V. Conclusion

In New England, we love our rivers – and with good reason. They bring fresh water, beautiful scenery, places to fish and boat and swim, thriving wildlife and plants, and familiar sounds of babbling or flowing sounds. They powered our region's industrialization and have helped build and sustain its important agricultural, recreational, and tourist industries. Many of our communities and many of our favorite places are along the banks of a stream or river.

Yet one aspect of our rivers that we have too often failed to understand, or at least to remember, is that they flood – and when they flood, they have tremendous power. We have not sufficiently anticipated or prepared for the destructive effects of powerful river floods. For this reason river floods have frequently had damaging consequences for the buildings, infrastructure and other investments we have placed across streams or on riverside lands. Recently, policymakers have voiced concerns about the coastal flooding and hurricanes that may come with climate change, about heat waves and snow – but as a region and in our hundreds of communities we are still failing to plan ahead for the times when our familiar rivers and streams will become raging torrents. Such times are likely to come more often in the future. Just as climate change threatens sea level rise, it also promises to bring larger and more frequent river floods to inland areas as well as to coastal regions, as extreme weather events like hurricanes and rain-on-snow events become more frequent and more extreme.

It is time we learn, understand, prepare and act. We must all become much more river-smart.

This report has aimed to give the residents, community leaders, government agency staff, and policy makers critical information and guidance that can help.

Chapters 1 through 3 provided background information. Chapter 1 provided important historical context within which to understand New England's river floods. It had two crucial lessons: river floods are common, not infrequent and rare; and we have made them more destructive by confining river channels and by building so much infrastructure in and along streams.

Chapter 2 provided a user-friendly overview of the science of fluvial geomorphology, a science that explains the ways that rivers move, and why and how they can become destructive to our homes, communities and investments. The chapter included 16 key insights about river hazards that come out of this river science, and three core lessons for science and management. Keep this chapter and its insights as an easy reference.

Chapter 3 provided background on governance in New England for rivers and riverside lands. It emphasized the strengths and challenges of our New England system of relatively autonomous local governments, which includes over 1500 towns and cities, many with participatory Town Meetings and largely volunteer governments. The chapter also summarized the strengths and challenges of federal and state agencies in meeting New England's communities' need to become more river-smart. In both local communities and in federal and state government agencies, strengths and the challenges are equally great. We finished the chapter with an overview of our own research, in which seven different organizations showed us what is possible despite the challenges. If you, too, are working to find ways to move your community or state toward better protection from damaging river floods and are feeling discouraged by the challenges, you may want to spend some time looking at the stories of these and similar organizations. They are truly inspiring. Details on many of their efforts are featured in Examples in Chapter 4, and several will have more detailed profiles posted on our website, https://extension.umass.edu/riversmart.

The heart of our effort is in Chapter 4. Our five target recommendations in Chapter 4 provided guidance. We suggested ways federal and state policies and programs can do a better job of helping New England communities to become river-smart.

We chose our recommendations based on four criteria: they would make federal and state policy significantly more effective and helpful to New England residents, landowners and communities in their efforts to become river-smart; they would require relatively little additional money; they would require relatively limited regulatory change; and they were general enough to be adapted to different state, regional and local contexts.

If you are a community leader, a government agency staff person, a policy maker, or just someone concerned about rivers or the threat of river flood damage, we invite you to take our ideas and adapt them for your needs. Use them to advocate for new and refined policies and programs that will help you and others make your state, community, region or property more river-smart. Our ideas are built on those of many other people, and we hope this report will become another step and building block, a resource for anyone and everyone in the region.

Though the recommendations are intentionally general, we know that often it is hard to imagine how to do something without far more specific guidance. Embedded in each of the recommendations were several Examples. The Examples show how someone in New England is doing one of the things we have recommended. Each is built on our research and very helpful staff and community leaders who helped us build their profile. In some cases, you may be able to follow their example closely. In other cases, you will quickly realize its approach will not work in your community, region or state. In that case, use it for inspiration, and create your own approach.

We remain inspired by the many people we have met and talked to in the development of our research and this project. Rivers are at the heart of New England, and by becoming river-smart we can thrive alongside them for centuries to come.

The Bridge of Flowers in Shelburne Falls, Mass. This photo highlights just one of the many riverside landscapes that define New England communities. In contrast to the serenity shown in this picture, during Tropical Storm Irene in August 2011, the raging Deerfield River nearly filled the bridge's arches. Because the bridge was built well to pass water, sediment and debris, it remained whole, but the torrent caused significant damage to riverside properties. By helping New England communities to become river-smart, we can ensure that when our beloved rivers flood, more of our homes, buildings and infrastructure remain resilient, and the region's rivers support rather than ravage the iconic places and landscapes that we love in New England.

Summary of Target Recommendation #1

Develop Fluvial Hazard Assessments

Recommendation:

Develop and implement fluvial hazard assessment, mapping, and user access systems across the New England states.

(See page 38).

Recommendation elements:

Develop and implement fluvial hazard assessment protocols, systems for implementation, and user-friendly maps and information portals.

Summary of Target Recommendation #2

Upgrade Vulnerable Stream Crossing Infrastructure

Recommendation:

Support upgrades of vulnerable stream crossings across the six New England states

(See page 48).

Recommendation elements:

a) Improve stream crossing regulatory standards to support upgrades, be consistent across agencies, and allow site-specific flexibility (well under way in New England)

b) Streamline permit and funding processes and requirements, and incentivize replacing vulnerable and damaged crossings with upgrades

c) Develop and make available easy-to-follow design templates and guidelines for upgraded crossings which will receive quick permitting and funding review and high likelihood of approval

d) Develop and support an accessible inventory and database of stream crossings that identifies vulnerable crossings

e) Increase and diversify funding for stream crossing upgrades.

Summary of Target Recommendation #3

Support River-Smart Planning and Mitigation

Recommendation:

Support municipal efforts to prepare for and mitigate river flood hazards through planning and land use

(See page 55).

Recommendation elements:

a) Support municipal, multi-municipality, regional and state hazard planning that addresses river flood hazards

b) Enable and promote a diverse menu of mechanisms for communities to achieve river-smart conservation, mitigation, and development; support with technical, financial and legal assistance.

c) Ensure that support is available to communities on an ongoing basis, until their plans are fully implemented.

Summary of Target Recommendation #4

Provide Outreach and Training on River Dynamics and River-Smart Practice

Recommendation:

Prepare and disseminate outreach materials and training on river dynamics, lessons for river flood hazards, and river-smart best management practices.

(See page 61).

Recommendation elements:

a) Train transportation work crew personnel in New England on river dynamics and river-smart best management practices

b) Produce easily understandable outreach materials on river dynamics and practical lessons for land management; disseminate widely, especially to land use decision makers

c) Prepare in-depth outreach materials; create, publicize and maintain systems to deliver these quickly and efficiently upon request

Summary of Target Recommendation #5

Designate, Recognize and Support River-Smart Regional Intermediaries Practice

Recommendation:

Designate, recognize and support river-smart Regional Intermediaries to provide low-cost and no-cost technical assistance to municipalities, and to guide and assist with federal and state programs.

(See page 70).

Recommendation elements:

a) Ensure that all municipalities in New England have access to a river-smart Regional Intermediary, whose mission includes low-cost service for municipalities and which has capable, reliable staff who respect towns' authorities and support towns' capacities.

b) Use river-smart Regional Intermediaries to guide and assist with delivery of flood assessment, planning, mitigation and response services to local governments and landowners, and to gather and understand information on local needs and conditions.

Notes

1. National Oceanic and Atmospheric Administration, "Preliminary Hurricane/Tropical Storm Irene Weather Summary for the North Country," National Weather Service Forecast Office, September 2, 2011. http://www.erh.noaa.gov/btv/events/Irene2011/.

2. For some of the best collections of images and stories about Tropical Storm Irene's destruction in New England, especially Vermont, see: Free Press Staff, "An Irene Narrative: Journey through Devastation in Vermont," Burlington Free Press, September 4, 2011, http://archive.burlingtonfreepress.com/interactive/article/20110904/NEWS07/309040001/An-Irene-narrative-Journey-through-devastation-Vermont; Burlington Free Press, *The Year of the Storms: Vermont's Remarkable Experiences in 2011*, Burlington, VT: Pediment Publishing, 2011; M. Dickey Drysdale, *The Wrath of Irene Deluxe: Vermont's Imperfect Storm of 2011,* CreateSpace Independent Publishing Platform, 2012; Patrick Johnson,"Irene Has Gone but Problems Remain; Western Massachusetts Towns Waiting to Get Full Measure of Damage," Mass Live, August 29, 2011, http://www.masslive.com/news/index.ssf/2011/08/irene_has_gone_but_problems_re.html; "Power Outages, Flooding from Irene in Massachusetts," Associated Press, August 28, 2011, http://usatoday30.usatoday.com/news/nation/story/2011-08-28/Power-outages-flooding-from-Irene-in-Massachusetts/50169538/1.

3. See e.g. John Appleton, "Hurricane Irene flooding devastates several Western Massachusetts farm crops," August 30, 2011, http://www.masslive.com/news/index.ssf/2011/08/hurricane_irene_flooding_devas.html.

4. Sacha Pealer, "Lessons from Irene: Building Resiliency as We Rebuild," Vermont Agency of Natural Resources, January 4, 2012, http://www.anr.state.vt.us/anr/climatechange/Pubs/Irene_Facts.pdf.

5. For more background on fluvial geomorphology, see Vermont Agency of Natural Resources, "River Dynamics 101 - Fact Sheet," River Management Program, June 14, 2005, http://www.watershedmanagement.vt.gov/rivers/docs/rv_river_dynamics_101.pdf; Ellen Wohl, *Rivers in the Landscape: Science and Management*, Wiley-Blackwell, 2014; Gary J. Brierley and Kirstie A. Fryirs. *Geomorphic Analysis of River Systems: An Approach to Reading the Landscape*, West Sussex, UK: Wiley-Blackwell, 2012; Ellen Wohl, "Time and Rivers Flowing: Fluvial Geomorphology since 1960," *Geomorphology* 216 (July 2014): 263–82; Ann Smith, Abbey Willard, Linda Henzel, and Mike Kline, "Living in Harmony with Streams: A Citizen's Handbook to How Streams Work," Friends of the Winooski River, White River Natural Resources Conservation District, Winooski Natural Resources Conservation District, 2012; http://www.winooskiriver.org/images/userfiles/files/Stream%20Guide%201-25-2012%20FINAL.pdf.

6. See e.g. R.C. Walter, and D.J. Merritts, 2008, Natural Streams and the Legacy of Water-Powered Mills, *Science* 319 (5861): 299-304.

7. Eve Vogel and Alexandra Lacy, "New Deal versus Yankee Independence: The Failure of Comprehensive Development on the Connecticut River, and Its Long-Term Consequences," *The Northeastern Geographer* 4 (2), 2012: 66–94. For more information on several of these past New England floods see: http://www.floodsafety.noaa.gov/states/ma-flood.shtml.

8. See e.g. Motoyoshi, Tadahiro, "Public Perception of Flood Risk and Community-Based Disaster Preparedness," in S. Ikeda, T. Fukuzono, and T. Sato, Eds. *A better integrated management of disaster risks: Toward resilient society to emerging disaster risks in megacities.* Terra Scientific Publishing Company & National Research Institute for Earth Science and Disaster Prevention, 2006, 121–34, https://www.terrapub.co.jp/e-library/nied/pdf/121.pdf.

9. Department of Environmental Conservation, Water Quality Division, "Options for State Flood Control Policies and a Flood Control Program," Waterbury, VT: Vermont Agency of Natural Resources, February 1999, http://www.watershedmanagement.vt.gov/rivers/docs/rv_act137.pdf.

10. Much of attention in flood management and control has been on controlling or reducing flood risk. But in recent years there has been increasing emphasis on the notion that no matter what we do, there is always some risk left – some "residual risk" (see e.g. Ludy, Jessica and Kondolf, G. Matt 2012: "Flood risk perception in lands 'protected' by 100-year levees," *Natural Hazards* 61: 829-842; Carter, Nicole, Flood risk management: Federal role in infrastructure, CRS Report for Congress, Order Code RL33129, 2005, http://digital.library.unt.edu/ark:/67531/metacrs7915/m1/1/high_res_d/RL33129_2005Oct26.pdf.) Our report places more emphasis on the tangible, physical processes of river dynamics than on abstract concepts of risk and residual risk, but our analysis here of what happens when people try to armor rivers and streams helps to explain some of why there is always residual risk.

11. U.S. Geological Survey, "100-Year Flood-It's All About Chance. Haven't We Already Had One This Century?" U.S. Department of the Interior, April 2010, http://pubs.usgs.gov/gip/106/pdf/100-year-flood-handout-042610.pdf.

12. Federal Emergency Management Agency, "Flood Zones," FEMA, April 26, 2015. http://www.fema.gov/flood-zones.

13. There are also considerable technical uncertainties with these numbers, especially for less common floods, and especially as the climate continues to change.

14. Frumhoff, P.C., J.J. McCarthy, J.M. Melillo, S.C. Moser, and D.J. Wuebbles, "Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions," Synthesis report of the Northeast Climate Impacts Assessment (NECIA), Cambridge, MA: Union of Concerned Scientists (UCS), 2007.

15. Data from NASA Goddard Institute for Space Studies, New York, NY, accessed via the website: "Updating the Climate Science: What Path is the Real World Following?" Makiko Sato & James Hansen, Columbia University Earth Institute, http://www.columbia.edu/~mhs119/.

16. Weider, K. and D.F. Boutt, Heterogeneous water table response to climate revealed by 60 years of ground water data, *Geophysical Research Letters*, 37 (L24405), 2010.

17. See note 5.

18. Bierman, Paul, Lini, Andrea, Zehfuss, Paul and Church, Amy 1997: Postglacial Ponds and Alluvial fans: Recorders of Holocene Landscape History, *GSA Today* 7(10): 1-2; Kline, Michael, and Barry Cahoon, "Protecting River Corridors in Vermont," *Journal of the American Water Resources Association* 46 (2), 2010: 227–36.

19. Vogel and Lacy, note 7.

20. Understanding this constant geomorphic change is important for habitat monitoring, too. See Poole, Geoffrey C., Frissell, Christopher A., and Ralph, Stephen C., "In-Stream Habitat Unit Classification: Inadequacies for Monitoring and Some Consequences for Management," *Journal of the American Water Resources Association* 33(4), 1997: 879–96.

21. The general stability will be maintained even as meanders and other features shift because while some parts of the river increase their meanders and braids, others will shorten or lose them. Processes that shorten meanders include, for example, when some meanders get so wide that adjacent curves join, creating a shortcut where the water flows instead. The abandoned meander, no longer connected to the stream channel, is called an oxbow lake. Alternatively, sometimes lower-valley rivers can break through the sediments in their own flood plains and form a shorter channel, as New Hampshire's Suncook River did, described in Example 1, p. 11.

22. See e.g. Wohl, E. 2014, A legacy of absence: Wood removal in US rivers. *Progress in Physical Geography*, October 2014 vol. 38 (5): 637-663.

23. This section was informed in large part by Department of Environmental Conservation, "Flood Hazard Area and River Corridor Protection Procedure," Vermont Agency of Natural Resources, October 6, 2014. http://floodready.vermont.gov/sites/floodready/files/documents/2014-10-06%20%20Final%20Draft%20Flood%20Hazard%20Area%20and%20River%20Corridor%20Protection%20Procedures.pdf.

24. "Room for the river" or "space for the river" has become a key policy in the Netherlands, which long managed its flood-prone lands by trying to confine and straighten its rivers. The phrase has been taken up in many other countries as well. See e.g. Climatewire, "How the Dutch Make 'Room for the River' by Redesigning Cities," Scientific American, January 20, 2012, http://www.scientificamerican.com/article/how-the-dutch-make-room-for-the-river/; Warner, Jeroen, Jeroen Frank Warner, Arwin van Buuren, and Jurian Edelenbos, Eds., *Making Space for the River: Governance Experiences with Multifunctional River Flood Management in the US and Europe,* IWA Publishing, 2013.

25. "Otter Creek," The Connecticut River Watershed Council, The Conservation Law Foundation, 2012, https://www.youtube.com/watch?v=frJFJMfPMd4.

26. For example: We can slow runoff even before it gets to streams and encourage infiltration, by minimizing impermeable surfaces and removing drainage ditches. We can plant vegetation along stream banks and in riverside floodplains and riparian areas. We can restore deepened, incised channels by raising their beds and reconnecting them with their floodplains. We can even re-shape river channels to stop head cuts or to re-create meanders and braids (though this can be very costly and must be done with some humility, as rivers do not always cooperate in following our constructed natural paths). We can remove old dams that constrain channel movements, and at the same time allow beavers to create small-scale storage in a diversity of places. See Department of Environmental Conservation, "Flood Hazard Area and River Corridor Protection Procedure," Vermont Agency of Natural Resources, October 6, 2014, http://floodready.vermont.gov/sites/floodready/files/documents/2014-10-06%20%20Final%20Draft%20Flood%20Hazard%20Area%20and%20River%20Corridor%20Protection%20Procedures.pdf.

27. Insights from UMass professor Anita Milman and postdoc Ben Warner, and from the Massachusetts Department of Ecological Restoration's Tim Chorey, all of whom were also doing research on New England communities' perspectives in relation to flood risk and river-smart development, were particularly helpful. See e.g. Anita Milman & Benjamin Warner, The Interfaces of Public and Private Adaptation: Lessons from Flooding in the Deerfield River Watershed, *Global Environmental Change*, 2015, (36):46-55, and Mass Division of Ecological Restoration: Culvert Replacement Survey, at: http://www.cmrpc.org/mass-division-ecological-restoration-culvert-replacement-survey. All interpretations in this report are our own.

28. Over 150 towns in New England have fewer than 500 people, and almost one-third of all municipalities in the region have fewer than 2,000.

29. Investigations of the Creating Resilient Communities group, the Vermont Rivers Program, and the White River Partnership were part of the RiverSmart Communities project funded by the UMass Center for Agriculture, Food and the Environment. Investigations of the New Hampshire Post-Incident Recovery Response Team / US Army Corps of Engineers Silver Jackets, the Natural Resources Conservation Service, and the North Atlantic Aquatic Connectivity Collaborative were part of the RiverSmart Communities and Federal Collaborators project, funded by the U.S. Army Corps of Engineers Institute for Water Resources. We learned about the Franklin Regional Council of Governments through our work on the other projects, especially through our work with the Creating Resilient Communities group.

Image Credits

Cover photo: Christopher Condit, John Fellows and Massachusetts Geological Survey, 9/18, 2011.

Page 8: North Adams Transcript, provided courtesy Paul W. Marino, North Adams local historian, used by permission from http://paulwmarino.org/.

Page 9: left- Irene Images, Vermont Rivers Program; right – "Destroyed land near Hancock, VT," Lars Grange and Mansfield Heliflight, 8/31, 2011, at http://www.mansfieldheliflight.com/flood/.

Page 10: Irene Images, Vermont Rivers Program.

Page 11, Example 1: top- Vermont History Explorer, Vermont Historical Society, at https://vermonthistory.org/explorer/vermont-az/vermont-ef/203-floodof1927az; bottom left – USDA Farm Service Agency; bottom right – Google Maps. For more on the Suncook River avulsion see: http://des.nh.gov/organization/divisions/water/wmb/rivers/suncook-river.htm.

Page 12: "More damage and a destroyed house along Route 100," Lars Grange and Mansfield Heliflight, 8/31, 2011, at http://www.mansfieldheliflight.com/flood/

p. 14: "Route 4 / Route 100 South of Killington completely destroyed," Lars Grange and Mansfield Heliflight, 8/31, 2011, at http://www.mansfieldheliflight.com/flood/

Page 16, Example 2: left - Roland Schneider, in Vermont Long-Term Disaster Recovery Group, "We're going to get it done: Vermont's Response to Tropical Storm Irene," The Vermont Disaster Relief Fund, www.VermontDisasterRecovery.com; right – Jerry LaBlond, The Herald, Randolph, VT, at http://photo.ourherald.com/flood2011.

Page 16, bottom right: Watershed diagram by Christine Hatch and Eve Vogel.

Page 18: Floodplain diagram by Christine Hatch.

Page 20: Upper right: Vermont Rivers Program (3 stages of a multi-stage used in many documents, e.g. River Corridor Protection and Management Fact Sheet, at http://dec.vermont.gov/sites/dec/files/wsm/rivers/docs/rv_rcprotectmanagefact-sheet.pdf), adapted by Christine Hatch and Aayushi Mishra; bottom right – White River: George Springston, in Vermont Rivers Program and Floodready Vermont, at http://floodready.vermont.gov/flood_protection/river_corridors_floodplains/river_corridors.

Page 21: top left: Noah Slovin; middle right: Todd Menees, Vermont Rivers Program; bottom left: Christine Hatch.

Page 24: Timothy Dexter, Wikimedia, 2014: https://en.wikipedia.org/wiki/New_England_town.

Page 27: Amy Wildt, in Vermont Long-Term Disaster Recovery Group, "We're going to get it done: Vermont's Response to Tropical Storm Irene," The Vermont Disaster Relief Fund, p. 12, www.VermontDisasterRecovery.com.

Page 32: top - White River Partnership, 2012, http://whiteriverpartnership.org/2012-accomplishments/. Bottom: NRCS Massachusetts, 2011, http://www.nrcs.usda.gov/wps/portal/nrcs/detail/ma/newsroom/releases/?cid=nrcs144p2_014175.

Page 36, Recommendation #1 Summary photo: Alex Schwartz, Cassie Tragert, Cassandra Zawadski and Gillian Gunderson, 2015.

Page 38, Example 3: top – Vermont Natural Resources Atlas. http://anrmaps.vermont.gov/websites/anra/. ; bottom - Gomez & Sullivan in association with Parish Geomorphic, Draft Final Channel Management and River Corridor Protection Plan,

Walloomsac River and Roaring Branch, Bennington County, Vermont, December, 2007, p. 26. This and other Vermont stream geomorphic assessments are on line at: https://anrweb.vt.gov/DEC/SGA/finalReports.aspx.

Page 40, Example 4: Stream Geomorphic Sensitivity, Walloomsac River and Roaring Branch, Bennington County, Vermont; FEMA Flood Insurance Rate Maps Panels 0411D and 0413D, available at: https://msc.fema.gov/portal. Figure adaptations by Eve Vogel, Christine Hatch, and Aayushi Mishra.

Page 43, Example 5: top left- Inter-fluve Inc.; top right- Paul Nguyen; both photos in Massachusetts Division of Ecological Restoration, Massachusetts Stream Crossing Handbook, 2012, p. 10, available at: http://www.mass.gov/eea/docs/dfg/der/pdf/stream-crossings-handbook.pdf; bottom - Vermont Agency of Natural Resources/Vermont Agency of Transportation.

Page 44, Example 6: Graphic adapted by Joe Shoenfeld, Eve Vogel and Aayushi Mishra from Carrie Banks. For more on culvert replacement costs from the studies referenced in this Example, see Economic Benefits from Aquatic Ecological Restoration Projects in Massachusetts, Massachusetts Department of Ecological Restoration, 2015, at: http://www.mass.gov/eea/docs/dfg/der/pdf/summary-of-der-economic-benefits-studies-all-phases.pdf; Economic & Community Benefits from Stream Barrier Removal Projects in Massachusetts, Massachusetts Department of Ecological Restoration, 2015, at: http://www.mass.gov/eea/docs/dfg/der/pdf/phase-iii-benefits-from-stream-barrier-removal-projects.pdf; and Jessica Levine, An Economic Analysis of Improved Road-Stream Crossing, The Nature Conservancy, Adirondack Chapter, 2013, at: http://www.nature.org/ourinitiatives/regions/northamerica/road-stream-crossing-economic-analysis.pdf. For Becket case study see Amy Singler and Carrie Banks, Massachusetts Stream Crossing Case Studies, 2015, available at: http://massriversalliance.org/wp-content/uploads/2015/10/MassStreamCrossingCaseStudiesAmRivers-DER10-13.pdf.

Page 47, Example 8: left - North Atlantic Aquatic Connectivity Collaborative, Prioritizing Crossings for Assessment, available at: https://www.streamcontinuity.org/assessing_crossing_structures/prioritizing_crossings.htm; right – Vermont Agency of Transportation and the Vermont Regional Planning Commissions, VTCULVERTS, available at: http://vtculverts.org/.

Page 49, Example 9 – Christine Hatch and Marie-Francoise Hatte.

Page 51, Recommendation #3 Summary: FloodReady Vermont, "Protect River Corridors and Floodplains," available at: http://floodready.vermont.gov/flood_protection/river_corridors_floodplains.

Page 53: Vermont Agency of Commerce and Community Development, in Environmental Protection Agency, Office of Sustainable Communities Smart Growth Program, "Planning for flood recovery and long-term resilience in Vermont: Smart Growth Approaches for Disaster-Resilient Communities," EPA 231-R-14-003, July 2014, p. 13, available at: https://www.epa.gov/sites/production/files/2014-07/documents/vermont-sgia-final-report.pdf.

Page 56, Example 10: Sharon, VT Town Plan, 2015, available at: http://www.sharonvt.net/allselectboardminutes/doc_download/483-sharon-town-plan-adopted-apr-6-2015.html.

Page 57, Example 12: Figure by Eve Vogel, Joe Shoenfeld and Aayushi Mishra.

Page 58, Example 13: left - Vermont Department of Environmental Conservation, River Corridor and Floodplain Management Program and Shoreland Protection Program Biennial Report to the General Assembly Pursuant to Act 110, January 2015, available at: http://floodready.vermont.gov/sites/floodready/files/documents/Act%20110%20Legislative%20Report%20January%202015.pdf; right - Flood Ready Vermont: River corridors, at http://floodready.vermont.gov/flood_protection/river_corridors_floodplains/river_corridors.

Page 63, Example 14: Vermont Rivers and Roads Training Program Update April 2, 2014, http://legislature.vermont.gov/assets/Documents/2014/WorkGroups/House%20Fish%20and%20Wildlife/Improving%20the%20Quality%20of%20State%20Waters/Rivers%20and%20RoadsTraining%20Program/W~Shayne%20Jaquith~VT%20Rivers%20and%20Roads%20Training%20Program%20Update~4-2-2014.pdf.

Page 64, Example 15: Noah Slovin; Example 16, Massachusetts Office of Coastal Zone Management and Massachusetts StormSmart Coasts.

Page 65, Recommendation #4 Summary: Massachusetts Metropolitan Planning Organization Regions, available at: http://www.ctps.org/drupal/data/html/programs/public_involvement/P3_images/Mass-MPOsFINAL-01.jpg.

Page 69, Example 17: John Lazenby, in Vermont Long-Term Disaster Recovery Group, "We're going to get it done: Vermont's Response to Tropical Storm Irene," The Vermont Disaster Relief Fund, p. 9, www.VermontDisasterRecovery.com.

Page 70, Example 18: Both images from NADO Research Foundation 2012: "Lessons learned from Irene: Vermont RPCs address transportation system recovery," Center for Transportation Advancement and Regional Development with support from the Federal Highway Administration, Washington, DC, available at: https://www.nado.org/wp-content/uploads/2012/06/IreneVT.pdf.

Page 71, Example 19: Town of Deerfield, Massachusetts.

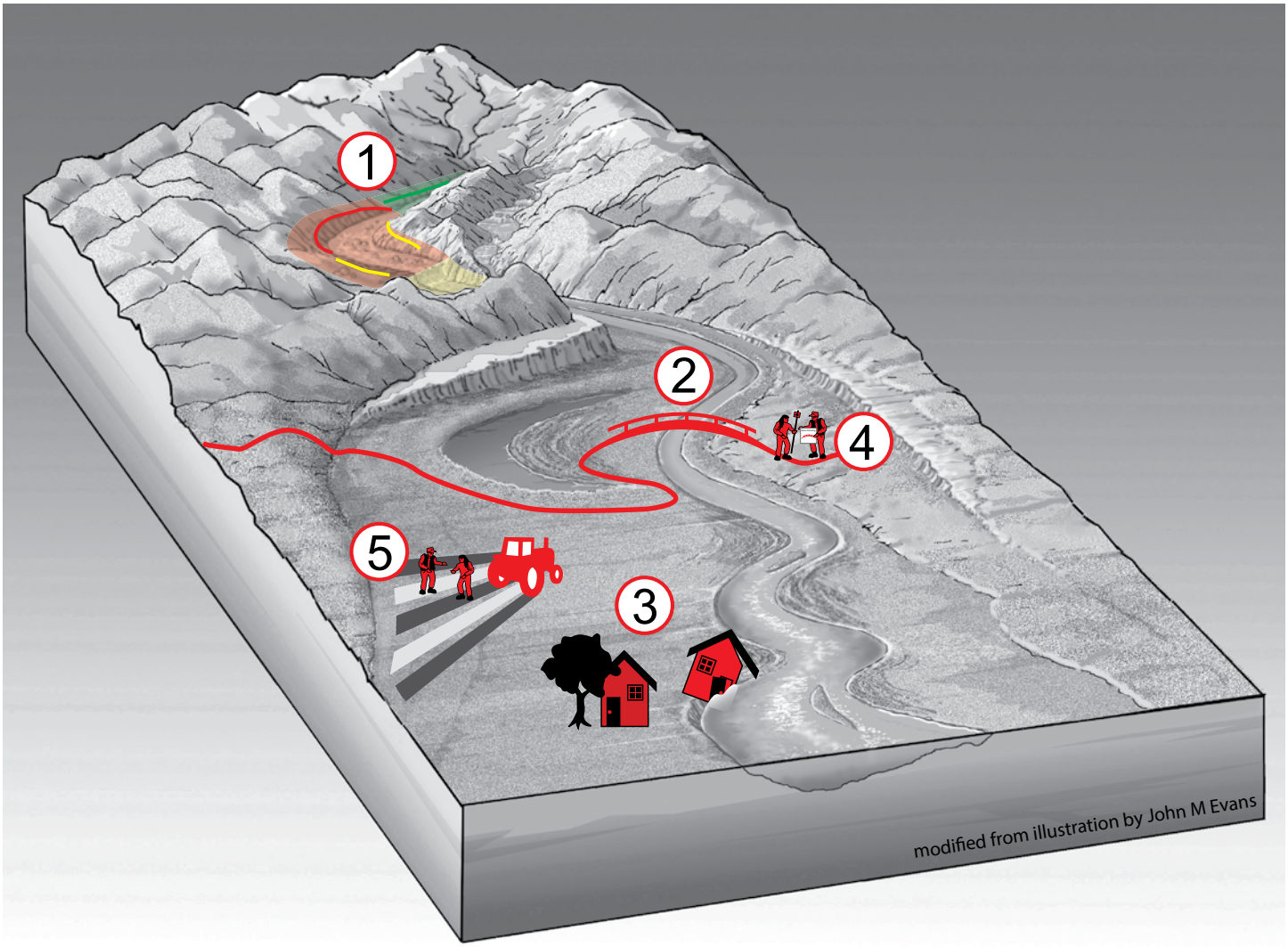
Page 72, Example 20: Photo - NRCS, Conserving Natural Resources in Vermont, January 2012, available at: http://www.nrcs.usda.gov/wps/PA_NRCSConsumption/download?cid=stelprdb1256847&ext=pdf; map - NRCS Zones and Offices in Vermont, available at: http://www.nrcs.usda.gov/Internet/FSE_MEDIA/stelprdb1083444.jpg.

Page 73, Example 21: Nicole Gillett.

Page 78: Joe Shoenfeld.

Inside back cover: Diagram – modified by Christine E. Hatch from illustration by John M. Evans.

Back cover: Diagram – John M. Evans, Scientific Illustrator.



Back cover: This river process diagram was made especially for the RiverSmart Communities project to illustrate a variety of river processes that shape rivers and their landscapes from mountain headwaters to valley floodplains. You can get more information at https://extension.umass.edu/riversmart/river-processes.

Here, the added illustrations highlight our five report's five policy recommendations as they might be put into practice:

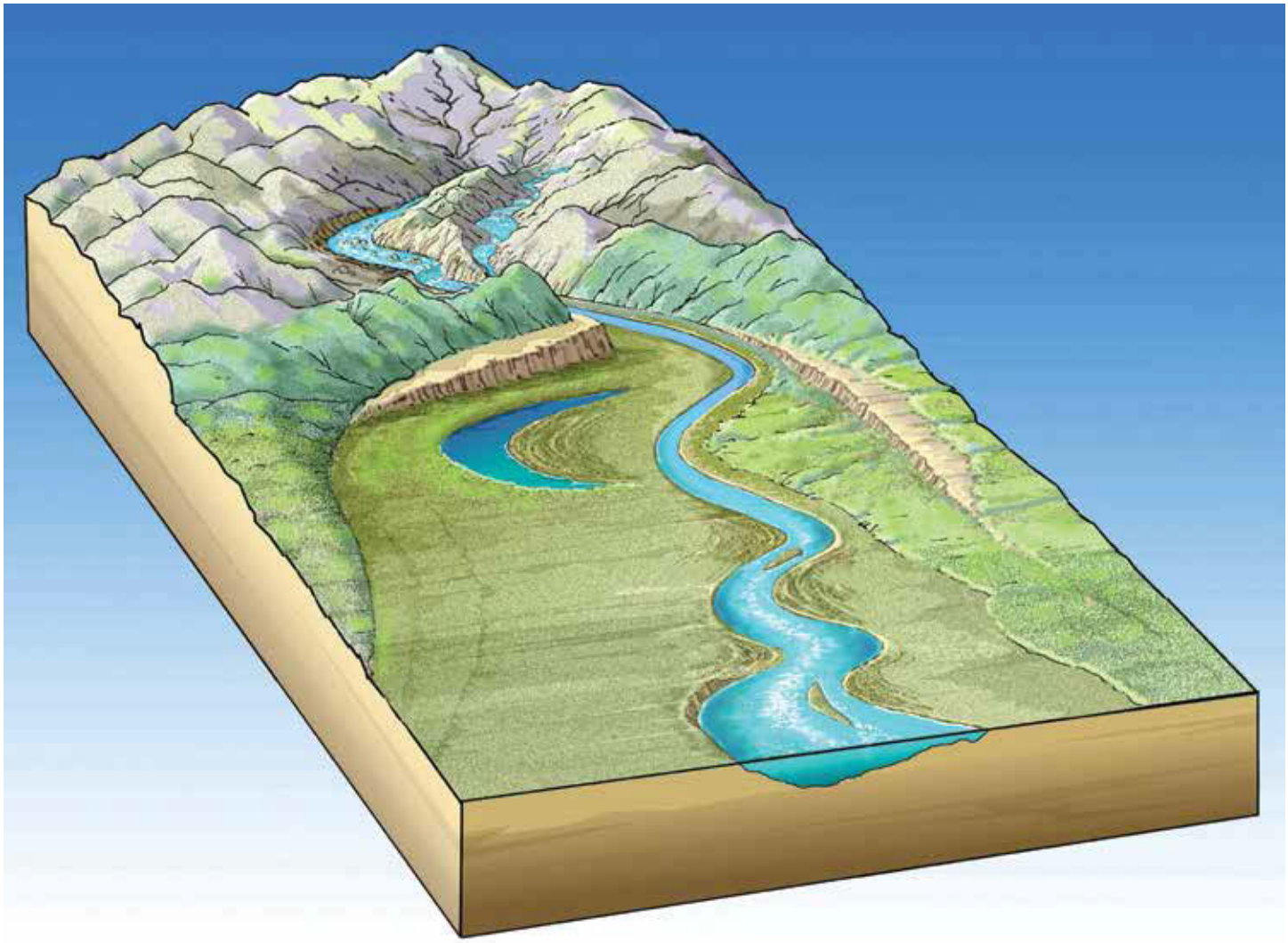
#1 Develop Fluvial Hazard Assessments – Fluvial hazards are mapped in this area as follows: Green shading upstream of the meander bend is a reach with low vulnerability, orange shading indicates a reach with high vulnerability to fluvial erosion, and yellow shading, downstream of the bend, is a reach with moderate vulnerability to erosion or deposition. More detailed assessment of streambank stability designates banks as already actively adjusting (red lines), having erosion or deposition potential (yellow lines), or stable (green line).

#2 Upgrade Vulnerable Stream Crossing Infrastructure – This road used to go over a pipe culvert which often became blocked or failed. Now, the culvert has been replaced with an open-bottomed bridge that easily passes water, sediment and debris, and provides good aquatic habitat.

#3 Support River-Smart Planning and Mitigation – One of these houses was built on top of a streambank that failed during the recent flood. Future houses will be built farther back, following a fluvial hazard assessment and a local hazard mitigation plan.

#4 Provide Outreach and Training on River Dynamics and River-Smart Practice – A Department of Public Works engineer is being trained in river-smart construction so future roads and bridges will be built to withstand river floods.

#5 Designate, Recognize and Support River-Smart Regional Intermediaries – A technician from a regional planning council is meeting with a farmer as part of developing a flood mitigation program.



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