

**Forest Value and Carbon Costs Associated with the
proposed 500kW Solar Array off of
Upper Loveland Road
in Norwich, Vermont**

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THE VALUE OF FORESTS

Vermont is a distinctive landscape of mountains, forests, rivers, ridgelines, shorelines, iconic farms, small villages, and compact cities. The Green Mountain State is one of the most forested in the country, and science confirms what many Vermonters have long known: by keeping our natural landscape intact and forested we can maintain our highly effective and low-cost natural infrastructure to address mounting global environmental challenges, including climate change. The local and regional actions we take today to protect our forests hold tremendous significance for quality of life in the state of Vermont, and in the town of Norwich, tomorrow.

Vermont's and Norwich's forests are a key component of, and inseparable from, New England's forests which define our region, which provide vast benefits to human and natural communities at local to global scales, and which reinforce our cultural heritage and sense of place. Our forests offer a rich array of human and natural habitats, and they support a wide range of positive human experiences while providing many valuable natural resources for our use -- all while adding more than \$10 billion annually to New England's tourism industry. David Foster et al, *Wildlands and Woodlands – Broadening the Vision for New England*

Affects Physical, Mental and Spiritual Health

Never in our nation's history has it been more important to protect every acre of forest and open space, for at this time profound changes are occurring in the American public's relations to nature. These shifts reflect an increasingly urban nation, where now more than three quarters of Americans live, and an ever more indoor-oriented public, where Americans now spend on average 90% of their time. Stephen Kellert, *Building for Life: Understanding and Designing the Human-Nature Connection*

Reflecting this rapidly increasing separation from nature, technology permeates every aspect of our lives today. A 2010 Kaiser Family Foundation study found that American youth spend an average of 53 hours a week using entertainment media while spending less than 40 minutes per week outside (American children spent more than 4 hours outside each week only a generation ago).

“Today, 8–18-year-olds devote an average of 7 hours and 38 minutes to using entertainment media across a typical day (more than 53 hours a week). And because they spend so much of that time ‘media multitasking’ (using more than one medium at a time), they actually manage to pack a total of 10 hours and 45 minutes’ worth of media content into those 7½ hours.” -

[Kaiser Family Foundation](#)

We have to consciously bring more nature into our lives—not just to escape technology's documented negative effects, but also to access the positive benefits that nature provides.

In a study of 20,000 people, a team led by Mathew White of the European Centre for Environment & Human Health at the University of Exeter, found that people who spent two hours a week in green spaces -- local parks or other natural environments, either all at once or spaced over several visits -- were substantially more likely to report good health and psychological well-being than those who don't. The effects were robust, cutting across different occupations, ethnic groups, people from rich and poor areas, and people with chronic illnesses and disabilities. - [Nature](#)



Figure 1. Norwich resident experiencing nature in the proposed Upper Loveland Road project area.

According to Yale Environment 360, time in nature is an antidote to stress. “It can lower blood pressure and stress hormone levels, reduce nervous system arousal, enhance immune system function, increase self-esteem, reduce anxiety, and improve mood. Attention Deficit Disorder and aggression lessen in natural environments, which also help speed the rate of healing. - [Yale Environment 360](#)

Ample evidence indicates that people’s physical and mental health, productivity, and wellbeing depend upon ongoing beneficial contact with nature, whereas a lack of contact with nature is directly tied to health and behavioral problems such as an increase in obesity, attention disorders, and depression. This evidence has been derived from workplace, education, health, and childhood development studies, all revealing that the positive experience of nature is a biological and cultural necessity and not a dispensable recreational amenity. - Stephen Kellert and E. O. Wilson, *The Biophilia Hypothesis*

Spending more time outdoors nurtures our “nature neurons” and our natural creativity. For example, at the University of Michigan, researchers demonstrated that, after just an hour interacting with nature, memory performance and attention spans improved by 20%. In workplaces designed with nature in mind, employees are more productive and take less sick time. - [The Guardian 12 Feb 2014](#)

Spending time in the natural world not only makes you feel better, but spending time in the natural world also makes you behave better, according to a study published in the *Personality and Social Psychology Bulletin*.

“Stopping to experience our natural surroundings can have social as well as personal benefits,” says Richard Ryan, coauthor and professor of psychology, psychiatry and education at the University of Rochester. While the salubrious effects of nature are well documented, from increasing happiness and physical health to lowering stress, this study shows that the benefits extend to a person’s values and actions. Ryan and his team of researchers at the University of Rochester found that exposure to natural as opposed to man-made environments leads people to value community and close relationships and to even be more generous with money.

[- National Library of Medicine](#)

The health of our region’s and our town’s citizens, environment, culture, and economy remains inextricably linked to the health of our forests. Spending time in the woods snowshoeing, cross-country skiing, hunting, fishing, hiking, berry picking, making maple syrup, walking with friends and family, and a host of other forest-based activities defines our local and regional culture. Spending time in our natural surroundings provides us with a deep and abiding sense of place and belonging.

According to *Yale Environment 360*, “The growing body of research — combined with an intuitive understanding that nature is vital and increased concerns about the exploding use of smartphones and other forms of technology — has led to tipping point at which health experts, researchers, and government officials are now proposing widespread changes aimed at bringing nature into people’s everyday lives.

“For example, researchers and policymakers now talk about “park deserts” in urban areas. Cities are adding or enhancing parks, and schools and other institutions are being designed with large windows and access to trees and green space — or blue space, as in aquatic environments. Businesses are increasingly aware of the desire among employees for access to green spaces. ‘It’s needed to attract a skilled workforce,” said Florence Williams, author of *The Nature Fix*. ‘Young people are demanding high-quality outdoor experiences.’- [Yale Environment 360](#)

An increasing number of healthcare providers are also embracing the back-to-nature paradigm, reports *Yale Environment 360*. “One organization, Park RX America, founded by Robert Zarr of Unity Healthcare in Washington, D.C., declares its mission “to decrease the burden of chronic disease, increase health and happiness, and foster environmental stewardship, by virtue of prescribing Nature during the routine delivery of healthcare by a diverse group of health care professionals.” The organization has 10,000 parks in its “prescribing platform.” - [Yale Environment 360](#)

Regional Plan Advocates For Green Infrastructure

Two Rivers Ottauquechee Regional Commission is an association of thirty municipalities, including Norwich, in east-central Vermont. TRORC advocates for the needs of member towns, and articulates a vision for building a thriving regional economy while enhancing the region's quality of life. According to TRORC, the physical and mental health and wellbeing of our citizens depends upon healthy ecosystems, parks, and other conserved areas; and that parks and greenspaces are essential components of well-designed, vibrant, and healthy communities.

"Land use choices influence the underlying determinants of community and environmental health, such as obesity, heart disease, mental health, social isolation, nutrition, and air quality. Developing coherent strategies that integrate health considerations is critical... Providing residents with parks and greenspace not only beautifies communities but can also increase the well-being of people. Healthy by Nature is a movement about the physical and mental health benefits of green infrastructure and states that spending more time in nature improves human health, that human health depends on healthy ecosystems, and that parks or other conserved natural areas contribute to vibrant and healthy communities. Studies also show that people who connect with nature often feel less isolated and can form connections with neighbors.

"As the built environment has become increasingly car-centric, levels of physical activity have correspondingly declined. Reduced physical activity has resulted in population weight gains. To counter these trends, it is necessary to make communities more conducive to physical activity once again, particularly walking and cycling.

"Designing our communities to be safe and walkable in a way that provides access to essential goods and services is extremely important for all ages... The implementation of bicycle and pedestrian trails has been demonstrated to promote a healthy lifestyle. Biking and hiking trails can promote increased activity and can be created with smaller amounts of land than large parks. They can often be created from 'leftover' or unwanted land." - TRORC Regional Plan

Ecosystem Services

Citizens of our region, state, and town benefit from forests in many ways. Forests provide an inexpensive and cost-effective means of supplying clean water to both local residents and major population centers without the need to build and pay for costly filtration plants. At the same time, forests help to store and slow runoff from storms, thereby lessening the frequency and magnitude of floods.



Figure 2. Trees to be cut for solar project on steep slopes threaten home downhill with increased flooding.

In addition to greatly enhancing our quality of life, our region's forests remove over 760,000 tons of air pollution each year. The associated improvements in air quality bring such health benefits as reduced cases of respiratory illness, asthma, and hospitalizations from air pollution related illness. In New England, these benefits are valued at \$550 million per year.

Our forests also provide global benefits by offsetting more than 20 percent of our region's carbon dioxide emissions that would otherwise contribute to climate change. By protecting and sustainably using our forests we can maintain and even enhance these and many other benefits we derive from them. - David Foster et al, *Wildlands and Woodlands – Broadening the Vision for New England*

Economic Importance

“The economic importance of Vermont's working forest has garnered considerable attention as of late. This recognition has seen a renaissance in the “Buy Local” movement, which started with food but now includes forests. From firewood to lumber, biomass to fine furniture, carbon sequestration to clean water, our forests have value. Forest-based manufacturing and forest-related recreation and tourism are significant economic drivers for Vermont, resulting in a substantial contribution to our state's economy.” - [Vermont Department of Forests](#)

DEVELOPMENT IN NORWICH'S FOREST

Locally in Norwich, Vermont, the connected woodlands and green spaces within the mosaic of public and private properties in downtown provide the natural infrastructure needed for both a healthy ecosystem and nature-based recreation and enjoyment of our local natural beauty for the health and well-being of the town's population (Figure 3). Our health and wellbeing depends on the access to our forests that has been provided by private landowners and public agencies. The extensive trail network beginning on Main Street in the heart of downtown connects these various properties and healthful environments and knits them into a seamless whole, facilitating widespread access to and public enjoyment of the local forested landscape.



Figure 3. Tracks of Norwich residents and resident deer in the proposed Upper Loveland Road solar project area.



According to the scientific journal *Australas Psychiatry*, “solastalgia is a new concept developed to give greater meaning and clarity to environmentally induced distress. As opposed to nostalgia -- the melancholia or homesickness experienced by individuals when separated from a loved home -- solastalgia is the distress that is produced by environmental change impacting on people while they are directly connected to their home environment.” - [National Library of Medicine](#)

“Solastalgia is when your endemic sense of place is being violated,” says professor Glenn Albrecht. - [BBC Future](#)

Many citizens of Norwich who depend upon access to our nearby forests for mental, physical, and spiritual health feel that these very places we cherish are under assault from industrial development facilitated by a town government that is ignoring the expressed wishes of the citizenry who voted to approve the 2020 Norwich Town Plan.

Resource and Ridgeline Protection in the Town Plan

The Norwich Solar Technologies Upper Loveland Road 500 kw Project is proposed for a critical parcel within the downtown Norwich forest mosaic that is designated as a “resource and ridgeline protection zone” by the Norwich Town Plan. The area is part of a core habitat block mapped by the Vermont Agency of Natural Resources.

According to The Norwich Town Plan, “The Norwich Town Plan states the town’s objectives, policies and actions for guiding future land use and development in the community. This plan is a guide for municipal decision-making. It also contains policies directing the deliberations of the selectboard, Planning commission, Development Review Board and other town and state boards and commissions in reviewing development proposals.”

“Under Land Use Objectives,” the Town Plan states:

“Identify, protect, and preserve important natural and historic features of the Norwich landscape, including significant natural and fragile areas, outstanding water resources (including rivers, aquifers, shorelands and wetlands), significant roads, waterways and views, important historic structures, sites or districts (including archaeological sites) (24 VSA §4302 (c) (5)). 2-1.e 2-1.f 2-1.g

“Encourage and strengthen Norwich forestlands by maintaining and improving forest blocks and habitat connectors (24 VSA §4302 (c) (6) (C), (9)).

Interconnect the existing system of trails for access to nature for Norwich residents and visitors (24 VSA §4302 (c) (1) (D) (4), (8) (B)).

“2.5 Future Land Use

“LAND CAPABILITY. A key principle of land use planning is to guide development towards land best suited to the purpose and discourage and prevent uses inappropriate to the landscape. capability assessments identify landform attributes which can constrain future development. The following attributes influence future land use decisions in Norwich.

“STEEP SLOPES are poorly suited to development. The landform of Norwich is dominated by narrow valleys and steep slopes. As severe weather events increase in frequency and intensity, reviewing land use regulations as they pertain to development on steep slopes will be needed.



Figures 4 and 5. Forested Ridgeline with Steep Slopes to be cut for solar project

“SOIL TYPE is a major determinant of development in the absence of municipal wastewater systems. Norwich does not operate a municipal wastewater system. Norwich provides potable water in the village through the Fire District, accessing aquifers to the north of the village, which allows for denser settlement.

“RIPARIAN AREAS (INCLUDING FLOODPLAINS) are sensitive environments often subject to flooding. Historically these areas have been used for agriculture (fertile silt deposits from stream action) and industrial power generation (for mills prior to the advent of electricity).

Today, repeated private property and public infrastructure losses due to flooding and erosion from severe storms is best resolved by avoiding continued development in these areas.

“About 67 percent of the area identified as having solar potential is currently under forest. Aside from the economic cost of clearing, the release of carbon from cleared lands would diminish the climate benefits of solar development on these sites. - *Norwich Town Plan 2020*

“This plan supports renewable energy production in Norwich. For this policy to continue with broad community support it must be balanced with this plan’s policies related to: Protecting natural resources, environmental quality, scenic resources and rural character; Maintaining viable farms and the working lands needed to sustain them; Focusing development in those areas of town already served by existing public infrastructure; Preserving cultural resources within Norwich village Preserving the recreational and natural value of those lands identified in the Ridgeline Protection Overlay Area and Shoreline Protection Overlay Area; Increasing the supply, diversity and affordability of housing in Norwich this plan calls upon the Public Utility commission to issue Certificates of Public Good for projects between 15 kW and 500 kW based on the presumption that lands in Norwich meet the so-called ‘preferred site criteria’, except in areas already mapped as Ridgeline Protection overlay Area, the shoreline Protection overlay Area, and the designated village center.” - *Norwich Town Plan 2020*

[REDACTED]

[REDACTED]

[Plos One](#)

[REDACTED]

[Cool Green Science](#)

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[Cool Green Science](#)

[REDACTED]

[The Nature Conservancy](#)

[Bloomberg](#)

DEFORESTATION

Acre by acre our forests are vanishing, and the benefits we derive from them are vanishing with them. In 2010, scientists reported that after more than 150 years of forest regrowth following the regional decline in agriculture, the great period of New England reforestation had ended. They showed that forestland was being lost to development in every New England state and that the land was changing in irreversible ways.

“The incremental chipping away of forest and farmland by scattered development is hard to see day-to-day but it adds up over time and represents a significant threat to the region,” said David Foster, director of the Harvard Forest. “If we stay on the current path, we’ll lose another 1.2 million acres of open land by 2060.” David Foster et al, *Wildlands and Woodlands – Broadening the Vision for New England*

Our forested landscape faces the increasing loss of woodlands to residential and commercial development; to alternative energy projects, to ongoing parcelization and fragmentation; to massive declines in state and federal land-protection funding; to deterioration of iconic tree species such as chestnut, beech, hemlock, ash, and elm from introduced pests and pathogens; to unsustainable forest management in some areas; and to the mounting challenge of maintaining public support for land protection and traditional uses of the forest while confronted by competing socio-economic interests and demands.

Development eliminated 24,000 acres of forest in New England each year from 1990 to 2010, and the pace has not abated. At this rate, another 1.2 million acres of forest and open space will be lost to development in the next 40 years. This transformation will forever change the fundamental character of the New England landscape, diminish its beauty, and undermine its capacity to yield clean water, mitigate flooding, produce food and wood products, support wildlife, and provide other services needed and valued by New Englanders. David Foster et al, *Wildlands and Woodlands – Broadening the Vision for New England*

Deforestation in New England

New England reflects the national trend towards land conversion and forest loss. The region has been losing forestland to development at a rate of sixty-five acres per day -- and Vermont is losing 1,500 acres of forest every year -- according to a report by the Harvard Forest and a team of authors from across the region, including two scientists at the University of Vermont. Conversion to development is the biggest near-term threat to forests, bigger even than climate change, the scientists report. "If our goal is to make sure our forests in Vermont are resilient and able to adapt to the changes that climate change and invasive species pose, then the first critical step is to keep those areas forested," says co-author Tony D'Amato, an associate professor and director of UVM's Forestry Program. – [UVM Today](#)

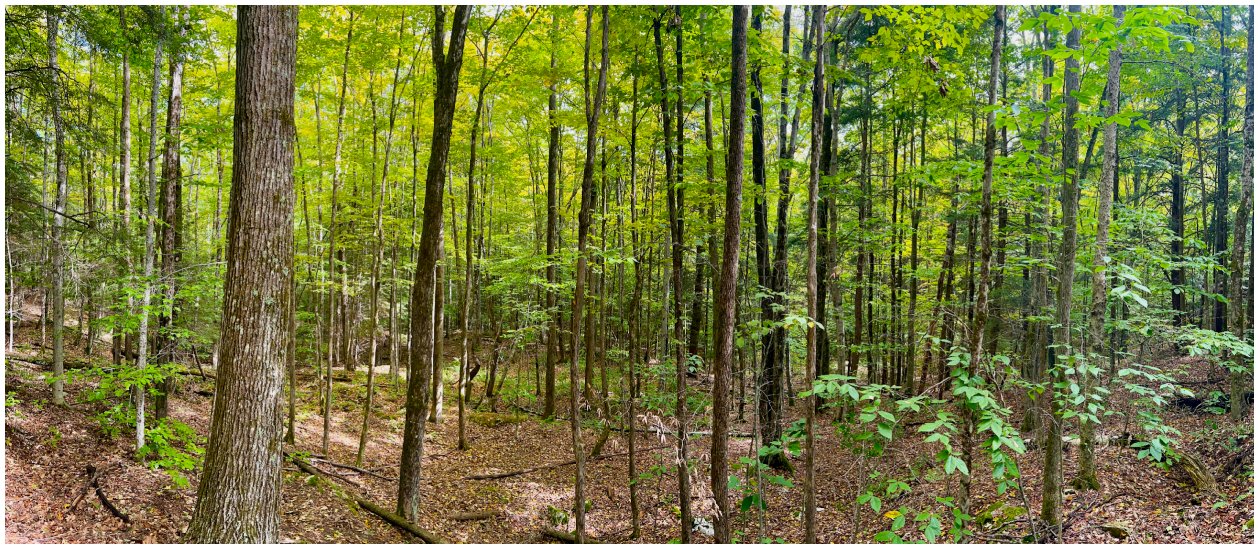


Figure 7. Forest to be converted to industrial solar array site

According to the 2021 Vermont Climate Assessment, land conversion diminishes the ability of our forests to capture and store carbon from the atmosphere. "Land use change and parcelization, most commonly conversion of forests to residential or commercial use, is a persistent trend in Vermont, a major threat to forest health and productivity, and a contributor to climate change." - [Vermont Climate Assessment](#)

Forest Fragmentation in Norwich

The NST Upper Loveland Road solar project will result in fragmenting the largest intact forest block in downtown Norwich. By reducing forest health and degrading habitat, fragmentation leads to loss of biodiversity, increases in invasive plants, pests, and pathogens, and reduction in water quality.

The movement of plants and animals, such as the young deer in Figure 8, is inhibited by forest fragmentation. Breeding and gene flow is therefore restricted and results in long-term population decline. Fragmentation is a threat to a forests' natural resilience. Disrupting connectivity of forest habitats may also inhibit forest adaptation and response to climate change. [United States Forest Service](#)



Figure 8. A young deer in the proposed Upper Loveland project area uses beech saplings as cover.

RELATIONSHIP BETWEEN CLIMATE CHANGE AND DEFORESTATION

Globally in the next 24 hours, deforestation will release as much CO₂ into the atmosphere as 8 million people flying from London to New York. Carbon emissions from deforestation far outstrip damage caused by planes and automobiles and factories. In just over 100 years the world lost as much forest as it had in the previous 9,000 years -- an area the size of the United States. Stopping deforestation is the fastest and cheapest solution to climate change, and yet the planet's, New England's, and Norwich's capacity to mitigate and adapt to climate change is diminished by ongoing forest loss and poor management. [The Independent](#)

Just one acre of Vermont forest absorbs the carbon dioxide emissions of 62 automobiles each year. The 8.2+ acres that will be cut to make room for the Upper Loveland Road solar project absorb the annual emissions of 514 automobiles each year – a sizable percentage of Norwich’s vehicles. Multiply that by the 25-year life cycle of the solar development, and those 8.2+ acres of forest absorb the equivalent annual emissions of 12,850 automobiles. - [Vermont Department of Forests](#)

RELATIONSHIP BETWEEN CLIMATE CHANGE AND FORESTS

The NST Upper Loveland solar site will turn an efficient 8.2+ acre carbon *sink* into an 8.2+ acre carbon *source*. New research, published in *Nature Climate Change* found that the world’s forests sequestered about twice as much carbon dioxide as they emitted between 2001 and 2019. In other words, forests provide a carbon sink that absorbs a net 7.6 billion metric tons of CO2 per year, which is 1.5 times more carbon than the United States emits annually. [World Resources Institute](#)

Overall, the data show that keeping existing forests standing remains our best hope for maintaining the vast amount of carbon forests store and continuing the carbon sequestration that, if halted, will worsen the effects of climate change. [World Resources Institute](#)

Every acre counts, and our region is losing forest by the acre as well as by large tracts. If New England loses 1.2 million acres of forest as projected it will mean losing our ability to absorb the equivalent emissions of 74,400,000 automobiles annually – a loss which will obviously have devastating consequences for the climate. David Foster et al, *Wildlands and Woodlands – Broadening the Vision for New England*

Annually, New England’s forests take up a vast amount of carbon dioxide from the atmosphere, providing the critical service of mitigating climate change. Across the region this storage offsets approximately 20 percent of the total carbon dioxide that is released across New England through fossil fuel combustion. By retaining existing forests and managing them regionally for older, mature conditions, New England’s role in climate mitigation will increase. David Foster et al, *Wildlands and Woodlands – Broadening the Vision for New England*

While national and global action is essential to halt and reverse the course of climate change, local action can make significant contributions to slowing its pace and helping the region absorb its impacts. Keeping our forests intact and managing them sustainably is one of our most effective tools in combating global climate change. David Foster et al, *Wildlands and Woodlands – Broadening the Vision for New England*

Converting forests into housing, commercial development, and sprawling alternative energy developments is likely to exert an even greater impact than climate change on our forests and the ecosystem services they provide over the next century. Development immediately and irreversibly destroys forest ecosystems, whereas climate change only gradually alters forest

composition and function. As a result, unless current circumstances change, development will be the largest driver of the destruction of our forests and the loss of their associated benefits to society over the next century. David Foster et al, *Wildlands and Woodlands – Broadening the Vision for New England*

Carbon Storage

According to the Vermont Department of Forests, Parks, and Recreation, “Trees are carbon sequestration and storage machines.”



Figure 9. Canopy of the mature forest in the Upper Loveland Road project area sequesters and stores carbon.

The need to combat global climate change, secure the benefits to society of nature’s infrastructure, and make our communities more resilient presents a significant opportunity for transforming how we protect and use our region’s land. Standing forests absorb 16 billion metric tons of CO₂ per year. However, the world’s forests also emit an average of 8.1 billion metric tons of carbon dioxide into the atmosphere each year due to deforestation. – [World Resources Institute](#)

To combat climate change here in New England and Vermont, and to make our natural and human communities more resilient, we actually have many effective tools at our disposal:

We can set bold state and regional targets for accelerating forest protection. We can manage our forests ecologically and sustainably while applying sound stewardship to increase ecosystem services. We can implement effective land-use protections. We can build resiliency to climate change by redeveloping built landscapes such as former industrial sites and commercial brownfields instead of healthy forests. We can support healthy human

communities by increasing forest cover and by promoting close interactions with nature. We can help rural communities create economic opportunities, and enhance human health and wellbeing, while sustaining the beauty, ecology, and productive capacity of our surrounding forested landscapes.

We can also reduce our consumption and conserve our resources. Vermont, New England, and the rest of the world have long since reached the limits to growth on a planet of finite resources. Despite the planet's non-negotiable physical limitations, regional and national trends continue towards increased resource consumption and more waste production. Reducing consumption and using land as efficiently as possible lessens impacts on our natural systems and increases our options for meeting future environmental challenges.

Here in Vermont our forests offer the single largest opportunity for cost-effective and immediate reductions of carbon emissions. Unlike solar power, our forests are renewable, self-replicating, and they require no fossil fuel inputs.

Vermonters can create a national model for responsible environmental stewardship in a landscape dominated by private land ownership. Protecting our forests offers a path to personal, ecological, and economic well-being that will benefit everyone in the state and will ensure that Vermont's forests provide vital benefits for centuries to come.



Figure 10. Claw marks of a black bear scar the trunk of a hemlock tree in the Upper Loveland Road project area.