appropriate sites for new structures nor for development that
increases the elevation of the base flood or obstructs the ability of streams to establish and maintain geomorphic equilibrium,” (Town of Lyndon, 2018).

Strategy 5. COMMUNITY RATING SYSTEM

Program: The Community Rating System

The Community Rating System (CRS) is a voluntary incentive program that provides an insurance premium benefit to communities that reduce flood hazard and increase resiliency by taking actions that exceed minimum standards set by the National Flood Insurance Program (FEMA, 2015). Communities can earn points and qualify for lower flood insurance premiums (up to a 45% reduction) by completing and documenting approved activities related to floodplain management, public information, and hazard mitigation, including open space protection, floodplain mapping, and adopting higher floodplain regulatory standards.

Many categories of open space (including parks, recreational fields, and natural areas) within the community’s FEMA regulated 100-year floodplain are eligible for CRS credit. Communities can accrue up to 900 credits for “open space preservation,” with the ability to earn up to 725 of these points for vacant lands within the floodplain. Communities can 75 points of additional credit by applying deed restrictions that prevent future development on open space parcels, and up to 100 points for parcels kept or restored to a natural condition, or that allow for natural floodplain functions.

Open space preservation credited through the CRS program has been shown to reduce property damage from flood events. A study of 450 communities enrolled in CRS between the years of 1999-2009 found that communities that preserved open space through the program saved an average of $200,000 in flood-related damages on an annual basis, controlling for an array of environmental, socioeconomic, and policy variables (Brody & Highfield, 2013). The researchers note that despite the documented flood risk mitigation benefits of open space preservation, on average, CRS communities receive only 21% of the total credits available under this activity.

One barrier to greater use of this approach is the administrative and technical burden of documenting eligible activities through CRS. Earning this credit for open space preservation involves substantial mapping and calculations that can be difficult or time consuming for municipalities to complete. The National Oceanic and Atmospheric Administration created a step by step guide for community planners and CRS administrators titled How to Map Open Space for Community Rating System Credit, with an accompanying workflow for technical analysts working with geographic information systems (GIS) (NOAA, 2020). The guidance covers how to calculate the community’s Special Flood Hazard Area, identify lands that qualify for open space preservation, calculate credit for preserved open space, determine whether preserved open space qualifies for extra credit, and gather supporting documentation for each parcel.

In a similar vein, the Nature Conservancy developed an app called the Community Rating System Explorer that aims to simplify the process of crediting open space preservation through the CRS program. The tool can help municipalities identify lands within the community that are already eligible for CRS points, as well as properties that could be preserved in the future (The Nature Conservancy, n.d.). Users can even export maps and analysis that can be plugged into the CRS application. Produced as part of The Nature Conservancy’s Coastal Resilience program, the tool is currently available for two counties and eight communities in coastal North Carolina, and is being expanded for use in several communities in the Gulf of Mexico.
We are not aware of a comparable tool to assist inland communities with application to CRS. Land trusts could lend much needed capacity and technical expertise to under-resourced municipalities who are interested in accessing the flood insurance premium reductions available for preserving open space in floodplains through the CRS program.

Appendix C. Funding Programs

Floodplain Buyouts

Hazard Mitigation Grant Program (Federal Emergency Management Agency)
Following a Presidential Major Disaster Declaration, governors can request Hazard Mitigation Grant Program (HMGP) funding for all or portions of the state affected by the natural disaster. State and local governments, federally recognized tribes and tribal organizations, and eligible non-profit organizations can submit applications for funding to complete projects that “reduce or eliminate the losses from future disasters,” and states have discretion to select applications that meet its post-disaster recovery priorities. Floodplain buyouts are among the mitigation strategies eligible for funding under the HMGP. HMGP grants will pay for up to 75% of buyout costs, which means that a 25% state or local match is required to recover 100% of the property value.

Community Development Block Grant Disaster Recovery (Housing and Urban Development)
City and county governments that document proof of damages associated with a presidential disaster declaration can apply to the state for CDBG-DR funds that can be used to buy out residential and commercial properties for demolition. Deed restrictions placed on the buyout properties ensure that properties will be maintained as open space. Some communities elect to use these buyout properties to create public park amenities or manage them as flood storage areas (US Department of Housing and Urban Development, 2013). CDBG-DR funding qualifies as state or local match required by the FEMA HMGP, so the two programs are often used in conjunction. Additionally, CDBG-DR will fund buyouts on some properties that do not qualify for FEMA programs because they have not suffered repetitive losses or are not located within FEMA designated floodplains.
Appendix D: Rapid Review of Northern New England State Response to Flooding

We examined the state programs, tools, available funding, and land trust activity in the three northern New England states of Vermont, New Hampshire and Maine. Our review found divergent responses to flooding across the three states and substantial variability in land trust knowledge and awareness of their role in responding to this issue. The differences observed are largely driven by the frequency and visibility of inland flooding impacts in each state. Of the three states, Vermont’s efforts to mitigate flood hazard through land protection were the most robust. Our findings suggest there would be value in sharing lessons and approaches across states and organizations to facilitate effective response to this growing challenge.

All three northern New England states are projected to see an increase in both annual precipitation and extreme precipitation events over the course of this century, which may result in higher frequency and intensity of flooding (Runkle et al. 2017a,b,c).

Table D1. Summary of Flood Disaster Declarations and Average National Flood Insurance Program (NFIP) Claim Payments in Northern New England

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<thead>
<tr>
<th>State</th>
<th>FEMA Flood Disaster Declarations Since 1953</th>
<th>Average NFIP Claim Payment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vermont</td>
<td>16</td>
<td>$28,600</td>
</tr>
<tr>
<td>Maine</td>
<td>13</td>
<td>$12,600</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>10</td>
<td>$17,100</td>
</tr>
</tbody>
</table>

Data Source: Federal Emergency Management Agency, 2019

Table D2. Number of National Flood Insurance Program Claims Per Year*, 2012 - 2016

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Vermont</td>
<td>1,463</td>
<td>39</td>
<td>26</td>
<td>33</td>
<td>5</td>
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<tr>
<td>NH</td>
<td>170</td>
<td>43</td>
<td>27</td>
<td>14</td>
<td>11</td>
</tr>
<tr>
<td>Maine</td>
<td>55</td>
<td>44</td>
<td>38</td>
<td>13</td>
<td>13</td>
</tr>
</tbody>
</table>

*Yearly totals are reported from October the previous year to September in the year of reporting.

Data Source: Federal Emergency Management Agency, 2017

On average, flood disasters are occurring every four to seven years across these states (Table 1), with the greatest frequency in Vermont, where geology and topography contribute to stream flashiness. As demonstrated in Table 2, annual flood insurance claims in northern New England fluctuate within a relatively narrow band at the lower end of the range most years, but spike periodically following major flood episodes, as seen in Vermont and New Hampshire in the aftermath of Tropical Storm Irene in late 2011. Often state and conservation activity surges following disasters, when federal money is available to aid with recovery, and then diminishes in the years following. Few states take more proactive measures due to the episodic nature of these events.
**Vermont Synopsis**
Vermont has a significant and uniquely well-developed set of programs, tools, and funding to address inland flooding, driven both by the state’s water quality initiatives and experience gained through the response to severe flooding during Tropical Storm Irene in 2011. Flood hazard mitigation is an integral part of Vermont’s efforts to achieve state water quality goals and comply with a regulatory cap on phosphorous loading in Lake Champlain. Streambank erosion caused by stream movement during flooding (fluvial erosion) is a major pollutant source for waterways in the state and is thought to account for approximately 18% of the annual load of phosphorous in Lake Champlain (Lake Champlain Basin Program, 2018). The Vermont Clean Water Fund, which was created by the state legislature to reduce the amount of phosphorous and other pollutants entering the state’s waterways, provides funding for river corridor protection in headwater streams and other stormwater and erosion abatement projects. From 2016 to 2018, $138 million dollars were awarded by Vermont state agencies for clean water projects, including easements on 576 acres of riparian corridor (Vermont Agency of Administration, 2020). This emphasis has resulted in a set of land trusts and state agencies that are well equipped with data and specialized tools to address flood hazard through land protection, including an innovative river corridor easement (read more in Appendix B). In addition to preventing development in the floodplain, these easements transfer rights to manage or alter the river channel and require the maintenance of a dynamic riparian buffer, conferring multiple conservation values. Two leading land trusts have completed most of the river corridor easement projects through the state program, and demand for the grants exceeds current funding levels. As part of the response to Tropical Storm Irene, the Two Rivers-Ottauquechee Regional Commission coordinated a buyout program that used federal post-disaster mitigation and state matching funds to purchase and remove at least 150 structures in 40 towns, some of which have become public parks or recreational access points.

**New Hampshire Synopsis**
New Hampshire’s efforts to address flood hazard have focused heavily on the seacoast and coastal watersheds, which face the most costly and visible flooding threat associated with coastal storms and sea level rise. The state’s Floodplain Management Program employs a fairly traditional approach to managing flood hazard, with outreach and technical support focused on enrolling communities in the National Flood Insurance Program and promoting the adoption of land use and zoning ordinances with higher standards in floodplains. Though far from commonplace, we did find examples where New Hampshire watershed plans adopted protocols developed by the Vermont Agency of Natural Resources to perform geomorphic assessments and produce site-specific recommendations for restoration and land protection projects that could serve to reestablish river equilibrium and mitigate flood hazard (Bear Creek Environmental and Fitzgerald Environmental Associates 2009; 2010). A notable NGO-led effort in the state’s coastal watersheds is the “Land Conservation Priorities for the Protection of Coastal Water Resources” plan, developed by The Nature Conservancy. The plan included a Flood Storage and Risk Mitigation analysis that identified areas with high flood storage potential where land protection could serve to reduce vulnerability to flooding. To date, municipal outreach associated with the plan has focused on coastal communities.

**Maine Synopsis**
More than 130,000 Maine residents, or about 10% of the state population, live within the FEMA 100-year floodplain and are considered vulnerable to inland flood risk (Climate Central and ICF International, 2015). The Maine Floodplain Management Program of the Department of Agriculture, Conservation, and Forestry provides information, financial, and technical assistance to help communities reduce their vulnerability to flood damage. The focus of Maine’s efforts to address inland flooding from a conservation standpoint has been culvert mapping and replacement, largely driven by conservation
interest in better fish crossing through culverts. The Nature Conservancy in Maine has analyzed the Maine stream crossing data in an effort to identify locations where fish passage restoration priorities may align with municipal concerns about flood vulnerability (Sharon, 2019). There may be an opportunity to identify where upstream land protection could be paired with culvert replacement to ensure future flood reduction. Coastal flooding is a significant focus and accounts for over 70% of the flood insurance policies in the state (Maine Floodplain Management Program, 2019). Additional mapping and resources are available to coastal communities but have not been replicated inland.

**FLOOD MITIGATION IN VERMONT**

In Vermont, flood damages are caused by both inundation flooding, where structures are damaged by elevated water levels, and fluvial erosion, or damage caused by explosive movement of sediment. Fluvial erosion accounts for 75% of flood damages in the state in terms of dollars (Vermont State Hazard Mitigation Plan 2018). Many of the tools and strategies developed in Vermont are driven by a need to reduce erosion and may be most applicable in places with similar issues.

The Vermont Agency of Natural Resources has made reducing the state’s vulnerability to flood damage a priority and operates the Vermont Rivers Program within the Department of Conservation (DEC). Program staff include regional floodplain managers and river scientists available to assist municipalities with river corridor mapping and planning, bylaw review, and project implementation.

**Mapping**

To identify fluvial erosion hazard, which is not well-covered by FEMA Special Flood Hazard Area maps, the DEC has mapped river corridors across the state capturing the location of the side to side movement of the river’s “meander belt” plus a 50 ft buffer to provide for additional bank stability. The river corridor maps provide the basis for the Agency of Natural Resources’ floodplain protection strategy and conservation programs.

The state has compiled the best available data on flood vulnerability in the Vermont Flood Ready Atlas, a web-based mapping tool that allows users to view FEMA flood hazard areas, the extent of river corridors, protected land, participation in the National Flood Insurance Program, the status of hazard planning or mitigation actions at the community level, and other information (Flood Ready Vermont, 2020).

**River Corridor Planning**

The Vermont Agency of Natural Resources provides support for the development of reach-scale river corridor plans that draw on geomorphic assessments to describe departures from a river’s “equilibrium” point and recommend strategies to limit future encroachment of river corridors and priority actions for removing or retrofitting problematic structures. These plans identify important flood and sediment attenuation areas that are often ideal locations for river corridor easements.

**Tool: River Corridor Easements**

The Vermont Agency of Natural Resources promotes the use of river corridor easements as a tool to reduce flood hazard and restore ecological values in stream reaches identified as important flood and sediment attenuation areas (Kline 2010).

A distinct feature of the easement is the transfer of river channel management rights within a “meander belt” that contains sensitive lands prone to erosion through sale or donation of an easement to a land trust. This approach restricts the landowner from implementing erosion and channel adjustments or
developing new structures within the river corridor, but typically allows for agriculture and silvicultural management outside of the riparian buffer. Landowners are required to maintain a riparian buffer composed of native woody vegetation with a minimum width of 50 ft that moves location with the river.

As the river location changes, landowners may seek permission from the easement holder to modify or recover an allowable land use within the river corridor. The Vermont DEC acts as an “intended third party beneficiary” of the grant and can help the grantee determine whether proposed activities are consistent with the purpose of the easement, supply technical assistance, and assist with enforcement. Channel management rights can be purchased through a stand-alone easement, or as an amendment to other types of conservation easements. The tool is often used in conjunction with restoration or other conservation approaches.

Vermont land trusts can seek funding for river corridor easements from the Vermont Clean Water Fund, which was created in 2015 through State Act 64. Notably, the Clean Water Fund was established as part of the state’s commitment to the Environmental Protection Agency to reduce pollutant loads in Vermont Waterways through a revised total maximum daily load (TMDL) plan.

According to state leaders, the river corridor easement program has been successful, and demand has exceeded available state funding. As of 2018, most of the river corridor easements funded by the Clean Water Initiative Program had been completed by the Vermont River Conservancy and the statewide Vermont Land Trust (Vermont Agency of Natural Resources, 2019). The Vermont DEC has developed a river corridor easement template that could serve as a model for easements in other states, but without dedicated funding and technical support from a state agency, and land trusts in other could find the additional complexity of implementing and enforcing this tool to be a barrier.

**Incentives for River Corridor Protection Measures**

Vermont’s Emergency Relief and Assistance Fund (ERAF) provides state dollars to match Federal Public Assistance after a disaster declaration at a base level of 7.5% of eligible costs but offers additional incentives to communities that take specific actions to mitigate flood hazard. Only communities that protect river corridors or protect flood hazard areas from new encroachment and participate in the FEMA Community Rating System qualify for the highest state ERAF contribution of 17.5%.

**Land Trust Activity**

**Vermont Land Trust**

To inform their use of land protection as a flood resilience strategy, the Vermont Land Trust (VLT) commissioned a statewide study of stream erosion and deposition potential. This effort led by Milone & MacBroom, Fitzgerald Environmental Associates resulted in the creation of a series of maps, and a GIS-based tool called the “Vermont River Sensitivity Coarse Screen” (Schiff et al. 2015). The map scores stream reaches for erosion and deposition potential based on their location within a valley, and color codes segments red, yellow, or green to indicate whether excessive erosion or deposition is likely, possible, or not likely. Further interpretation is needed to determine the factors contributing to the designation, which may include stream power, topography, or channel confinement from development or natural features.

Variables scored by the tool can provide some insight into the flood hazard mitigation value that land protection could provide in a given location. In general, sites with high deposition risk, broad unconfined floodplains, high percentage of land in natural vegetation, high river to road ratio (indicating risk to
infrastructure), and sites in headwaters could be strong candidates for protection for their contributions to flood resiliency. VLT uses the coarse screen as an initial assessment tool before field verification when considering locations for river corridor protection projects. The tool provides basic information about river condition and processes that is particularly useful where finer-scale data do not exist. The tool is often used in conjunction with other data available in Vermont, including river corridor plans and maps, FEMA flood insurance maps, and field-based and site-specific stream geomorphic data.

Screenshots showing sample erosion and deposition screen scores and variables generated by the Vermont River Sensitivity Coarse Screen (Schiff et al. 2015).

Vermont River Conservancy
Conserving land for flood resilience is a major focus on the Vermont River Conservancy (VRC), which has completed dozens of river corridor easements using funding from the Clean Water Fund, the Vermont Agency of Natural Resources Ecosystem Restoration Grant Program, the Vermont Housing and Conservation Board, and other sources. A number of these river corridor easements are purchased on agricultural land, which serves to take the flood-prone land out of production and helps offset the associated loss of income to the farmer. In some cases, easements on town-owned properties have combined river corridor protection with recreational access. Additionally, the Vermont River Conservancy has partnered with the Vermont Housing and Conservation Board and others to conserve properties eligible for federal buyouts after Tropical Storm Irene.

FLOOD MITIGATION IN NEW HAMPSHIRE

Away from the coast, New Hampshire’s headwater streams confined in steep, narrow valleys are prone to flooding during episodes of intense precipitation because of limited floodplain area to store and dissipate flow (New Hampshire Homeland Security and Emergency Management, 2018). Many of the state’s larger rivers have been straightened, which contributes to higher risk of bank erosion and channel migration. In the winter months, inundation can occur upstream of ice jams, which tend to form away from the coastal plain in areas with steep terrain.

State Programs
The New Hampshire Office of Strategic Initiatives leads the state’s Floodplain Management Program, which administers the National Flood Insurance Program, and assists communities by supplying FEMA flood hazard maps, outreach materials, and model floodplain ordinances.
The New Hampshire Geologic Survey (NHGS) oversees the state’s Flood and Geologic Hazards Program, which focuses on flood-related inundation and erosion hazards. Program staff provide information and technical expertise to help communities prepare for and respond to flooding. They partner with the New Hampshire Department of Environmental Services to perform river site assessments pre and post-flood to analyze threats to property, infrastructure, and public safety.

The NHGS also coordinates New Hampshire’s interagency “Silver Jackets” flood management team, which includes representatives from more than 15 state and federal agencies. In 2019, the Silver Jackets team published the New Hampshire Flood Hazards Handbook: A Guide for Municipal Officials, which offers guidance on actions communities can take to prepare, respond, and recover from floods. A section on mitigating future impacts mentions preserving natural floodplain areas as an example of a green infrastructure strategy to improve resilience to flood hazards, but the New Hampshire-specific resources offered focus on the impacts of coastal flooding. New Hampshire has undertaken a statewide Stream Crossing Initiative to assess the condition of culverts and bridges and identify undersized crossings that could pose risk to public safety. Culverts are rated for ability to withstand 2, 10, 25, 50, and 100-year floods. The assessment data is publicly available through the NH Aquatic Restoration Web Mapper (New Hampshire Department of Environmental Services, n.d.).

Conservation Planning
We found two examples of watershed plans for segments of the Exeter River that employed geomorphic assessments following protocols developed by the Vermont Agency of Natural Resources (Bear Creek Environmental and Fitzgerald Environmental Associates 2009 and 2010). These plans make site-specific recommendations for restoration and land protection projects that could serve to reestablish river equilibrium and mitigate flood hazard. The plans consider land protection an appropriate strategy in places where surveys found minimal disturbance to stream reaches, healthy river structure and function, and fairly intact riparian buffers.

Mapping
The New Hampshire Flood Hazards Viewer, developed by the state’s Office of Strategic Initiatives, is an online tool that allows users to view and overlay effective digital and preliminary FEMA flood hazard maps, sea level rise scenarios, topographic elevation contours, and parcel boundaries (New Hampshire Office of Strategic Initiatives, n.d.) The flood hazard maps are digitized for the entire state, with the exception of Belknap County and the town of Lincoln.

Land Use Regulation
The New Hampshire Floodplain Management Program produced a Menu of Higher Floodplain Regulation Standards for New Hampshire Communities (New Hampshire Office of Strategic Initiatives, 2018) that details a range of regulations that exceed minimum federal standards required for participation in the National Flood Insurance Program that communities can adopt on a voluntary basis. The menu describes the benefit offered by each standard, provides sample ordinance language from New Hampshire communities that have adopted it, and indicates where communities can earn credits for implementing the standard through the Community Rating System.

Notable Efforts
The Nature Conservancy, New Hampshire led the development of “Land Conservation Priorities for the Protection of Coastal Water Resources” (Steckler, Glode, and Flanagan, 2016), intended as a supplement to Zankel et al.’s 2006 biodiversity-focused report, The Land Conservation Plan for New Hampshire’s Coastal Watersheds. The Coastal Water Resources plan included a Flood Storage and Risk Mitigation analysis that identified areas with high flood storage potential where land protection could serve to
reduce vulnerability to flooding. To model areas capable of storing flood waters beyond wetland and riparian area boundaries, analysts used LiDAR-derived high-resolution topographic data to map the extent of “low flats,” flood-prone lands next to wetlands. They then calculated the flood storage volume of the low flats and classified the areas into tiers of priority based on their capacity and flood mitigation potential due to location upstream of development and infrastructure.

The team of nonprofit organizations, public agencies, and academics behind the Buffer Options for the Bay (BOB) initiative promotes the protection and restoration of vegetated buffers around water resources in New Hampshire’s Great Bay region by creating resources to inform land use and policy decisions (Buffer Options for the Bay, 2018). BOB used the flood storage and risk mitigation data developed by The Nature Conservancy to produce maps for each of the 42 towns in the Great Bay Watershed. These maps can help communities prioritize permanent protection of lands that provide natural flood hazard mitigation services and keep development out of vulnerable areas. To date, outreach to municipalities has focused on coastal communities.

Southeast Land Trust, whose service area covers 99% of New Hampshire’s coastal watershed, considers these flood storage and risk mitigation areas as an important co-benefit when evaluating land protection projects but has not conducted proactive outreach to owners of properties with significant flood storage values.

*Map created by The Nature Conservancy for Brentwood, NH showing flood storage and risk mitigation opportunity areas (Buffer Options for the Bay, 2018)*

**FLOOD MITIGATION IN MAINE**

More than 130,000 Maine residents, or about 10% of the state population, live within the FEMA 100-year floodplain and are considered vulnerable to inland flood risk (America’s Preparedness Report Card 2015). Patterns of flood vulnerability in Maine are shaped by the state’s geography, which is characterized by an abundance of rivers that originate at high elevation and flow eastward to the
seacoast. These waterways are prone to rapid rise in mountainous locales following heavy rain events (Maine Emergency Management Agency 2018).

**State Programs**

The Maine Floodplain Management Program of the Department of Agriculture, Conservation, and Forestry provides information, financial, and technical assistance to help communities reduce their vulnerability to flood damage. The program promotes enrollment in the National Flood Insurance Program by holding workshops on flood map interpretation, facilitating mapping updates, reviewing local code, and sharing model floodplain ordinances. Program staff also help communities take actions to reduce their flood insurance premiums through the Community Rating System (Maine Department of Agriculture, Conservation, and Forestry 2013).

**Notable Efforts**

Climate projections for the Northeast anticipate an increase in extreme precipitation, which could put more strain on stream crossings and increase the likelihood of infrastructure failure (Fourth National Climate Assessment 2018). The Maine Department of Transportation has begun considering inland flood risk by including climate projections in its culvert resizing projects. The identification of at-risk structures has been facilitated by a road-stream crossing survey protocol developed by the US Fish and Wildlife Service Gulf of Maine Coastal Program to standardize field methodology to identify culverts and bridges across the state that act as barriers to aquatic and terrestrial species. Through the efforts of volunteers and staff from multiple federal and state agencies, and non-profit organizations, about 95% of stream crossings on public roads across the state will be surveyed by the end of 2019. The dataset is publicly available through the Maine Stream Habitat Viewer (Maine Department of Marine Resource, 2019).

The data collected through these surveys includes information about the location and condition of in-stream structures, which makes it promising as an indicator of which crossings could be vulnerable to failure, resulting in flood damage during high flow storm events. The Nature Conservancy in Maine has analyzed the Maine stream crossing data in an effort to identify locations where fish passage restoration priorities may align with municipal concerns about flood vulnerability (Sharon, 2019).

**Conservation Planning**

**Maine West**

Maine West, a regional collaborative of 13 partners working to strengthen connections between the conservation, community development, health and education sectors across 27 towns in western Maine, considered flood vulnerability in their strategic conservation plan in order to identify lands that contribute to climate resiliency for human communities. The partnership’s prioritization model incorporated FEMA floodplain data, developed areas subject to flooding, and undersized culverts that could be vulnerable to damage during severe storms (Culbertson, Labich, and Wilson 2018).