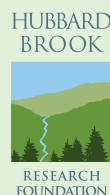


A Resilience Indicators Approach to Ensuring Equitable, Objective, and Continued Investment in Northern Border Communities



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Contributors

Raisa Kochmaruk from the Hubbard Brook Research Foundation conducted interviews, helped organize transcripts, and scheduled focus groups.

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A Resilience Indicators Approach to Ensuring Equitable, Objective, and Continued Investment in Northern Border Communities



*Final Project Report
March 2023*



Executive Summary

This report summarizes the results of a collaborative research project to understand community resilience in the Northern Border region, a federally designated area of Maine, New Hampshire, Vermont, and New York that borders Canada and generally has higher levels of unemployment, population loss, and lower incomes than neighboring areas. The long-term goal of this work is to develop objective metrics that can help align strategic federal and state investments in this region. The project was led by the University of Maine, University of Vermont, and Hubbard Brook Research Foundation, in collaboration with the USDA Forest Service's Northern Research Station, with support from the Northern Border Regional Commission (NBRC).

The investigators used mixed methods to achieve three key objectives: (1) develop a set of quantitative indicators of socioeconomic resilience for Northern Border communities; (2) generate baseline data about household members' views about community assets and challenges; and (3) understand perspectives across multiple sectors (e.g., scientific research, tourism and recreation, conservation, public and private land management) about how to think about ecological data in relation to community resilience.

The following sections share high-level results from each of these investigations. Section I presents town-level, publicly available socioeconomic data aggregated as an overall resilience index. Section II shares insights from a household-level survey to understand perceptions of community assets and challenges related to four dimensions: economic resilience, social resilience, public infrastructure, and the environment. Section III summarizes themes from a series of interviews and focus groups with cross-sector experts about the relationships between ecological trends and community resilience in the region.

KEY TAKEAWAYS

1. Publicly available data related to demographics, housing, labor, and social welfare can be used to construct town-level socioeconomic indicators for Northern Border communities.

An aggregated resilience index of 28 metrics, shown in Section I, suggests that the rural and natural resource-dependent communities are less resilient in the region, and these findings correlate with the counties the NBRC currently defines as "distressed." These results are important because they demonstrate the utility of using objective data to understand resilience trends at the community scale. Future work is needed to build out this approach into an updatable, interactive, online dashboard. When tracked over time, these indicators may provide quantitative evidence for improving or declining resilience in specific communities and across the region as a whole.

2. Household respondents in 12 counties across New York, Vermont, New Hampshire, and Maine describe natural capital as their greatest community assets, and financial and built capital (i.e., infrastructure) as their greatest community challenges.

Social resilience, related to perceptions of social connectedness and community leadership, is rated higher than perceptions of economic resilience and public infrastructure. These results, shared in detail in Section II,

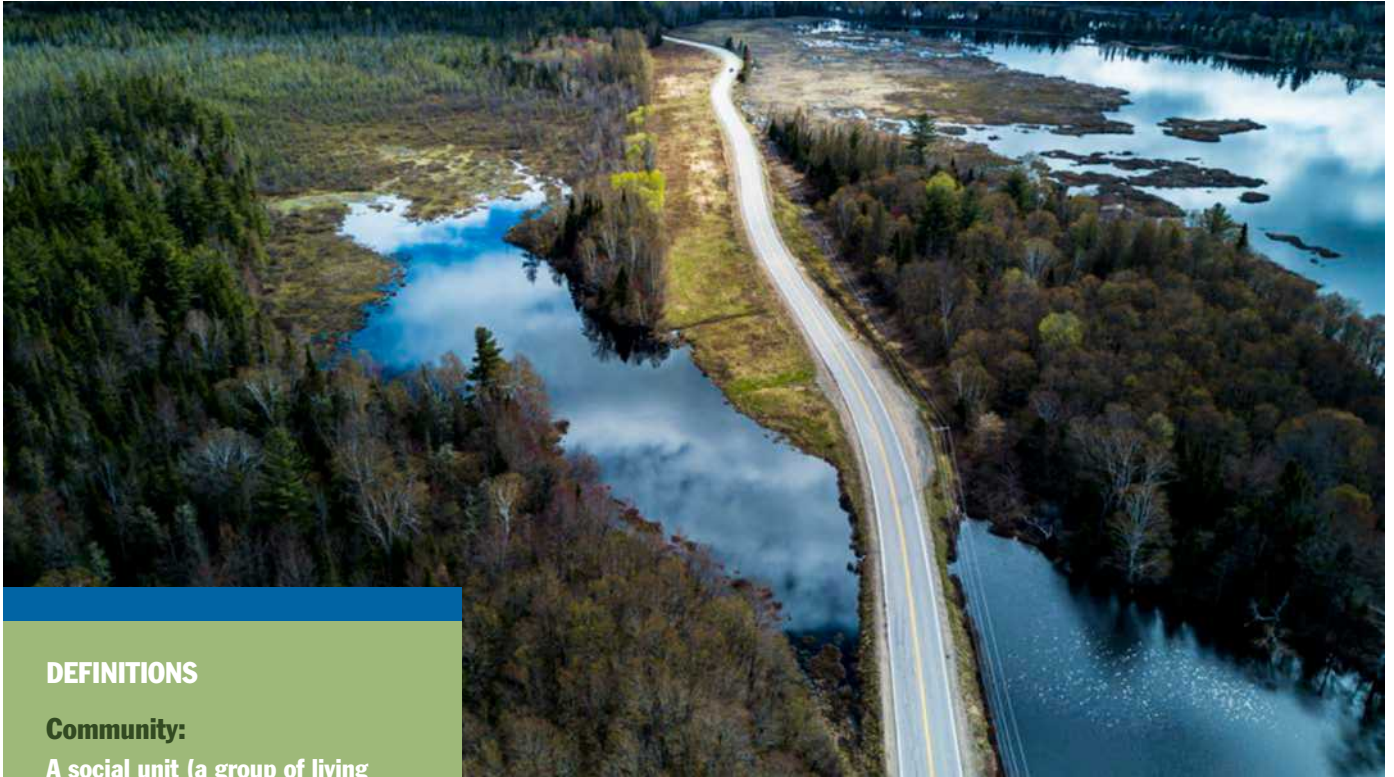
The long-term goal of this work is to develop objective metrics that can help align strategic federal and state investments in this region.

ABOUT THE NORTHERN BORDER REGIONAL COMMISSION

The Northern Border Regional Commission (NBRC) is a federal-state partnership, formed by congress in 2008, to help fund economic and community development projects in the northern areas of Maine, New Hampshire, Vermont, and New York whose local economies have been hard-hit by changing forest products markets and global competition. The mission of the Northern Border Regional Commission is to catalyze regional, collaborative, and transformative community economic development approaches that alleviate economic distress and position the region for economic growth.



**Northern Border
Regional Commission**



DEFINITIONS

Community:

A social unit (a group of living things) with commonality such as norms, religion, values, customs, or identity. For this project, a “community” shares a sense of place situated in a specific geographical area (e.g., a state, town, or neighborhood).

Indicator:

A trend or fact that indicates the state or level of something.

Northern Border Region:

A group of designated counties in Maine, New Hampshire, Vermont, and New York that border Canada and generally have higher levels of unemployment, population loss, and lower incomes.

Resilience:

The capacity of a system to tolerate or respond to “shocks” or disturbances and recover. In human systems, this is closely linked to the adaptive capacity of the system—the ability of individuals and the group to adapt to changing conditions through learning, planning, or reorganization.

are important because they suggest possible directions for targeted investments that build on community strengths and address community needs. They also point to the importance of integrating ecological factors related to natural capital into assessments of community resilience. Future work is needed to expand the survey to more diverse populations.

- 3. Interviews and focus groups with leaders from the scientific research, conservation, forest products industry, rural economic development, and tourism/outdoor recreation sectors highlight the importance of a healthy forest ecosystem to community resilience in the Northern Border region and the value of integrating both ecological and economic data into community resilience metrics.** Forest cover, forest condition, and ecosystem services are key indicators. Participants expressed interest in metrics and reports that allow local, state, and regional decision-makers to consider both ecological and socioeconomic trends together in a regional context. These results are important because they point to pathways for future data synthesis and use for both the target audiences of this report (NBRC and USDA) and also regional NGOs, state policymakers, and local community leaders.

Recommended Next Steps

The findings from this project point to clear opportunities for future data collection, synthesis, and presentation to inform decision-making related to investment in forest-dependent communities throughout the Northern Border region. We recommend that the socioeconomic resilience indicators dashboard should be expanded to include multiple years of data, as tracking these indicators over time would provide quantitative evidence for improving or declining resilience in specific communities and across the region. In addition, findings from our community resilience surveys could

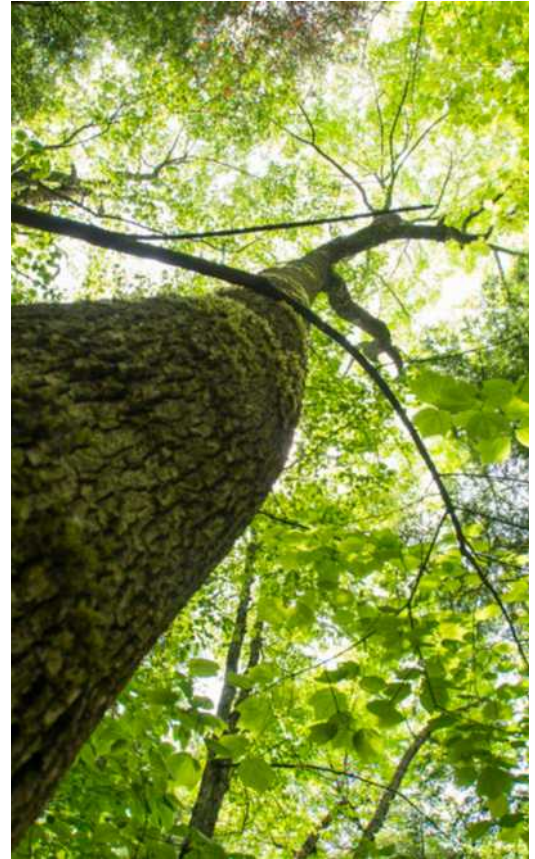
be compared with the socioeconomic indicators to assess the degree to which the two methods compare in terms of quantifying and tracking local and regional resilience. The next phase of work should also establish ecological indicator baselines at a more meaningful scale for local decision making (e.g., town/community forest), better link socioeconomic and ecological indicators, and collect more standardized indicators related to outdoor recreation and stewardship. Finally, future projects should build communication plans that support continued cross-sector engagement and information exchange, and link local decision-makers at the woodlot and town forest scale to the state and regional scales.

ADDITIONAL RESOURCES

Reed, Joseph, “Measuring & Planning for Community & Climate Resilience” (2022). *Electronic Theses and Dissertations*. 3609. <https://digitalcommons.library.umaine.edu/etd/3609>

Sherman, Gabrielle, “Socioeconomic Resilience of Natural Resource Dependent Communities” (2022). *Electronic Theses and Dissertations*. 3657. <https://digitalcommons.library.umaine.edu/etd/3657>

Sherman, Gabrielle, and Adam Daigneault. “Evaluation of Maine Resident Perceptions on Community Resilience, Conservation, and Natural Resource Industries” (2022). *Society & Natural Resources* (2022). <https://doi.org/10.1080/08941920.2022.2150798>





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↓ "Casperitas" GOURDS



↓ Green "Shokichi Shiro" GOURDS



↓ PINTED LITTLE "GOURDS"

SECTION I:

Establishing and Tracking Socioeconomic Resilience Indicators for the Northern Border Region

AUTHORS:

Adam Daigneault and Aaron Weiskittel

Overview

The economy of several communities throughout the Northern Border region depends heavily on the health and sustainable management of its forest. In fact, the relative contribution of forested lands to the gross domestic product for most counties in the four-state Northern Border region is among the highest in the United States (~4%). The abundance of forestland in the region can be a blessing and a curse because many rural communities are primarily dependent on a single ecosystem service (i.e., timber and other forest products) and the tax revenue that related industries provide. Several communities in the region have been dependent on a single industry or ecosystem service for decades, facing hardship when markets shift and demand is reduced (e.g., recent mill closures), leading to crises of economy, culture, and identity (e.g., new manufacturing, recreation). Furthermore, the region's forest faces increasing pressures from land use change, shifts in ownership, and invasive pests (e.g., emerald ash borer, spruce budworm) and other environmental stressors (e.g., extreme weather).

This project used a mixed methods approach to better quantify and understand the resilience of forest-dependent communities across the Northern Border region. A key component of this project was to use publicly available data to develop quantitative socioeconomic resilience indicators for the more than 1,000 “communities” (typically municipalities) located within the region. In this context, an “indicator” is a quantitative metric that represents a trend or fact that indicates the state or level of something (e.g., population change, median household income).

What is socioeconomic resilience?

Resilience is described as the ability of a system to absorb shocks and stressors while retaining functionality. Within the context of communities, shocks may consist of disruptive events such as recession, natural disaster, local losses of industry, and social unrest. Resilience therefore is the ability of a community to continuously support human well-being in the aftermath of such an event (Figure 1). Although it is observable that



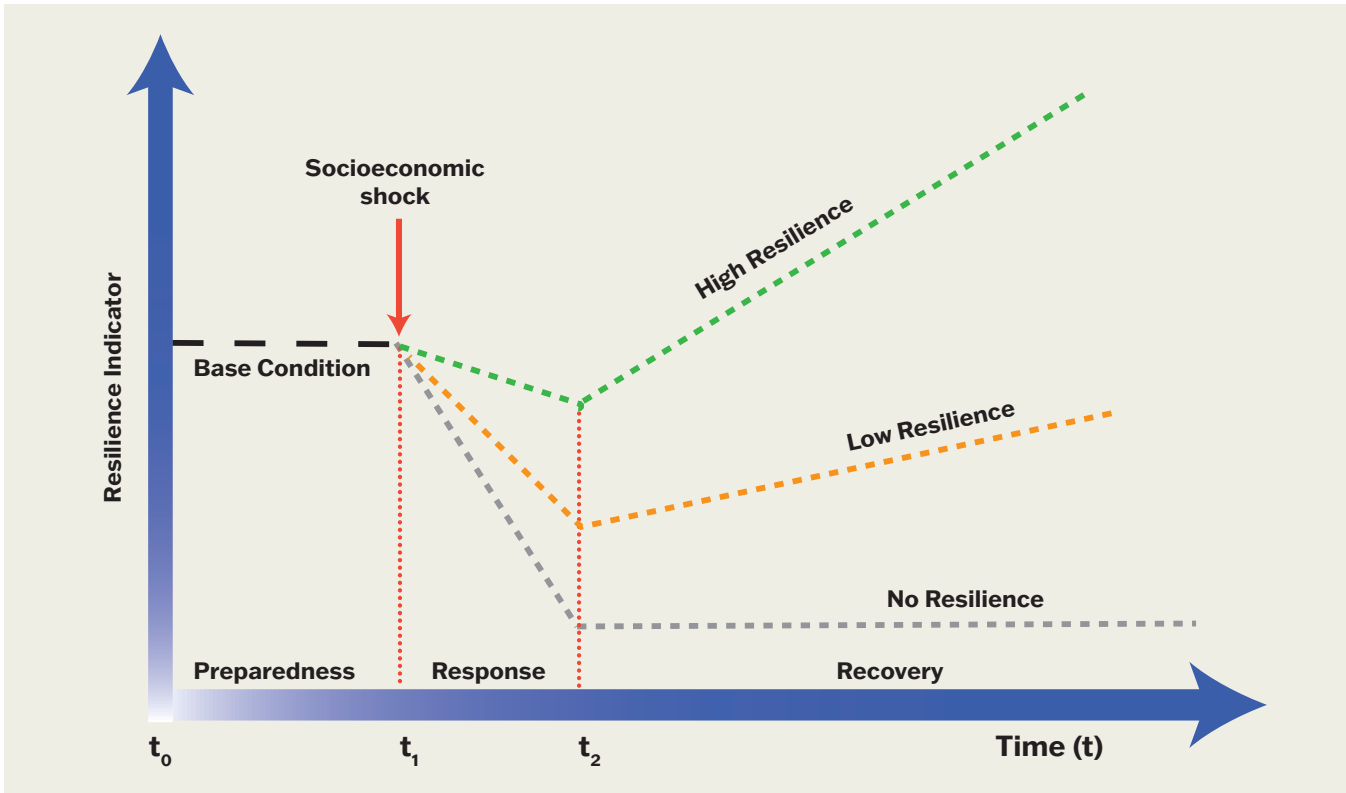


Figure 1. Key concepts of quantifying and measuring socioeconomic resilience. Black dashed line shows the base condition of a resilience indicator over time, t_0 to t_1 . Dashed lines at t_1 show possible trajectories following a socioeconomic shock. The period between t_1 and t_2 shows the initial drop of the indicator in response to the shock. The period following t_2 shows recovery: high resilience is indicated by rebound above the base condition; low resilience is indicated by rebound that remains below the base condition; no resilience is indicated by no rebound.

certain communities perform this function better than others following a shock, no exact measurement of resilience exists. Instead, its presence is implied through the measurement of proxies known to contribute to socioeconomic condition as well as local-scale qualitative assessments of community assets and performance.

Communities harboring social and institutional inhibitors to adversity preparedness are especially vulnerable to shocks. The exact degree of vulnerability is determined by the inherent sensitivity of the system to harm (Cutter et al. 2014). In recent years, interest in the resilience of communities has grown following divergent responses to hardship such as economic downturn, natural disaster, and social-political shifts (Berkes and Ross 2013; Cavaye and Ross 2019). Resilience has been conceptualized within various frameworks as an embedded feature of a system which enables adaptation and recoverability in the post-disturbance environment or as the adaptive process which manifests in response to the exposure event (Adger 2000; Nguyen and Akerkar 2020). In the context of this project, resilience can be thought of as how susceptible an economy is to shocks that alters its growth path, and that these shocks can consist of competitive, market, technological, policy, and related conditions that shape the evolutionary dynamics and trajectories of a community's socioeconomic well-being over time (Briguglio et al. 2006; Simmie and Martin 2010).

Resilience Index Methodology

- We closely followed Cutter et al (2014) and SVI (CDC, 2022) to identify a set of indicators applicable to the Northern Border region.
- All indicator data came from publicly available sources and had the same measurement year. In this case, we used 2018, as that was the most recent year data was available from all sources.
- Most indicators can be updated on an annual or at least sub-decadal basis so that they can be consistently tracked over time.
- Nearly all indicators were collected at the census county subdivision level, which are typically aligned with municipal boundaries.
- Correlation and Cronbach's alpha analysis was conducted to eliminate highly correlated variables (and avoid double counting) and allocate indicators into four subcategories: Community, Social, Economic, and Housing. This resulted in a total of 28 indicators that went into the Total Socioeconomic Resilience Index (Table 1).
- All indicators were 'normalized' and converted to a continuous scale between 0 (low resilience) and 1 (high resilience) following the Cutter et al (2014) Baseline Resilience Indicators for Communities (BRIC) approach.

Table 1. Indicators used to construct Northern Border Socioeconomic Resilience Index

Indicator	Measurement	Index Subcategory	Resilience Impact	Justification	Source
Population change	% from 2010	Community	+/-	Rapid change places strain on local institutions.	5-year ACS
Population under 20 years	% total pop	Community	-	Potential for increased capacity in future	5-year ACS
Property tax rate valuation	\$ per \$1,000	Community	-	Constraints household finances and investment	State Tax Agencies
Municipal valuation (USD \$)	Total \$	Community	+	Available assets	State Tax Agencies
Mean advertised max download speed	Mbps	Community	+	Digital infrastructure can enhance educational and commerce capabilities	FCC
Median Age	Age	Social	-	Older population generally less healthy and productive	5-year ACS
Educational attainment: High school graduate or higher	% total pop	Social	+	More educated population have more skills and capability	5-year ACS
Educational attainment: Bachelors degree or higher	% total pop	Social	+		5-year ACS
People below poverty level: Total	% total pop	Social	+	Wealthier population often more adaptable and places less stress on social services	5-year ACS
People below poverty level: Under 18	% total pop	Social	+		5-year ACS
People below poverty level: 65 years and older	% total pop	Social	+		5-year ACS
Health insurance coverage	% total pop	Social	+	Higher coverage associated with a healthier & more productive population	5-year ACS
Median household income	\$	Economic	+	Wealthier population often more adaptable and places less stress on social services	5-year ACS
Household (HH) with Social Security	% total pop	Economic	-		5-year ACS
Total labor force participation	% total pop	Economic	+	Active workforce earning income and utilizing skills	5-year ACS
Unemployment rate	% of labor force	Economic	-	Limited economic opportunities	5-year ACS
Mean commuting time	minutes	Economic	-	Longer commute means less local economic opportunities	5-year ACS
HH with public assistance income	% total pop	Economic	-	Wealthier population often more adaptable and places less stress on social services	5-year ACS
HH with Supplemental Security Income (SSI)	% total pop	Economic	-		5-year ACS
Service occupations	% total working pop	Economic	-	Typically earn low income and reliant on other economic sectors	5-year ACS
Agriculture; forestry; fishing and hunting; and mining	% total working pop	Economic	-	Typically earn low income and reliant on natural resources	5-year ACS
Arts; entertainment; recreation; and accommodation and food services	% total working pop	Economic	-	Typically earn low income and reliant on other economic sectors	5-year ACS
Fiber optic direct connection	% total pop	Economic	+	Digital commerce capability	FCC
Median housing value	\$	Housing	+	Greater assets and quality of housing conditions	5-year ACS
Housing occupancy rate	% total pop	Housing	+	Housing stock quality	5-year ACS
Median monthly gross rent	\$	Housing	-	Cost of living and budget flexibility	5-year ACS
Owner-occupied housing	% total pop	Housing	+	Self-reliance of community population	5-year ACS
Broadband connection	% total pop	Housing	+	Capability of households for educational and commerce activities	FCC

- Individual indicators were then averaged within each resilience category to generate 4 subindex scores, as well as across the entire set to generate a Total Socioeconomic Resilience Index score.

Key Results

Results of indices for total socioeconomic resilience (Figure 2) and separate (i.e., sub) components of that index are shown in Figure 3a-d. An interactive map of these five indices can be found on the project's Tableau Public dashboard.¹ Key findings include:

- Total resilience is estimated to be highest in areas surrounding Burlington, VT, Hanover, NH, and Saratoga Springs, NY; and lowest in the Downeast area of Maine, northern New Hampshire, and parts of the Adirondacks.
- The individual community, social, economic, and housing resilience indices all have varying influence on total resilience, although these indices are highly correlated in many areas of the Northern Border region.

- More rural and natural resource-dependent communities in the region are typically less resilient. These findings correlate with the counties the NBRC currently defines as “distressed.”
- These results are important because they demonstrate the utility of using objective data to understand resilience trends at the community scale.

Future work would build out this approach so that an interactive online dashboard can include multiple years of data. When tracked over time, these indicators may provide quantitative evidence for improving or declining resilience in specific communities and across the region as a whole.

¹ https://public.tableau.com/app/profile/adam.daigneaultviz/NBRCResilienceIndicators/Index_All#1

Northern Border Regional Commission Resilience Index / Total Socioeconomic Resilience

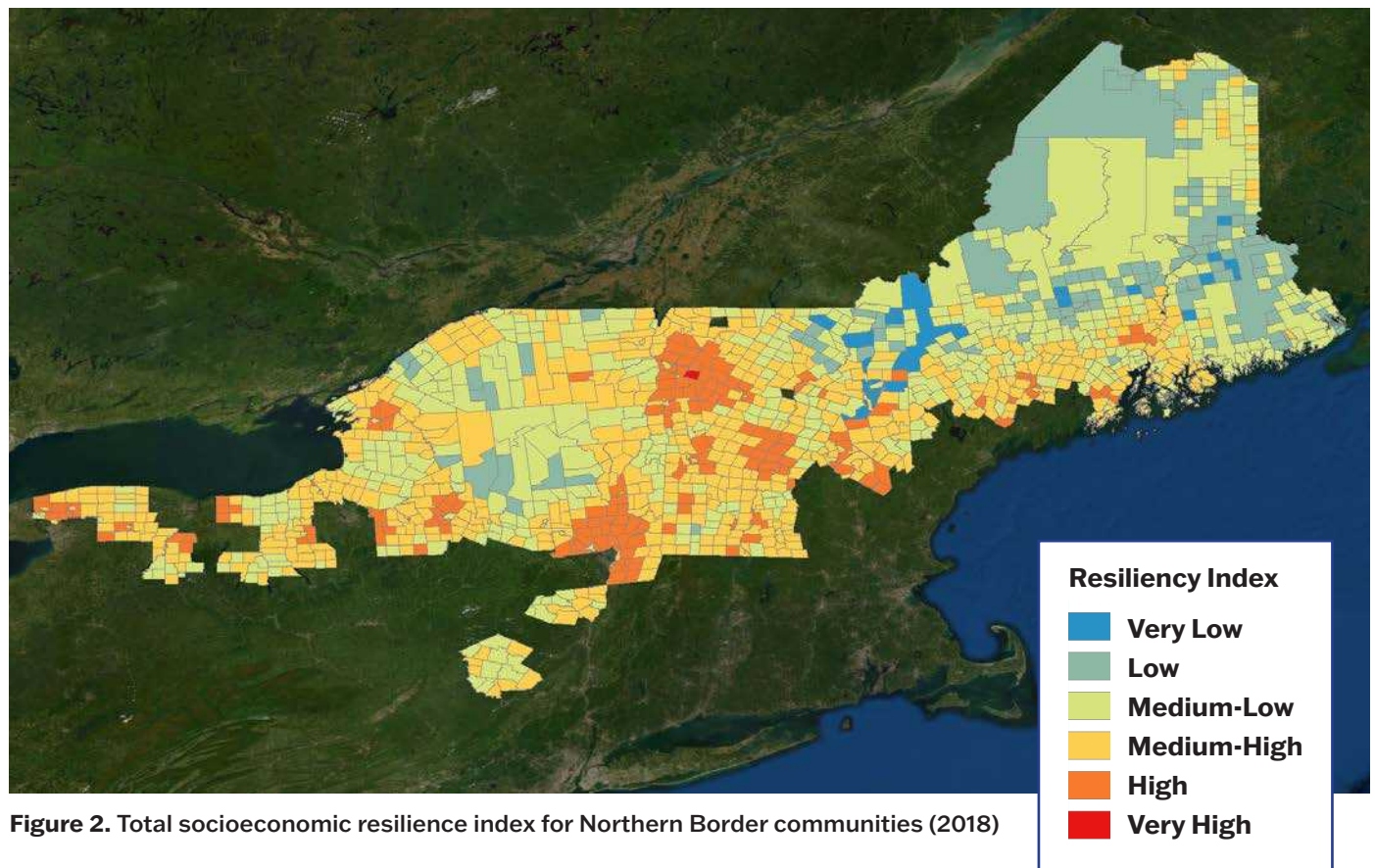


Figure 2. Total socioeconomic resilience index for Northern Border communities (2018)

► To explore these maps online, please visit

https://public.tableau.com/app/profile/adam.daigneaultviz/NBRCResilienceIndicators/Index_All#1

Northern Border Regional Commission Resilience Index / Total Community Resilience

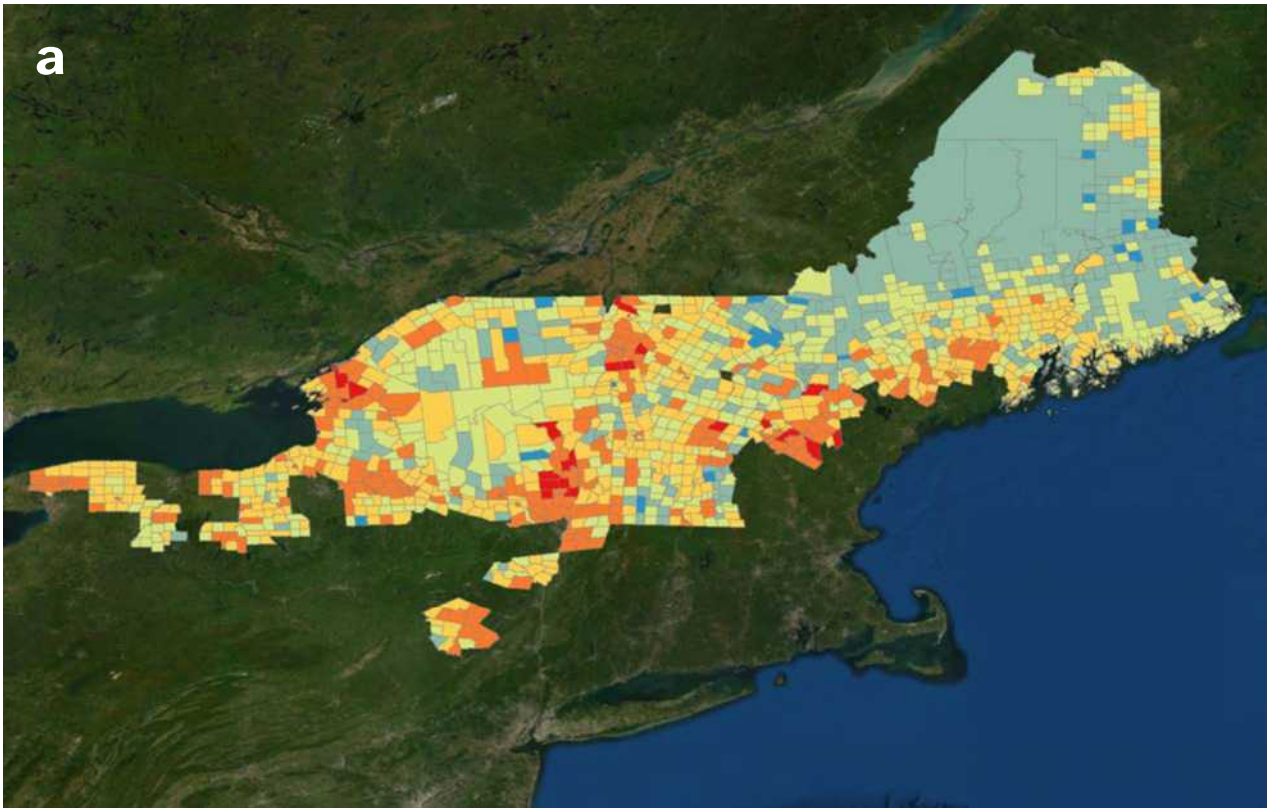
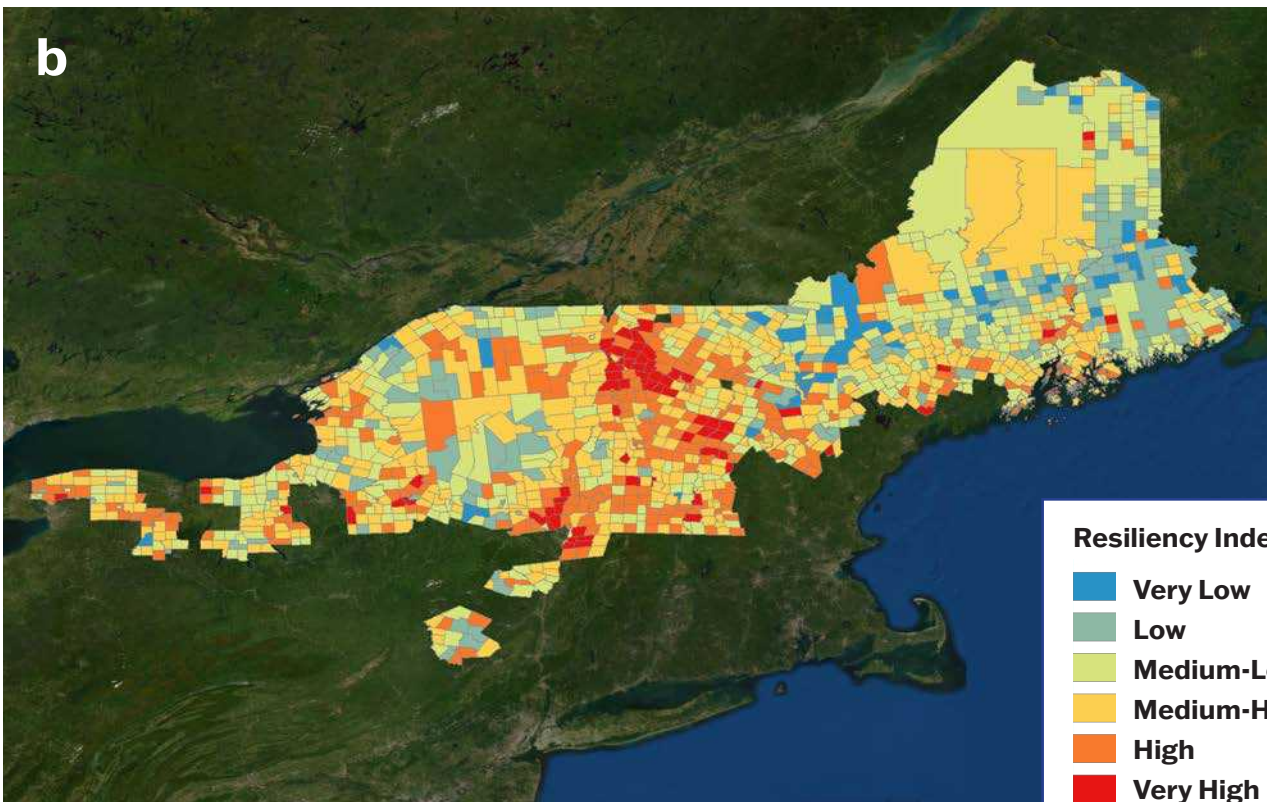
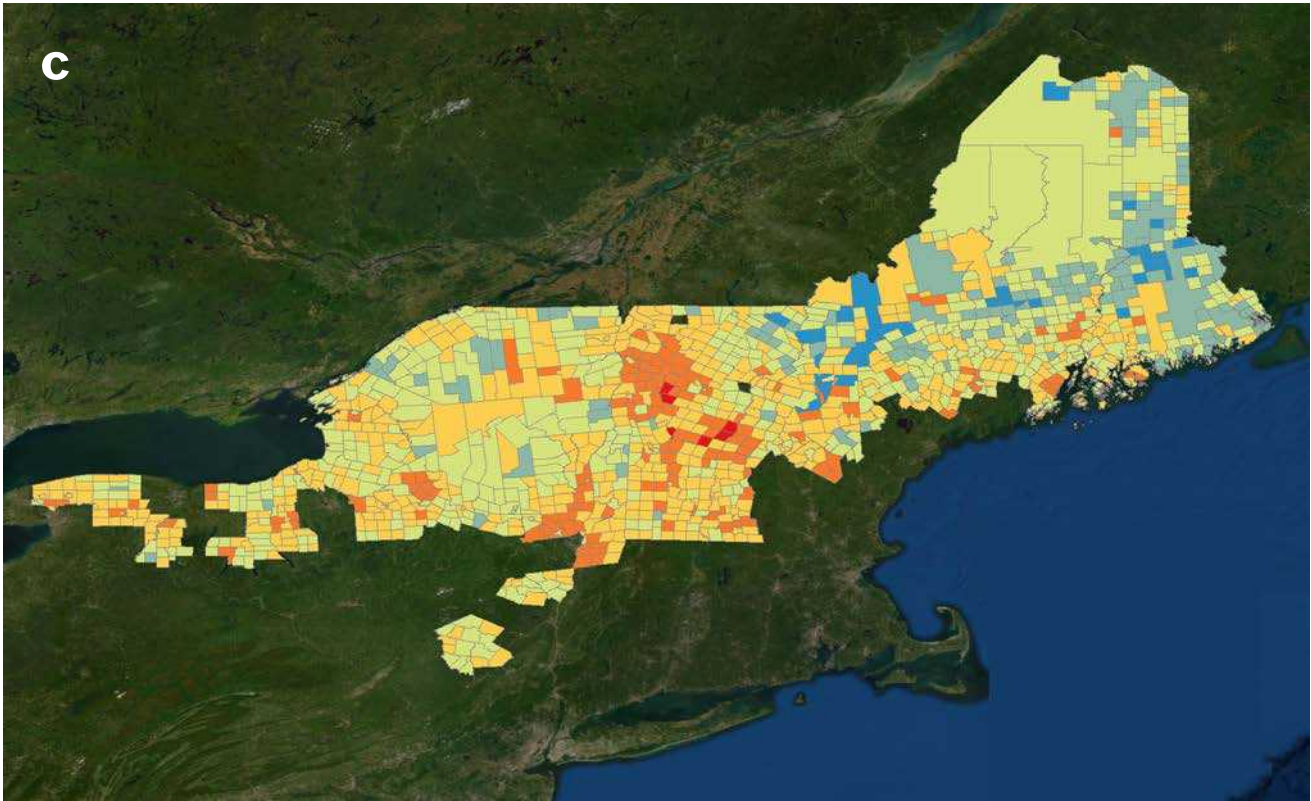


Figure 3. Individual socioeconomic resilience indices for Northern Border communities (2018), a) Community, b) Social, c) Economic, and d) Housing

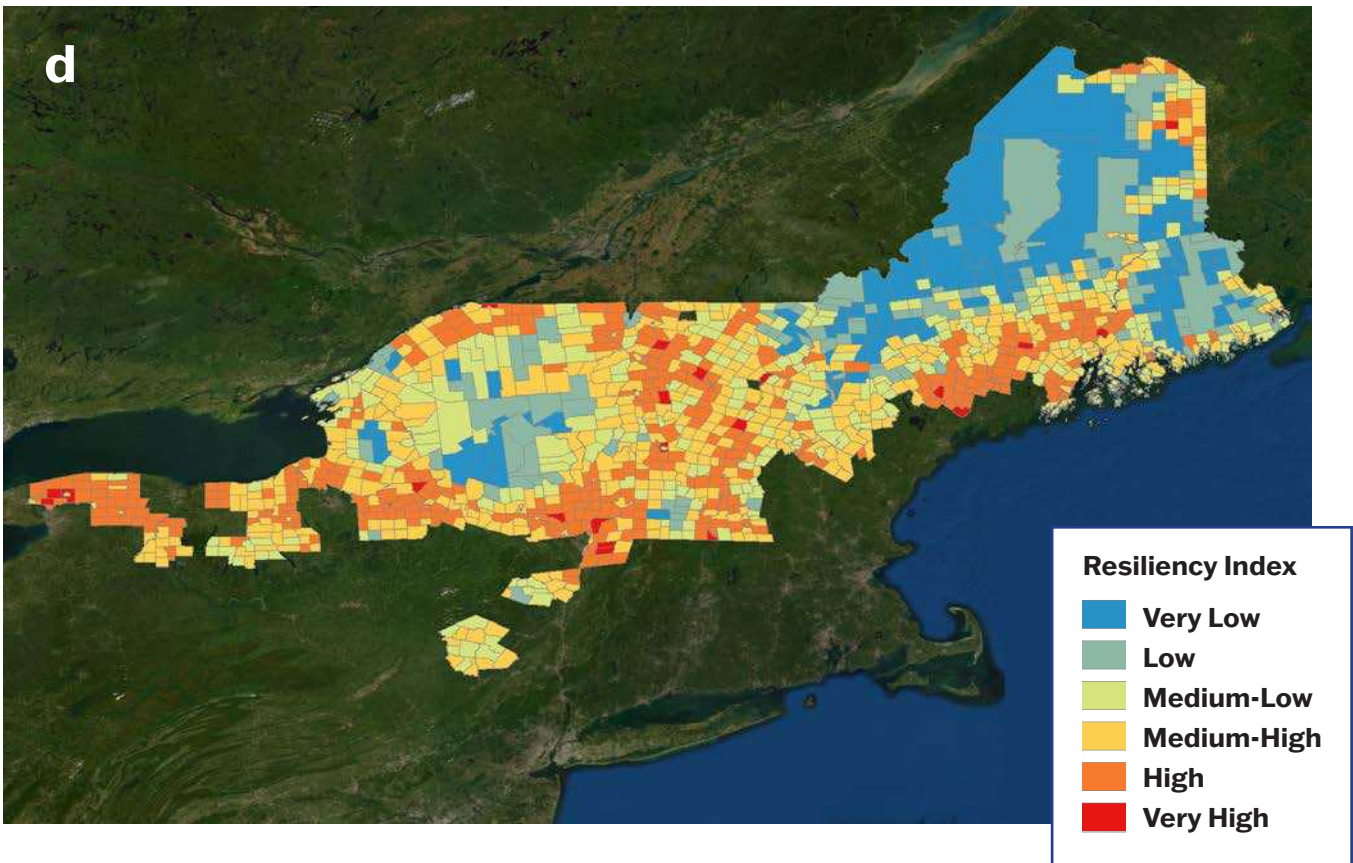
Northern Border Regional Commission Resilience Index / Total Social Resilience



Northern Border Regional Commission Resilience Index / Total Economic Resilience



Northern Border Regional Commission Resilience Index / Total Housing Resilience







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Three runners are seen from behind on the sidewalk in front of the theater. The runner on the left is wearing a white shirt and dark shorts. The runner in the middle is wearing a green tank top and red shorts. The runner on the right is wearing a green t-shirt and black shorts.

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SECTION II:

Exploring Community Resilience in the Northern Border Region: Insights from Maine, New Hampshire, New York, and Vermont

AUTHORS:

Amelia Catanzaro, Adam Daigneault, Kerry Daigle, Kelly Hamsbaw, Meredith T. Niles, and Claire Whitehouse

Overview

We conducted an electronic survey in Fall 2021 to understand how people living in the Northern Border region of Maine, New Hampshire, New York, and Vermont think about the resilience and well-being of their communities. More than 670 people shared their insights through the survey. This brief provides an overview of what we learned about four discreet dimensions of community resilience: social resilience, environmental resilience, economic resilience, and public infrastructure resilience. The results of this survey suggest possible pathways for future investments in the region to improve resilience at the community scale and across the Northern Border region.



What is Community Resilience?

There are many ways to define community resilience. In this project we use a model that divides community resilience into four dimensions:

- **Social:** social connections and community leadership
- **Environmental:** Conservation, open spaces, sustainability, and disaster preparedness
- **Economic:** business vitality, recreation, and tourism planning
- **Public Infrastructure:** essential needs and services such as housing, water, healthcare, and childcare

The survey asked respondents to rate each of these four dimensions as well as their community's overall resilience on a 10-point scale, with 1 being not resilient and 10 being very resilient.

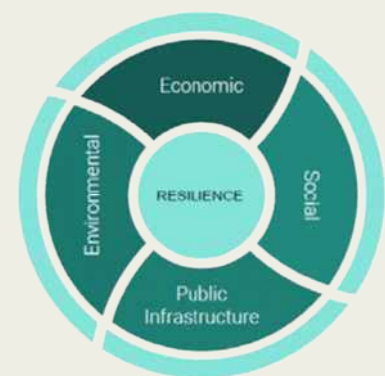


Figure 4. Dimensions of community resilience

This brief provides an overview of what we learned about four discreet dimensions of community resilience: social resilience, environmental resilience, economic resilience, and public infrastructure resilience.

About the Study Area

Our study spanned all four states of the NBRC territory. In consultation with NBRC leaders, we selected three counties per state (12 counties in total) as “hubs” for survey sampling. We used Every Door Direct Mail, a tool offered by the U.S. Postal Service, to send postcards to a random selection of 3,000 to 3,500 households in each county (40,000 total), inviting residents to complete the survey online.

Study Counties of Interest:

Oxford, ME	Addison, VT
Washington, ME	Caledonia, VT
Aroostook, ME	Windham, VT
Belknap, NH	Cayuga, NY
Carroll, NH	Essex, NY
Sullivan, NH	St. Lawrence, NY

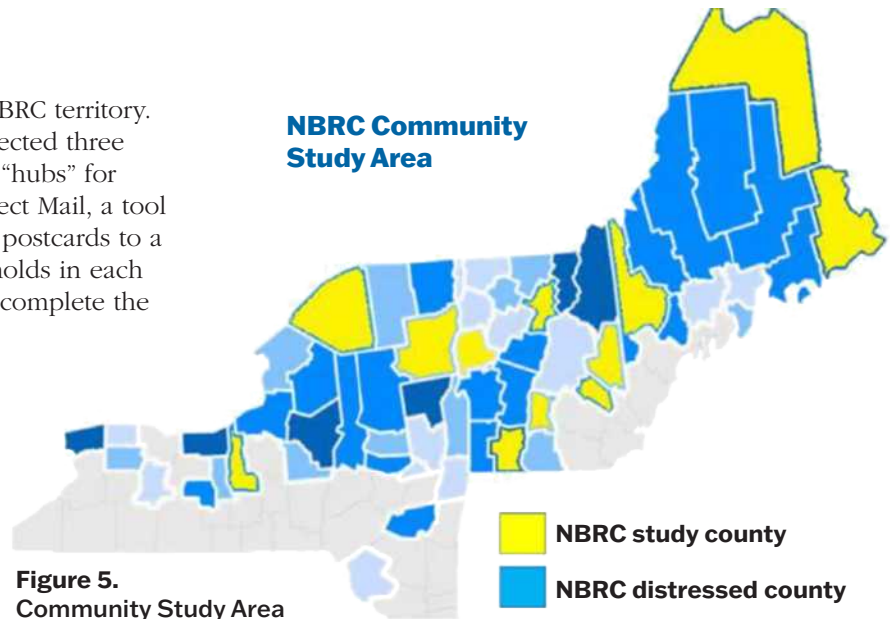


Figure 5. Community Study Area

About Survey Participants

- 677 completed responses from all four states
- Compared to the averaged demographics of the region, survey respondents were:
 - Higher income (nearly 75% had annual household incomes over \$75,000)
 - Highly educated (more than 75% held at least a bachelor’s degree)
 - Older (more than half of respondents were over the age of 60 at the time of the survey)

Survey Participants

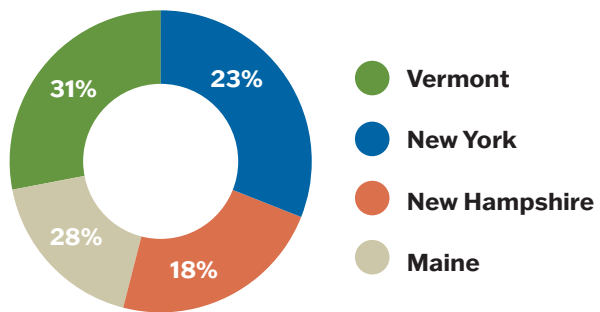


Figure 6. Survey participants by state

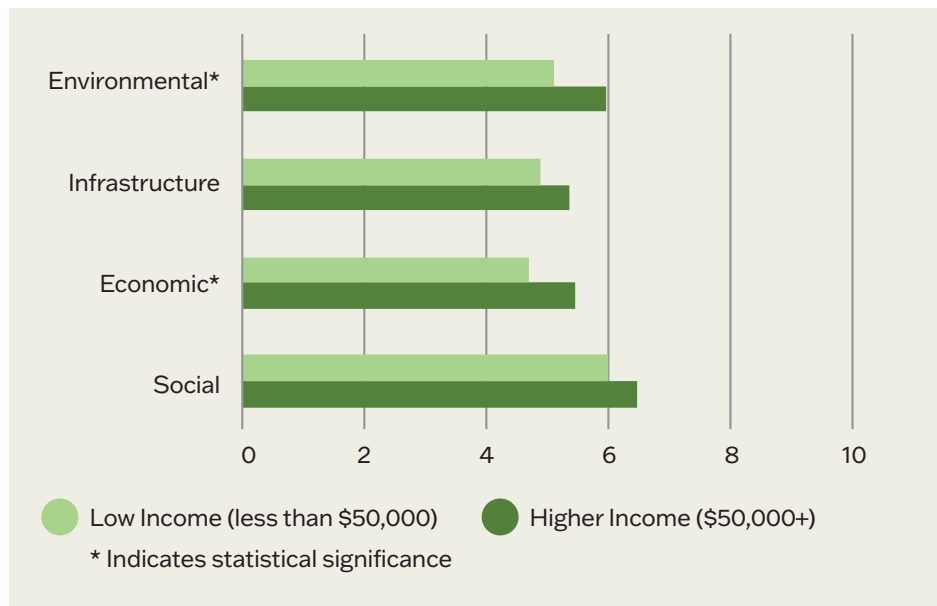


Figure 7. Average stated resilience scores by income level. (1 = not resilient, 10 = very resilient)

Survey Findings

We analyzed survey responses in multiple ways. For the closed-response survey questions, we examined descriptive statistics and conducted Kruskal Wallis rank sum tests to assess relationships among survey questions. In our summary of statistical tests below, the word “significant” or “significantly” indicates a p-value² of <0.05. We used content analysis to categorize open responses to the questions on community assets and challenges.

Survey participants reported moderate community resilience across all four dimensions. Average resilience scores for all measures ranged between around 5 to around 6.5 out of 10 (with 1 being “not resilient” and 10 being “very resilient”).

Average resilience scores were lower across the board for respondents with an annual household income under \$50k. This difference was significant for economic resilience and environmental resilience, with respondents in households making less than \$50k more likely to give a lower resilience rating. While there was some variation in resilience ratings by age group, none of these differences were statistically significant.

² A p-value is a number calculated as part of a statistical test that describes how likely it would be to produce these same test results if the null hypothesis were true (in our case, the null hypothesis is that there is no relationship between the two survey questions in the test). A p-value of 0.05 is the standard cut-off for determining significance and implies that there would only be a 5% chance of producing the same test results if the null hypothesis were true.

Table 2.
Average stated resilience scores by resilience dimension.
(1 = not resilient, 10 = very resilient)

Dimension of Resilience	Mean
Social	6.32
Environmental	5.71
Economic	5.23
Infrastructure	5.21
Overall	6.14

Community Assets and Challenges

The survey invited respondents to list the top three assets and the top three challenges in their community. We used the Community Capitals model developed by Flora et al. (2004) as a framework for content analysis of these questions. The Community Capitals model divides the resources for sustainable community and economic development into seven categories: natural, cultural, human, social, political, and built. We assigned each asset and challenge listed by respondents to one of these seven capitals.

The majority (52%) of community assets named by respondents were types of natural capital. These assets included: natural resource amenities (e.g., air quality, climate, water); land/open spaces (e.g., forests, mountains, wilderness, beaches); places for recreation (e.g., skiing, hiking, biking); working lands (e.g., farming, fishing, hunting); and conservation (e.g., land trusts, state parks). The majority of challenges listed by respondents fell into the infrastructure-related categories of built and financial capital, which together made up 59% of total challenges. Built capital challenges mostly included housing affordability and availability, internet, and roads and transportation. The majority of financial capital challenges mentioned involved the sustainability of businesses and industries, availability of jobs, low wages, and poverty.

Perceived Assets

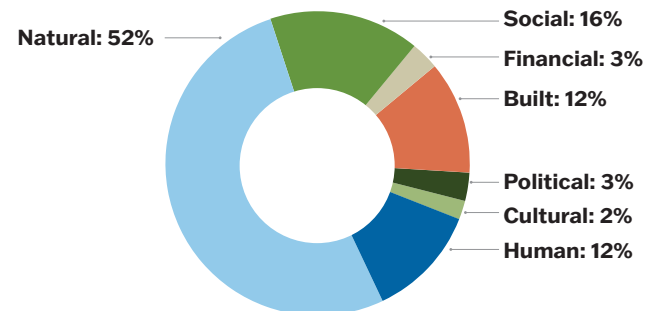


Figure 8. Perceived assets by community capital

Perceived Challenges

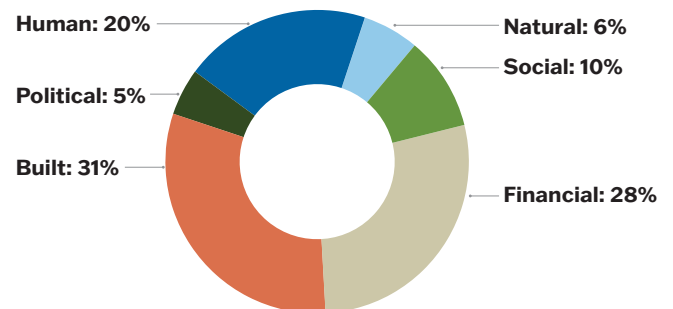


Figure 9. Perceived challenges by community capital

Social Resilience

Respondents consistently rated social resilience the **highest** compared to other forms of resilience, regardless of age or income level. In addition to rating social resilience from 1-10, respondents were also shown a series of statements about the town they reside in and asked to rate their level of agreement from “strongly disagree” to “disagree.”

While income was not a significant factor in the social resilience score, income was related to the responses to some of these statements. Respondents in households making less than \$50k annually were significantly **less likely to agree that...**

- They generally trust the people who live in their town
- Their town has a wide range of volunteer opportunities
- They generally trust how decisions are made in their town by elected leaders and local officials
- Their town’s leaders act in the best interest of its people

Environmental Resilience

Environmental resilience followed social resilience as the second highest rated resilience score, and the majority of respondents agreed with all of the questions we posed relating to the environment.

Yet respondents in households making less than \$50k per year rated their community’s environmental resilience significantly lower than higher income households. Answers to several of the individual questions also differed according to income. Respondents in households making under \$50k annually were significantly **less likely to agree that:**

- Their town has sufficient natural resources
- Their town is well-prepared to respond to natural disasters
- Their town is taking actions to improve environmental sustainability

Economic Resilience

- Economic resilience, along with resilience of public infrastructure and resources, was consistently rated the **lowest**, regardless of age or income level.
- Those with lower household income had less confidence in the resilience of the economy and were significantly more likely to give economic resilience a low rating.
- Respondents with an annual household income under \$50k were significantly **less likely to agree** that:
 - Their town contributes to the economy of the surrounding region.
 - Their town is economically diverse.
 - Their town is better off today than it was 20 years ago.
 - Their town will be better off 20 years from now compared to today.
 - The opinions of residents are valued when creating an economic plan for their town.
 - People living in their town have the financial means to meet their essential needs.
 - Outdoor recreation and tourism are important to the future of their town.

Only 3% of respondents listed financial capital elements as an asset of their community.

Assets in the Community

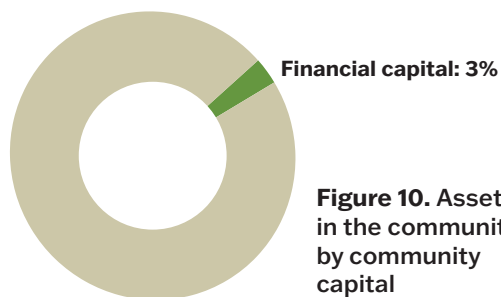


Figure 10. Assets in the community by community capital

Ways that community members described social resilience as an asset to their community:

- “Strong sense of community”
- “The people in our community make it a great place to live.”
- “Community connections”

How community members describe challenges to social resilience:

- “We need a community center in town to have events and have social gatherings.”
- “Social divide”
- “With no local high school, young people do not develop close community ties, and are very apt to stay away after graduation.”



How community members describe economic resilience challenges:

- “Loss of businesses in the local area as a result of COVID, railroad construction and changing economics.”
- “Need for financial resources to invest in local businesses; we have too many empty buildings on our Main Street. Businesses would provide employment and attract and keep young people.”
- “Having very little capacity for economic growth in terms of businesses with storefronts.”
- “Economic disparity between impoverished residents and affluent second homeowners.”
- “Lack of economic opportunities.”

Infrastructure Resilience

Along with economic resilience, built infrastructure resilience consistently scored the **lowest** among residents, regardless of age or income level. And **the majority of respondents disagreed** that their town had sufficient safe and affordable housing or affordable childcare.

Though income was not significantly related to the overall infrastructure resilience score, responses to several of the individual infrastructure questions did differ by income. Respondents in households making under \$50k annually were significantly **less likely to agree that:**

- People in their town were able to meet their basic needs
- People in their town were able to solve their own problems
- People in their town had access to quality internet service
- People in their town had access to healthy, fresh foods

Among all the challenges named in open responses to the survey, **built capital challenges were most frequently cited (31%)**. Built capital and financial capital (28%) combined made up nearly 60% of the cited challenges.

Summary and Next Steps

This work has highlighted that residents of the Northern Border region perceive their communities to be moderately resilient overall, and especially resilient in social aspects. Respondents consistently identified built infrastructure and financial challenges as the greatest resilience challenges facing the region. Lower income respondents ranked economic and environmental resilience significantly lower than higher income respondents, and also were less likely to agree that their town met specific markers of resilience in each category. Future work will continue to explore these topics, especially among a more representative and lower-income sample, as the majority of respondents to this survey were higher-income and higher educated, which may influence the perceptions of resilience within their community.

Community members saw many opportunities for improving their community's infrastructure:

"Most of our roads FINALLY got high-speed internet a month ago (thank you, federal pandemic \$\$!!), but there are still some places that lack this resource. This would greatly aid the development of economic opportunities."

"Widening local roads for biking and adding & connecting trail systems to encourage healthy life style and environmentally safe travel to other regions of the state."

"Treating child care and health care and elder care as necessary infrastructure! To allow people to live, work and play here without stress and anxiety."

"We have infrastructure challenges, utility bills of town buildings could be reduced by switching to solar, sidewalks could be improved to improve safety, all could be done through grant programs if properly motivated elected officials took the opportunities."





SECTION III:

Ecological Indicators of Community and Economic Resilience

AUTHORS:

Sarah Garlick

Overview

For forest-dependent communities like those in the Northern Border region, environmental conditions tie directly to local economies and ways of life. Given these ties, including ecological attributes in a resilience index, along with demographic and economic trends, may provide important insights to guide community-investment decisions. However, knowing which aspects of the environment are most salient to those decisions, and which ecological datasets to potentially prioritize as resilience indicators, are not always clear. To address this gap, we convened experts from key sectors in the Northern Border region, including forest products, conservation, recreation, rural economic development, and policy, to hear multiple perspectives on how forest ecosystem research, data, and science-based tools might be used to inform investment decisions in forest communities.

Our approach involved one-on-one interviews and three online focus groups with 24 total participants during February–May 2022. We framed the interviews and focus group discussions around three generic scenarios:

- (1) conserving and managing a town forest for community resilience;
- (2) designing a statewide initiative to improve the recreation economy; and
- (3) investing in the future bioeconomy of the region.

We chose these topics to reflect the current economic context of the Northern Border region, characterized by a shift in dominance from the forest-products industry to tourism and recreation, and also to encourage thinking about potential investment decisions at different scales (community, state, region). As a framework for thinking about available ecological datasets and tools that could be used as socioeconomic resilience indicators, we asked participants to consider the Vermont Forest Indicators Dashboard created by the Forest Ecosystems Monitoring Cooperative (FEMC). This online tool, available at: <https://www.uvm.edu/femc/indicators/vt>, shares 33 metrics related to the status of Vermont’s forests (see Table 3). We asked participants to consider which of these metrics would be most relevant to one of the three simplistic scenario statements written above, and what additional data they think should be applied in these contexts.

Forest ecosystems are complex, as are rural communities and economies. Pages 24 and 25 summarize the key themes that emerged from our lively conversations and the ecological indicators participants felt were most salient to each of these broad topics. Following those summaries are sections devoted to each focus group topic. These results are important because they suggest specific pathways for directly incorporating ecological data and tools into future analyses of socioeconomic resilience in forest-dependent communities.

Table 3. List of metrics used in FEMC’s Vermont Forest Indicators Dashboard

Structure	Condition	Services	Stressors
Forest Cover	Crown Dieback	Timber Harvest	Precipitation Acidity
Hardwood Regeneration	Forest Damage	Stream Indicator	Growing Season
Softwood Regeneration	Tree Growth	Species	Length Ozone
Stand Complexity	Canopy Density	Hunting	Exposure Mercury
Mean Forest Patch Size	Forest Mortality	Harvests	Deposition Minimum
Forest Connectivity	Damage and Decay	Carbon Storage	Temperature Maximum
Tree Species Diversity	Tree Mortality	Maple Syrup Production	Temperature
Stand Age Diversity		Recreation Rates	Precipitation
		Forest Bird Diversity	Snow Cover
			Climate Extremes
			Drought
			Damage by Invasive Pests

Key Results / Focus Group Themes

TOPIC #1: Conserving and managing a town forest for community resilience

- (1) Whose priorities define management plans for town forests? One view focuses on what people want and orients around community priorities (which may be diverse); one view focus on the “rewilding” of nature and ecosystem services.
- (2) Ecological indicators must consider baselines. Local data from community forests might be helpful for thinking about baselines.
- (3) We need better ways of linking managers and community decision-makers at the town level to regional datasets and trends, like those shared in the FEMC tool.

Relevant Ecological Indicators

Forest cover, forest health/condition, recreation rates, diversity of recreation types

TOPIC #2: Investing in the future bioeconomy of the region

- (1) Concern about forest condition and stocking relative to visions for next-generation forest products and economies. A need to get forest condition back to a positive place.
- (2) Landownership and markets play an important role; carbon markets will influence this
- (3) Importance of maintaining forest products industry in the mix of the recreation industry

Relevant Ecological Indicators

Forest cover, connectivity, age and species diversity

Condition: growth, decay, regeneration

Multiple services (see Services box, page 25)

TOPIC #3: Designing a statewide initiative to improve the recreation economy

- (1) There is a severe backlog of stewardship needs as recreation rates increase. Quantifying annual state-level investment in stewardship might be an important indicator.
- (2) Balancing a diversity of recreational experiences on the landscape is essential.
- (3) Importance of considering economic and environmental issues (and data!) together.

Relevant Ecological Indicators

Forest cover, forest health/condition, connectivity, air quality, erosion, links to downtown, trail density, recreation trends: membership, visitation

Services: balance across sectors (hunting, logging, hiking, biking, etc.)

Economic indicators: private businesses income/growth, workforce, housing

Stewardship: statewide figures on investment in recreation infrastructure and user education

Key Results / Discussion Points about Possible Ecological Indicators of Community Resilience

STRUCTURE

Hardwood and softwood regeneration: Changes here indicate potential forest health issues, climate impacts, etc., and shape what the future forest will look like and be able to produce in terms of products.

Forest cover: Need forestland to provide the resources for a sustainable forest bioeconomy. Need forest cover for community forests and recreation. This is an easy one to track over time.

Forest connectivity: Much of our bioeconomy is dependent on maintaining forests, sustainable management, and connecting people to the land. Connectivity of systems is critical or we risk segmenting habitats, systems, and economic factors, making a sustainable economy a challenge. Connectivity is important for quality recreation trails.

Age and species diversity: A diverse bioeconomy is likely to be more resilient than one that is dependent on just a few species. The products a bioeconomy can produce hinge on species mix and availability of certain age classes. Diversity of ages/sizes within and between stands and of tree species are important indicators of the potential for sustainable forest management. Age and species diversity also enhance the recreation experience.

CONDITION

Tree growth: Gives an indication of opportunities and often guides when and what type of management is best, but can't be in a vacuum because high tree growth could mean you have too much young forest right now that is growing fast. Active forest management should result in improved growth and yield for residual stand, thereby improving forest health and timber quality.

Forest damage, decay, mortality: A thriving forest bioeconomy can incentivize forest management, thereby improving forest health and reducing risk of loss, damage, and decay. Increasing levels of mortality across the landscape can be a large detriment to meeting all the needs of a bioeconomy, including recreation/tourism. Increased forest mortality could be a red flag for an area whose economy depends on a healthy forest either for products or uses.

Regeneration: Regeneration dynamics, including tree recruitment dynamics, live to dead biomass ratios, tree damage, and land use change dynamics, relate to the future of the forest.

Tree quality: Acceptable growing stock, e.g. risk/vigor/form, are critical indicators. Amount of growing stock is only part of the story; the quality and vigor must be adequate for sustainability of production.

SERVICES

Product mix: Beyond simply timber harvest volume, the associated product mix is critical. The bioeconomy may become increasingly interested in the greenhouse gas implications of such products. Wood/biomass production and carbon storage are critical factors to the success of the bioeconomy.

Workforce: Promote healthy workforce in the forest, how do we attract people to work in the forests to address the wealth of diverse bioeconomy opportunities in a sustainable manner.

Recreation rates: Increases here would cut both ways: more impact on land, more conflicts with other land uses, but could also create new economic opportunities for businesses that cater to recreationists. Changes in recreation use can sometimes be in conflict with timber harvesting. Need to balance a diversity of experiences, including hunting. Consider the parking-lot indicator: is it overflowing?

Land use change: These metrics will become important if the recreation economy grows and people want to live closer to these amenities (trailheads and ski runs).

Timber harvest and syrup production: From a scale of economic impact perspective, both are very large economic contributors. Declines in these indicators would be bad. Stability is probably good. Steep increases would raise questions about sustainability.

Mix of ecosystem services: Investing to provide a sustainable to increasing level of all of these is the key so when one declines for natural or social reasons, there are other services contributing to the economy. We have to make sure we are paying attention to how these services intersect and play well together, especially over time.

Public sentiment: Trends in public perception, interest in, and accurate understanding of some of these services (harvest, carbon, hunting) will influence investment potential and effect, regulations, etc., as much as resource conditions.

STRESSORS

Climate change: Understanding the impact of climate change on all service sectors, and planning for those changes, planning for resilience, is key. Climate (extremes, precipitation., snow cover, drought) are drivers of forest growth/health and important determinants of potential success or failure of bioeconomy investment.

Snow cover: Snow cover is a key condition; also a constraint for many recreation activities.

Ticks: For a lot of communities when they think about trails, they are thinking about ticks. This is a big consideration.

Heat: When it's unseasonably hot, people don't want to be in the mountains climbing a treetop course or zip-lining, they'll want to be at the beach.

Conserving and managing a town forest for community resilience

Summary

We asked seven participants to consider and discuss together the topic of conserving and managing a town forest for community resilience: what that goal might look like to them, which indicators from the FEMC tool (Table 3) might be relevant to this goal, and what trends in ecological data or other relevant metrics might indicate success or warning signals. The group involved professionals from forest management, forest research, and rural economic development. Many participants brought up forest cover as a relevant indicator that is relatively easy to measure, as well as interest in indicators of forest health (e.g., condition, crown dieback). One participant noted that managers of town forests collect local data relevant to their forest management plan. The potential to link those local data to regional trends shared in the FEMC tool and trends in the “stressors” column is an important opportunity.

During the focus group, three key themes emerged. The first was a discussion about **whose priorities should define management plans for town forests**. Two divergent perspectives emerged: one emphasized the importance of community values defining the management plan, which likely focus on access and recreation. The other emphasized the importance of ecological values defining the management plan, focusing on the importance of forests for providing clean air, water, and habitat for wildlife.

“These are community forests, so the number one thing should be: What do people want and are they happy with? And it to me, that’s a huge challenge in managing these kinds of public forests, because as scientists, we want things like healthy forests and forest cover, and people want bike trails and they want an ice cream kiosk and they want a bunch of things ... As soon as the parking lot is full and there’s evidence of degradation and the trail is eroded — yes, it’s an indicator of stress, but it’s also it’s an indicator of success that people want [to conserve and use the] site.”

“We have some communities that are very much managing their properties for firewood, for timber extraction in a sustainable and healthy way. And we have many communities whose top priority is recreation. ... People appreciate, you know, the many gifts of a forest.”

“I’m really inspired by [a call] for the need for an Earth-centered worldview, because it really isn’t about humans anymore. We’ve overtaxed the planet, and we need to change the way we are. And so it’s important to hear what people want, but it’s also perhaps more important to let people know that a community forest can only do so much.”

The second theme that emerged was a discussion about **the importance of considering baselines when interpreting ecological data as indicators of resilience**. Participants emphasized that decision-makers should consider local data and goals from the management plans of community forests when they think about baselines and whether trends indicate moving toward or away from a goal.

“Even in a multi-use community forest where, you know, the parking lot is overflowing and there may be evidence that there’s lots of people there, [we have to ask] how is that changing over time? ... What are the initial starting conditions? And also thinking about that in the context of natural processes.”

Finally, the third theme of the discussion was **a call for linking managers and community decision-makers at the town level to regional datasets and trends**, like those shared in the FEMC tool. One participant noted that there are collectively 400,000 acres of conserved town forest land in Vermont, New Hampshire, and Maine, which represent an important contribution to the health of the regional ecosystem. A town forest manager said that regional forest health trends, in particular, would be helpful to share, to plan prescriptions and justify those plans to community members.

“You know, people managing a community or a town forest at the local level, they have no tie to this data. They have no tie that any number of researchers are doing this incredible data collection or keeping track of things over time. And so making that connection between the local land, the local managers—and I mean the community folks—and then the research, is really going to be key to any effort to not only identify new indicators, but to talk about how current indicator data can be utilized. You’ve got to open the gates of communication there.”

Topic #2:

Designing a statewide initiative to improve the recreation economy

Summary

We asked ten participants to consider and discuss together the topic of designing a statewide initiative to improve the recreation economy and how ecological attributes like those in the FEMC tool might be used to inform decisions in this category. The group involved professionals from outdoor recreation advocacy organizations, rural economic development organizations, public and private land managers, economic research, and ecological research. Participants noted that many of the indicators in the FEMC list are relevant to this topic, particularly forest health/condition, connectivity, and the metrics in the “services” category. However, many felt that the FEMC list was far from complete, and that additional metrics related to trail erosion, trail density, and the links from trails to downtown areas, were key. During the focus group, participants expressed frustration that they were asked to consider these ecosystem-focused indicators in absence of socioeconomic data. They emphasized the importance of understanding economic indicators like private businesses income/growth, workforce, and housing, in the context of this topic.

The three key themes that emerged from the focus group relate to under-addressed stewardship needs, the importance of balancing a diversity of recreational experiences on the landscape, and a call for decision-makers across sectors to consider economic and environmental aspects of outdoor recreation together in a more integrated way. In terms of stewardship, participants sounded the alarm that **increasing recreation rates are not being met with adequate investment in stewardship of recreation lands**. The group brought up an idea of quantifying annual state-level investment in stewardship—and comparing that metric across states—as an important step that might spur action.

“The cascade of ill effects from overuse without commensurate stewardship capacity is a radiating, rippling-over-time, forest-health nightmare in the making.”

“There is so much recreational use. There’s all kinds, and it’s wonderful and growing and diversifying. There’s this tremendous backlog of stewardship needs, just writ large, that nobody has capacity for, no matter who you are: agency, nonprofit, private landowner. And so it seems like ‘Stop the Bleeding’ would be a great first investment.

“The outdoor recreation experience is underpinned by a healthy natural resource context, and that will all collapse like a house of cards.”

“One of the things that will help find that balance between stewardship and economic impact is funding for supporting infrastructure.”



Participants talked about the **importance of a recreation economy that supports multiple kinds of experiences and ensures access to nature for all communities**, not only the typical “outdoor recreation enthusiast.” Participants also talked about needing to balance other ecosystem services like timber provisioning, on the same lands as outdoor recreation.

“If you see any one form of recreation becoming too dominant, that’s going to cause problems in other areas. So how can you maintain a balance of recreation such that no one of them is having too many bad effects at once?”

“I’ve been thinking a lot about access to nature and who can use these recreational assets that we have. There’s the difference between proximity and accessibility.”

“Some people might not think of themselves as an outdoor recreation enthusiast, but they still enjoy going for a walk at lunch, or looking at birds, or just looking out their window at a nice natural scene. How do we bring those benefits of nature to more people? I would really love that to be a tenant of a broader outdoor recreational plan.”

“I’m a supporter of mountain biking, but these places are winding single track through everywhere. It is harder and harder to have a remote experience. There is no forest cover issue — no forest dieback — but to me they are not forests anymore; they are bike parks. These [issues] are not showing up in the data, but they are ruining my experience.”

“I really appreciate it when there’s a timber harvest going on in a recreation area. I think it is a really good reminder to recreationists that logging is okay. The fact that logging is happening actually helps us maintain that place as a place to recreate a lot of the time.”

Finally, several participants, particularly those from outdoor recreation-focused organizations, voiced an appeal that **we must integrate economic and ecological perspectives to move forward.**

“Being an outdoor recreation manager, [I’m always thinking:] who am I talking to? Am I preaching our economic impact numbers or am I talking about our stewardship practices? But I don’t think they should be separate conversations. And sometimes when I’m talking to the stewardship people, I keep my visitor numbers and my economic impact numbers really hush-hush. ... but I don’t think they should be separate. I do think they are interconnected. And we should be preaching this story about how we’re having this positive impact on the economy while also being good stewards of the world.”

“The elephant in the room is the economy. The recreation economy. There’s nothing [in this list of example data sets] that’s even remotely related to the actual economy. What about private businesses? What about policy? What about funding? My line is it always takes a bake sale to build a trail because there’s absolutely no funding.”

“I think taking a step back is incredibly important [and] including the economy as part of the conversation. ... it’s a multilayered, very complex problem. ... But when we stop and think about what are the basic issues, what policies that we’re riding on, I think we need to roll it back and focus on the bigger picture of things before we get into, you know, looking at this list [of data sets].”

Topic #3:

Investing in the future bioeconomy of the region

Summary

We asked eight participants to consider and discuss the topic of investing in the future bioeconomy of the region, with a focus on the forest-related products side of the economy. We asked participants about what that topic means to them, and how decision-makers might use ecosystem attributes and datasets like those in the FEMC tool (Table 3) to inform their work. The group involved professionals from forest management, the forest products industry, and forest research, as well as organizations focused on rural economic development. Participants noted the **interconnectedness of issues that fall under this topic, including resilience, workforce, carbon sequestration, and markets.**

“My primary concern is maintaining opportunities for sustainable forest management, and that involves a lot of different aspects: having the workforce available, having the operational capacity to do that work, having a good understanding of the different silvicultural treatments that are appropriate and feasible for achieving the different goals that we have, and knowing what those goals are. So they’re carbon related, they’re resilience related, they’re production related — and then having the markets and the product potential for [the stocking] we currently have in our forests, which might look a little different than what it did in times past.”

“We’re thinking about how to support the existing industry as it stands and also supporting the sustainability for the future and future market growth as well.”

“When we think about investing in the bioeconomy, it is an opportunity to find those win-win solutions that both support sustainable forest management now and into the future, but also provide real, meaningful economic benefit to the rural communities that are located within that forest.”

Three broad themes emerged from the focus group: First, **concern about the condition of the forests in this region, particularly in commercial forestlands**, and a potential gap between the current condition and visions for a revived bioeconomy based on next-generation engineered wood products like cross-laminated timber. Participants noted that the current “acceptable growing stock” — the amount of forest that is healthy, with vigorous trees of good quality — is a major challenge in the region right now.

“I think the challenge is that to move from a space where we don’t have as much of that good quality, vigorous growing stock as we would like to see, to one where we do, often requires silvicultural investment that the payoff is in the future and is not now. So that requires a shift in our timeframe and our willingness to accept return on investment in the far future versus the near future. And that is a model that doesn’t necessarily align with everyone’s willingness or ability to put money into the northern forest right now,” said one participant.

“Or I think it suggests public investment,” a participant responded. *“That, to me, tips into the realm of public policy... because if the economic return to a landowner is decades out and probably into the next generation of landowners, it’s hard to think of economically why they would do that. So that’s why I say I think it tips more into the realm of policy and public investment. If that type of silviculture is really needed on a landscape scale, that to me is a different type of investment.”*

This led to the second key theme, which **is the importance of understanding landownership and markets in the context of this topic, and a recognition that emerging carbon markets will play a role in these forces**. Having longer-term carbon projects might be beneficial for increasing rotation cycles, which will have a positive impact on the forest, while at the same time giving a return to owners, one participant noted.



“I think what we’re now talking about is the bioeconomy we see in a region that is dominated by private land ownership. Markets for forest products—or lack thereof—determine a lot of what happens on the landscape.”

“Markets can drive and support sustainable forest management. They can also drive things in not great directions in terms of forest health.”

Finally, participants discussed **the importance of maintaining a forest products industry in the mix of the growing outdoor recreation industry**. Despite the increasing importance in the region of recreation and tourism, participants emphasized that replacing a forest products-based economy with a recreation-based economy might not be viable, especially for private landowners.

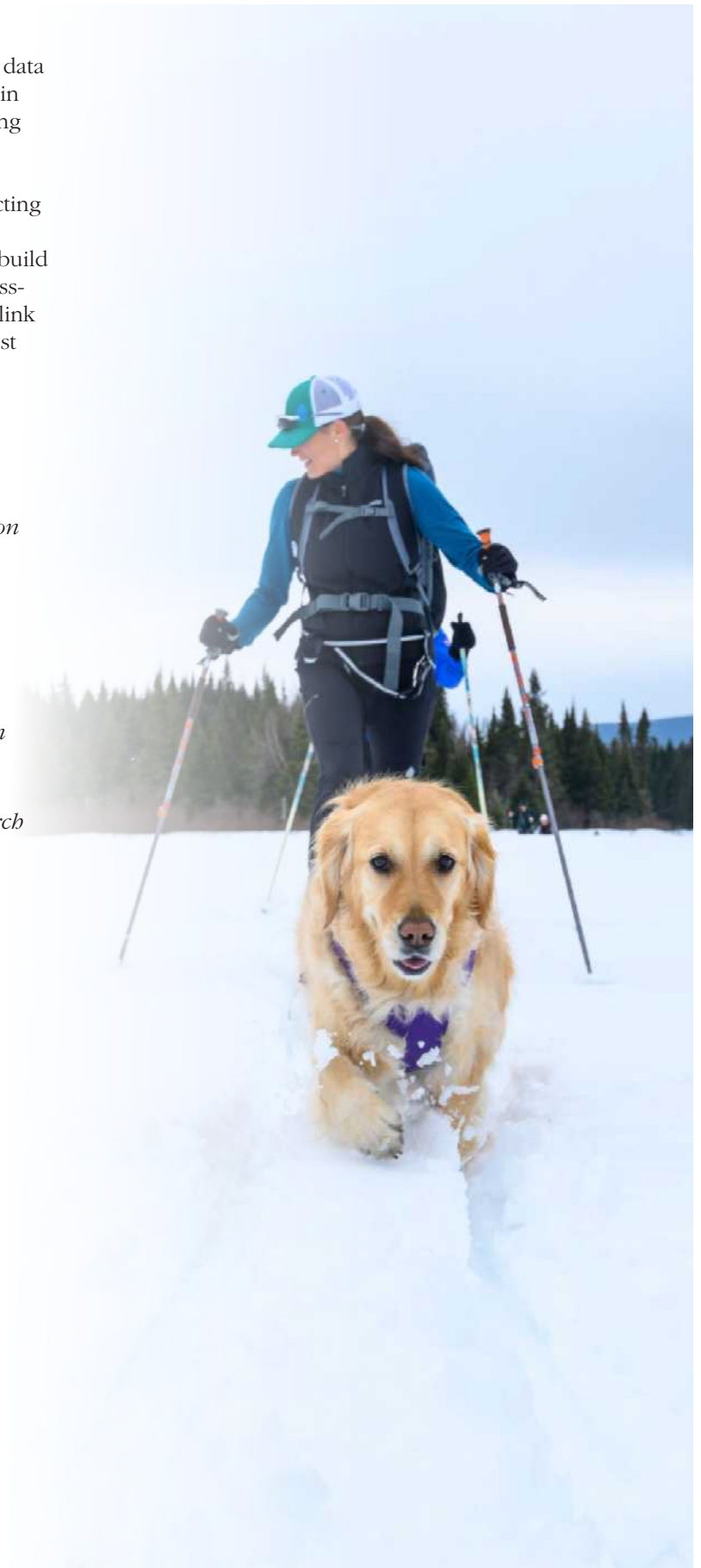
“The increase in recreation is happening everywhere. I think another facet of it, though, is that private landowners don’t see any economic benefit from recreation. Like in Vermont, as soon as you start charging people to recreate on your land, you lose your state liability protection. So I don’t know how that plays out, but I know this is an issue — that it’s certainly not a 1 to 1 replacement or even close from a landowner perspective. If you go from selling forest products and services to allowing recreation on your lands, one generates income for you, another doesn’t. And I think in terms of community well-being, again, [there’s a] pretty substantial gulf in difference between the types of jobs that the forest products economy once provided and the types of jobs that largely seasonal recreation now provides.”

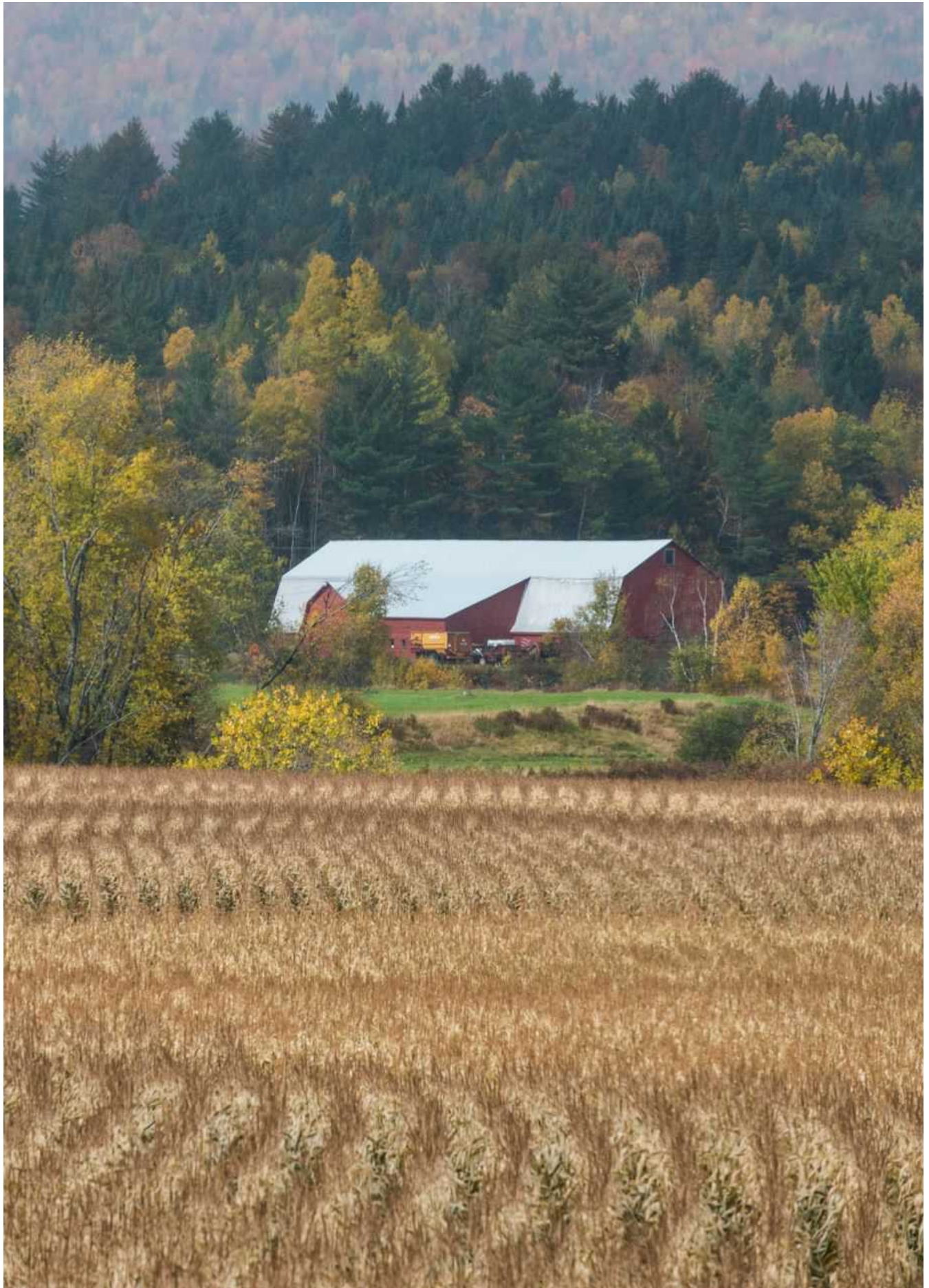
Future Work

These results point to clear opportunities for future data collection and synthesis to inform decision-making in the Northern Border region: for example, establishing ecological indicator baselines at a meaningful scale (like the town/community forest), better linking socioeconomic and ecological indicators, and collecting more standardized indicators related to outdoor recreation and stewardship. Future projects should build in communication plans that support continued cross-sector engagement and information exchange, and link local decision-makers at the woodlot and town forest scale to the state and regional scales.

Participants

Maura Adams, *Northern Forest Center*
Susan Arnold, *Appalachian Mountain Club*
Marina Bowie, *Northern Border Regional Commission*
David Brynn, *Vermont Family Forests*
Alexandra Contosta, *University of New Hampshire*
Adam Daigneault, *University of Maine*
Julie Evans, *Northern Forest Center*
Peter Groffman, *City University of New York and
the Cary Institute of Ecosystem Science*
Rich Grogan, *Northern Border Regional Commission*
Patrick Hackley, *State of New Hampshire*
Jessyca Keeler, *Ski NH*
Laura Kenefic, *USDA Forest Service, Northern Research
Station*
Stacy Lemieux, *White Mountain National Forest*
Abby Long, *Kingdom Trails Association*
Mike Morin, *Town of Bartlett, NH Conservation
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Ian Prior, *Seven Islands Land Company*
Tyler Ray, *Granite Outdoor Alliance,
Granite Backcountry Alliance*
Shannon Rogers, *University of New Hampshire,
Cooperative Extension*
Joe Short, *Northern Forest Center*
Michael Snyder, *State of Vermont*
Pamela Templer, *Boston University*
Chris Thayer, *Appalachian Mountain Club*
Aaron Weiskittel, *University of Maine*
Chris Woodall, *USDA Forest Service,
Northern Research Station*

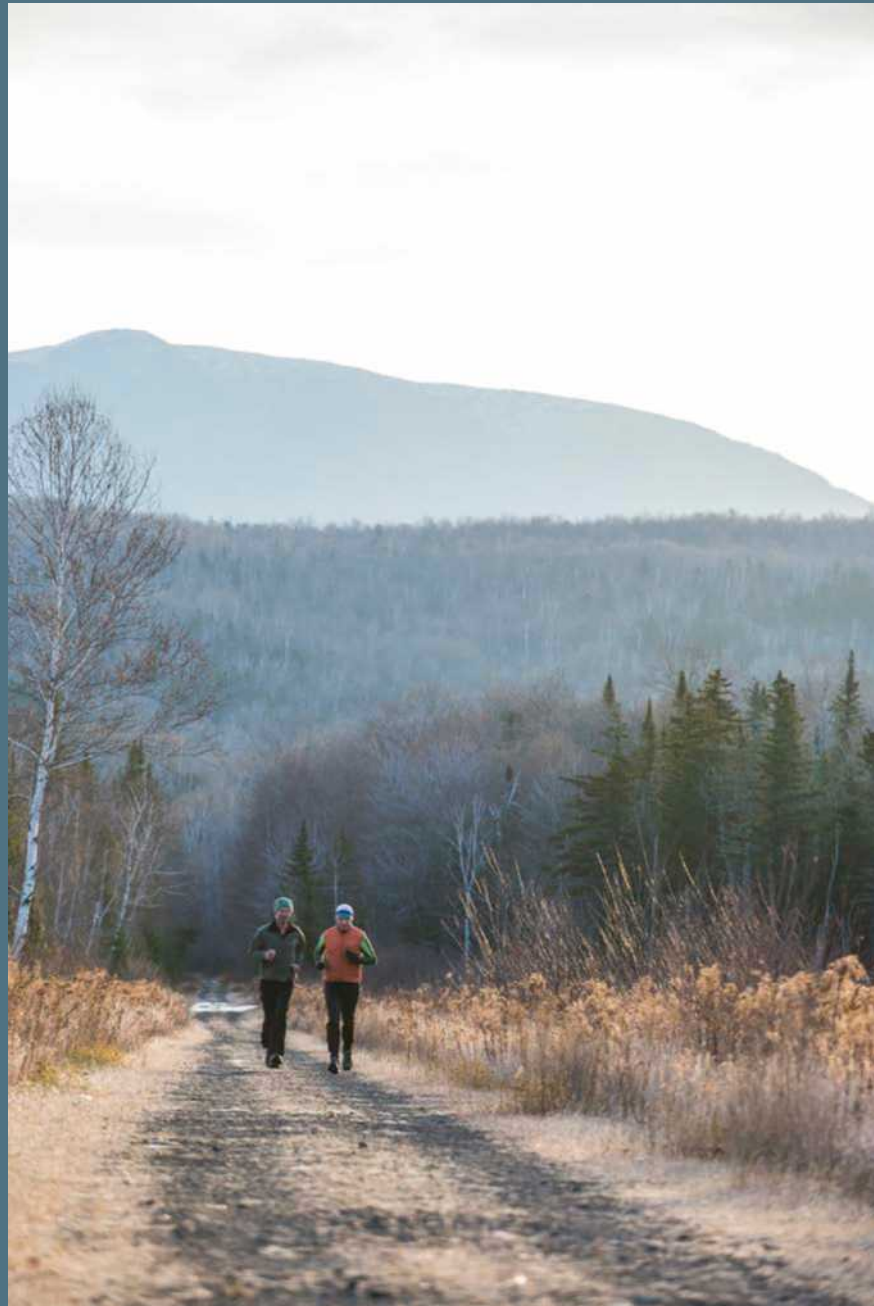




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