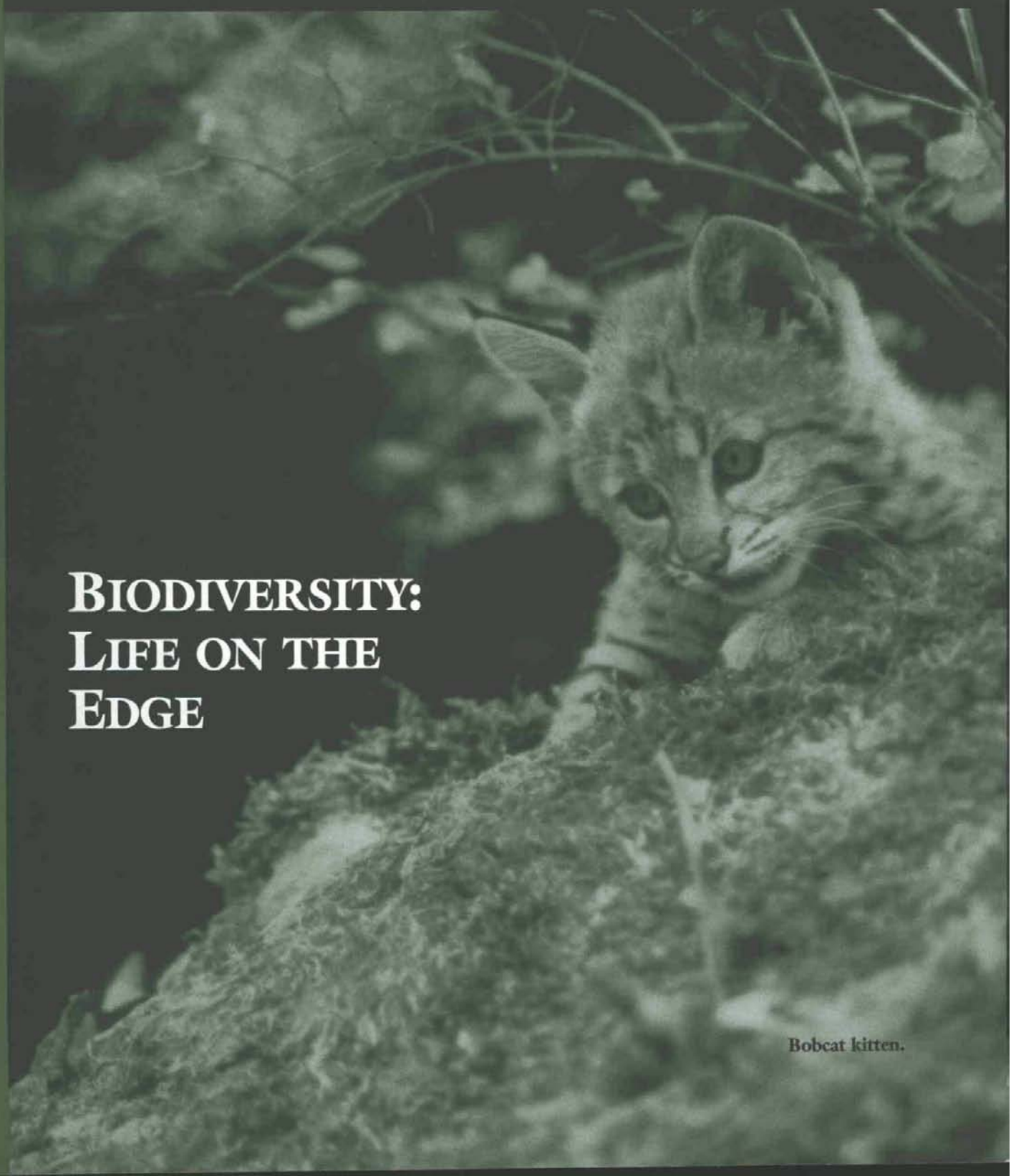
VNRC

Vermont Environmental Report

Published by the Vermont Natural Resources Council, Inc.

BIODIVERSITY: LIFE ON THE EDGE



Bobcat kitten.

Summer 2001

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BIODIVERSITY: THE WEB OF LIFE THAT BINDS US

BY ELIZABETH COURTNEY, Executive Director

It is unbelievable that in the thirty years since the passage of the Vermont Threatened and Endangered Species Act (TESA), not a single recovery plan has been completed for a threatened or endangered Vermont plant, insect, mollusk, amphibian, reptile or fish. It is even more incredulous that there has been no recovery plan for the threatened lake sturgeon, even though it is specifically identified in this hallmark legislation.

Thirty-one years ago, we thought we had it all figured out. The U.S. Congress passed into law the federal Endangered Species Act, along with the Clean Air Act, the Clean Water Act and the creation of the Environmental Protection Agency (EPA). Fast forward thirty years and what do we find? Varying degrees of success and failure in the implementation of each of the statutes and a herculean effort to clean up environmental messes on the part of the EPA.

At the heart of the species recovery planning process nationally, as well as in Vermont, is the reality that the issues surrounding habitat protection are complex and often political. A basic conundrum exists because privately owned lands in Vermont tend to be those with high biological diversity on the one hand, and a correspondingly high development potential on the other. The 19 or 20 percent of Vermont's "higher elevation, managed, conservation" lands do not match up with the "biodiversity hot-spots" of the lower elevation, more developable lands.

This makes for a challenging situation when it comes to habitat protection. The EPA 1999 *New England Regional Report* noted that between 1982 and 1992, 6,500 acres of land per year were lost to development in Vermont. Let us not forget, as Jim Andrews states in the feature article of this issue of the *VER* that "land is not a renewable resource." I think we can all agree that we are not capable of generating new land to mitigate this loss of habitat — habitat which supports the diversity of life.

Unfortunately, certain interest groups, government agencies and individuals believe that we can, with some degree of efficiency, generate new salmon or new sturgeon, and keep other endangered species alive in zoos and botanical gardens, while we whittle away at the habitat that supports these species naturally. We must stop deluding ourselves that it is acceptable to destroy naturally occurring wetlands and other critical habitat to make room for development, as long as we 'replace' the loses through off-site mitigation.

A sustainable approach to maintaining biological diversity requires that we change our behavior in order to avoid unnecessary habitat destruction. Is quadruple bypass surgery a lasting solution to the problem of poor eating and exercise habits? This fix-it-after-you've-blown-it-strategy is a high energy, high maintenance, high cost approach to problem solving, which could be easily obviated by an ounce or two of prevention. Remember your grandmother's admonition, "A stitch in time saves nine?" Preventative maintenance saves time, resources and the habitat that supports diversity. Crises management is always more expensive.

As we learn more about biodiversity, we will no doubt challenge the reasoning of the agencies and administrations who have failed to implement TESA. Their flawed approach has employed the models of specialization and compartmentalization, as opposed to the systems archetype of the biodiversity paradigm.

Peter Senge, in his 1990 treatise on organizational management, *The Fifth Discipline*, describes a systems approach to managing organizations:

"What we most need are ways to know what is important and what is not important, what variables to focus on and which to pay less attention to." We need ways to do this which can help Vermonters develop shared understanding of the problems, not just the symptoms, and their lasting solutions.

Senge notes, "From an early age we are taught to break apart problems, to fragment the world. This apparently makes complex tasks more manageable, but we pay a hidden, enormous price. We can no longer see the consequences of our actions (if) we lose our intrinsic connection to the larger whole."

As Kathy Lambert of the Hubbard Brook Research Foundation (HBRF) explains in this *VER* issue, we cannot understand the consequences of midwestern coal-burning power plants on the viability of sugar maples in Vermont if we do not understand the integrity of the ecosystems that support these trees. We can see, through the work of organizations such as HBRF, the futility of a compartmentalized approach to conservation and ecological restoration efforts. We now realize that if we do not address the whole system, we cannot prevent loss of species diversity.

To make the systems approach to biodiversity conservation work, we all need to participate. The systems approach requires all of us to understand this concept; a logical place to begin is to insist that our elected officials follow through on the long over due implementation of the Vermont Threatened and Endangered Species Act.

I hope this issue of the *VER* will help us all to take one giant step toward understanding biodiversity — the complex and elegant web of life that binds us together.

A BIODIVERSITY CONSERVATION PLAN FOR VERMONT?

BY PATRICK PARENTEAU

Writing in 1853, Zadock Thompson, Vermont's State Naturalist, bemoaned the loss of so much of the state's wildlife heritage to the changes on the land wrought by human hands. The top predators — cougars and wolves — were gone, victims of human ignorance and arrogance. Once plentiful species such as moose, beaver, and wild turkey had been reduced to relic populations that were soon to disappear altogether, along with the Atlantic salmon. It was even hard to find otters in Otter Creek. A biologically rich, complex forest ecosystem, shaped by millions of years of evolutionary forces, had been "simplified" and converted, in a little over a century, to a human-dominated agro-scape.

But then, over the course of the next century and a half, something remarkable happened: the forest came back. Not the exact same forest, of course, but close enough. And with it came the beaver, the moose, the pine martin, and the otter, as well as tantalizing signs that something resembling the catamount of yore may be stalking the green hills. Now the table is set for the return of the wolf — or, to put it in more functional terms, a wild canid capable of bringing down a moose — that could make the system whole again, provided people will give it a chance. Nature has given Vermonters and the other residents of the Northeastern forest a second chance at stewardship of our biological resources, and we would be wise to take advantage of the opportunity.

"Biodiversity" is the somewhat opaque term used to describe the complex web of life that exists on earth. The key concept is variability at all levels of biological organization, from genetics, to species, to natural communities, to ecosystems, to landscapes. Understanding and maintaining the interrelationships of all these living organisms and their physical environments is the key to ethical land use. Aldo Leopold said it best: "The first rule of intelligent tinkering is to save all the pieces." The goal of biodiversity conservation is to save all the pieces, to allow evolutionary processes of natural selection and adaptation to continue while enjoying the many benefits that healthy, diverse ecosystems provide.

With little fanfare, at least 14 states have adopted biodiversity plans and formed councils or other mechanisms to implement them. Others, including Vermont, are in various states of planning. These processes vary greatly in scope, objectives, and methodology, but all share a common characteristic: these are coalition efforts, built on principles of cooperation and collaboration among a wide variety of interests, some of which are not always compatible. Sound science, detailed inventories, and good maps are essential tools. Though public lands have an important, and in some cases crucial, role to play in biodiversity conservation, the real challenge lies in gaining the support and active participation of private property owners. With over two-thirds of the nation's landmass in private ownership, the fate of biodiversity depends on what happens on these lands.

In Vermont, there are a number of efforts underway to address biodiversity issues. The Agency of Natural Resources is developing a "Biodiversity Policy" to guide many of its regulatory and land management programs. The Vermont Biodiversity Project is a coalition effort involving many conservation organizations and the School of Natural Resources at the University of Vermont that is working on a statewide conservation strategy focused on eight "biophysical regions" of the state, such as the Northeast Highlands and the Champlain Valley. The VBP uses sophisticated GIS technology to develop "coarse-grained" maps at the scale required for landscape planning and management. One product of this effort has been the Vermont Conserved Lands Database (See *Summer 2000 VER)*, which shows that about one million acres of the land area of Vermont, comprising 19% of the state, is protected, in varying degrees, from development. This database also indicates that there are a number of "gaps" in protection of biodiversity throughout the state. Effective conservation requires a combination of protection for "core" habitats (like breeding areas), buffer zones, and "biological corridors" to connect core habitat.

Closing these gaps and creating adequate biological reserves is going to require more than inventories and plans; it's going to take money. The major threats to biodiversity are habitat loss and invasive species. Regulatory programs like the federal Endangered Species Act and the Vermont Threatened and Endangered Species Act do not deal very effectively with these problems and do nothing to prevent endangerment in the first place. Likewise, Act 250 and local land use controls are not adequate tools for landscape level protection. And though some property owners may be willing to manage their lands for ecological sustainability, it would be naïve to base an entire strategy on that assumption. The reality is that most property owners are going to expect to be paid something to forego development opportunities to preserve habitat, and the clear trend in the law is towards

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REMOVING OLD DAMS MAKES SENSE

Partnering with the Hardwick Electric Department and the Town of Hardwick, VNRC is working toward removal of the Jackson Bridge Dam. The dam is located on the Lamoille River just outside downtown Hardwick. It has no power generating capability and provides only nominal storage benefits for the downstream hydroelectric facility in Wolcott.

In many cases across the country, river restoration through dam removal has been a preferred alternative to maintaining aging dams that have outlived their usefulness. These old dams often create flood and safety hazards. In the case of the Jackson Dam, future upkeep and maintenance of the dam is the responsibility of the Electric Department and its ratepayers. Expenses to refurbish the dam may cost hundreds of thousands of dollars. That is the main reason the Electric Department and the Town are examining the dam removal alternative. Across the country, dam owners have found that removal is the cost effective alternative, and provides numerous environmental and public benefits.

Removal of Jackson Dam will create fish passage up into the Lamoille River headwaters and improve water quality. Currently, reservoir drawdowns, which occur several times a year, cause releases of sediment downstream degrading fish habitat. The shallow impoundment also heats up the river substantially, a major problem for cold-water trout throughout the Lamoille River.

Peterson Dam

Dam removal will also create opportunities for public access for Hardwick and the surrounding communities to the Lamoille River. And it will create educational opportunities for local school children to participate in science and field based projects.

Many partners are working together to make this project a success including the Lamoille River Anglers, the Vermont Agency of Natural Resources, the U.S. Fish & Wildlife Service, the Natural Resources Conservation Service, the U.S. Army Corps of Engineers and the Vermont Dam Evaluation Task Force.

VNRC: STILL FIGHTING FOR THE LAMOILLE

Yes, VNRC is still embroiled in negotiations about the future of the lower Lamoille River. For some time now, VNRC, Trout Unlimited, the State of Vermont, CVPS and the town of Milton have been at an impasse in discussions on the future of Peterson Dam and conditions under which the State would issue certification of CVPS' federal license. The license has been expired for 14 years now, but the facility continues to operate under annual licenses issued by the Federal Energy Regulatory Commission.

VNRC, TU and others have pushed their interests about the effect of the Dam on water resources and aquatic species, including Lake Sturgeon, walleye, and Atlantic salmon, several species of state-threatened mussels, as well as recreation and land use issues, that would include alternatives for Peterson's removal.

CVPS and others have raised alternatives to restoration of near-natural conditions in the Lamoille that relates to Peterson's continued existence and enhanced conditions for targeted aquatic resources in the Lamoille River and Lake Champlain eco-region, as well as electric power system capacity and reliability concerns for the area.

With any luck, the parties will soon come to some agreement about these difficult issues, and the lower Lamoille River will be improved for all Vermonters.

VNRC'S WETLAND RECLASSIFICATION INITIATIVE

Wetlands are some of the richest and most diverse ecosystems on earth, hosting vast communities of plants and animals. In addition to providing critical habitat for innumerable species, wetlands also function as nature's filters, removing a variety of water borne pollutants. In spite of these benefits, 35 percent of our historic wetlands were destroyed by 1988. Between 1990 and 1998, Vermont lost approximately 260 more acres of wetlands, with an additional 330 acres damaged, due to unauthorized dredging and filling. State permitting to fill wetlands is up by more than 500 percent since 1990. These figures do not include the loss or impairment of semi-permanent, or vernal, pools – temporary or seasonal wetlands that provide critical habitat, especially in the spring breeding season, for amphibians, fish, and migratory birds – nor wetlands that are not yet identified and included in state wetland inventories.

Since the passage of the Vermont Wetland Rules, however, only two wetlands have been designated Class One. The first Class One designation took place in 1991. The second occurred in September of 2000 when VNRC successfully argued that the Northshore Wetland in Burlington should be reclassified as a Class One wetland, and that a buffer zone of three hundred feet around the wetland was necessary to protect the wildlife and migratory waterfowl. With only two wetlands in the state protected under this designation, virtual-

ly all of Vermont's high quality wetlands are vulnerable to minimal protection from draining, development, and degradation. VNRC has embarked upon a project to increase protection of all existing wetlands by reclassifying more of Vermont's high quality wetlands to guarantee that each wetland receives the protection it deserves. Keep your eyes peeled for further developments on this front in the coming year.

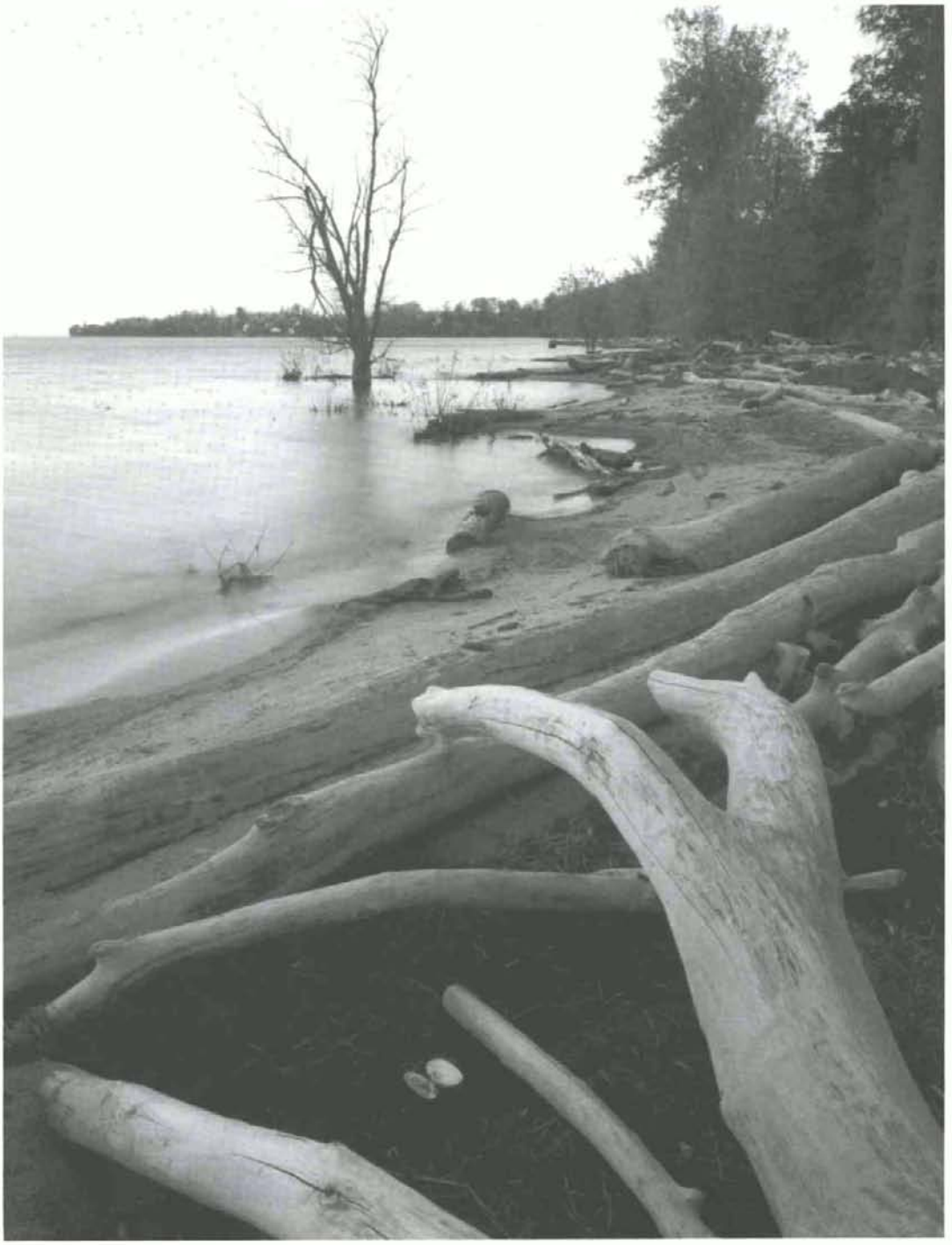
DIM THE LIGHTS!

While Vermont's General Assembly spent some time reviewing a host of bills relating to consumer awareness of energy sources, renewables and conservation (see VNRC's June 2001 Legislative Update), the power issue ignited at the federal level this spring.

The first sign of trouble came with the new Administration's budget request, which cut in half research and development dollars for energy efficiency and renewables. This was followed by the breaking of a campaign promise by President Bush, when he refused to regulate carbon dioxide, a principle cause of global warming. This retraction was followed by the Bush Administration's refusal to move forward on the Kyoto Protocol, an international agreement to reduce greenhouse gasses. Finally, the Administration issued its supply-side Energy Plan, which ignored numerous federal studies which strongly encouraged aggressive energy efficiency (see Winter 2001 *VER* interview with Rich Cowart), and, if employed by the federal government alone (the nation's largest power user) would cut Vice President Dick Cheney's call for 1,300 new power plants in half.

With the recent shift in power in the United States Senate, it now seems likely that the Bush Energy Plan will run into many obstacles. There is renewed hope that Senator Jefford's "Four Pollutant" bill (which would drastically reduce emissions of nitrogen oxides and sulfur dioxide, and for the first time regulate carbon dioxide and mercury) will receive the attention it deserves.

If you would like to help New England get its mouth off the tailpipe of the nation, be sure to write to your congressmen and senators, and support this bill!



Northshore wetland, Burlington, Vermont

GREEN TAX INITIATIVES TAKE ROOT

Following the successful December conference with the Vermont Law School, "Are Green Taxes a Solution for Pollution?", VNRC and the Vermont Fair Tax Coalition have redoubled their efforts to "green" Vermont's tax system and shift taxes away from things we want to encourage – like clean renewable energy – and toward things we want to discourage – like pollution. Initiatives are now underway in three areas: encouraging sustainable land use; reducing water pollution; and encouraging renewable energy and energy efficiency.

To encourage sustainable land use, VNRC is directing its efforts on tax incentives for downtown revitalization. The Downtown Bill currently before the legislature contains provisions for enabling municipalities to use land value taxation, levying a higher rate on vacant downtown land and a lower rate on buildings and improvements, so as to encourage higher use and development of downtown properties. Also under consideration is a land gains tax exemption for downtown property.

VNRC is also looking at ways to extend the current use program beyond farm and forest land to unique natural areas and habitat for threatened and endangered species, for example. Including these lands in the current use program will help reduce sprawl by encouraging more landowners to keep valuable open space land undeveloped.

To reduce water pollution, the Coalition is proposing to remove the sales tax exemption on pesticides and fertilizers used for non-agricultural purposes.

Coalition energy initiatives include tax credits for renewable and efficient energy investments and production and a sales tax exemption for renewable and efficient appliances and products. We are also working to implement a tax credit for alternative fuel vehicles.

A NEW PLANNING TOOL FOR COMMUNITIES

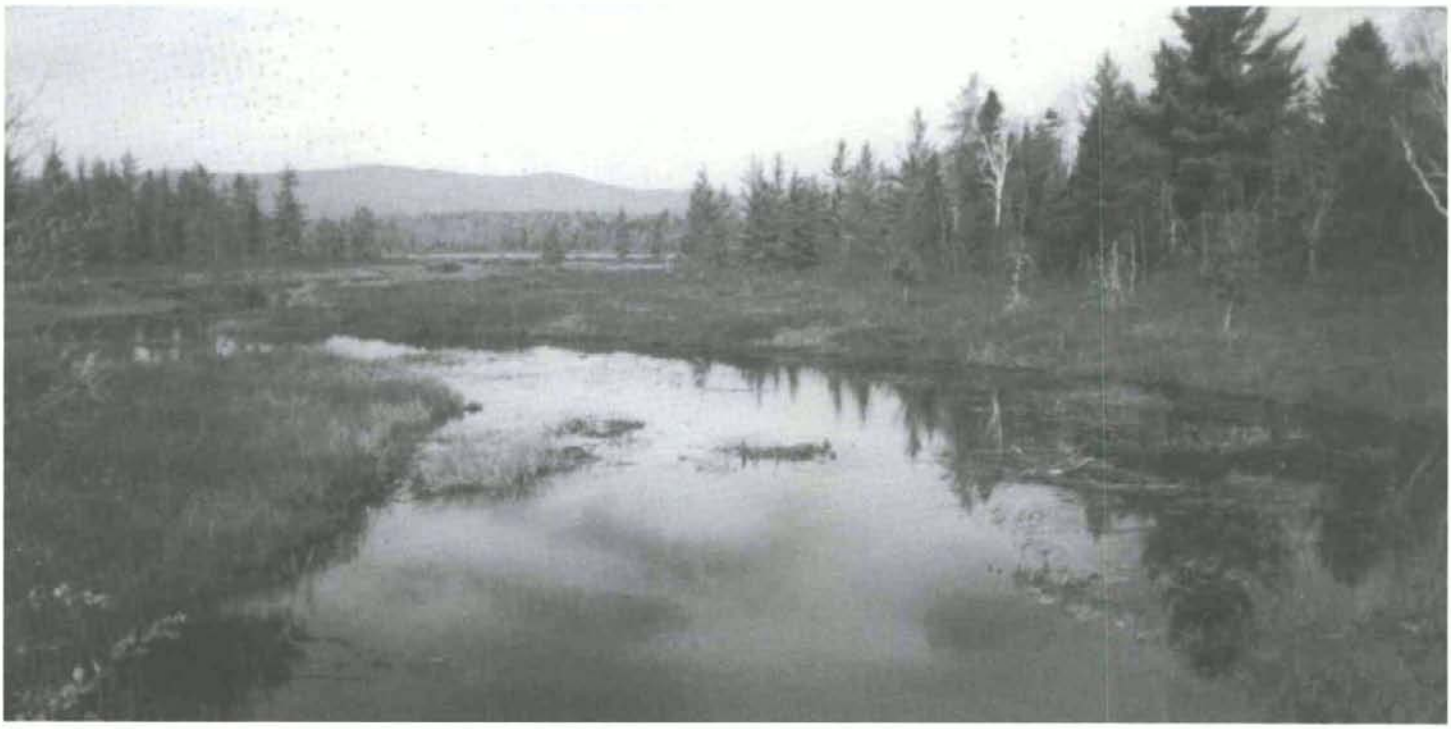
VNRC is partnering with the Vermont League of Cities and Towns on a study of the tax implications of growth under Act 60. The report, due to be published in 2002, updates the popular joint report by the two organizations published ten years ago – "The Tax Base and the Tax Bill." It is hoped that the new report will become a useful tool for communities in analyzing the fiscal impacts of development. It should enable communities to focus attention on the cumulative, long-term impacts of development, and to adopt new patterns of land use planning that will enhance environmental quality, fiscal responsibility, and community well-being. VLCT and VNRC are planning to meet with selected groups of towns and regional planning commissions this fall to review drafts of the report.

Please call VNRC for more information.

FORMER CHAMPION LANDS UPDATE

Nulhegan Waters

Good news- Summer 2000 Agency of Natural Resources Water Quality Division data collection in the Nulhegan



Nulhegan River

River system buttresses VNRC's rationale for 1998 petition to designate the river, its tributaries, and associated wetlands as Outstanding Resource Waters (ORW).

"The Agency sampled fish and macroinvertebrate communities in over 30 sites throughout the watershed," said Kim Kendall, VNRC Staff Scientist.

One of the best ways to measure water quality is to examine stream macroinvertebrate and fish communities, that is, the numbers and types of aquatic organisms sampled in a stream. Some organisms are sensitive to various types of pollution and habitat degradation.

"These data confirm that the river and its tributaries are in good to excellent health," said Kendall.

While a vast array of studies had been conducted on the wetlands in the Nulhegan watershed, the Agency of Natural Resources had completed only limited data collection on the river mainstem and tributaries prior to their summer 2000 sampling.

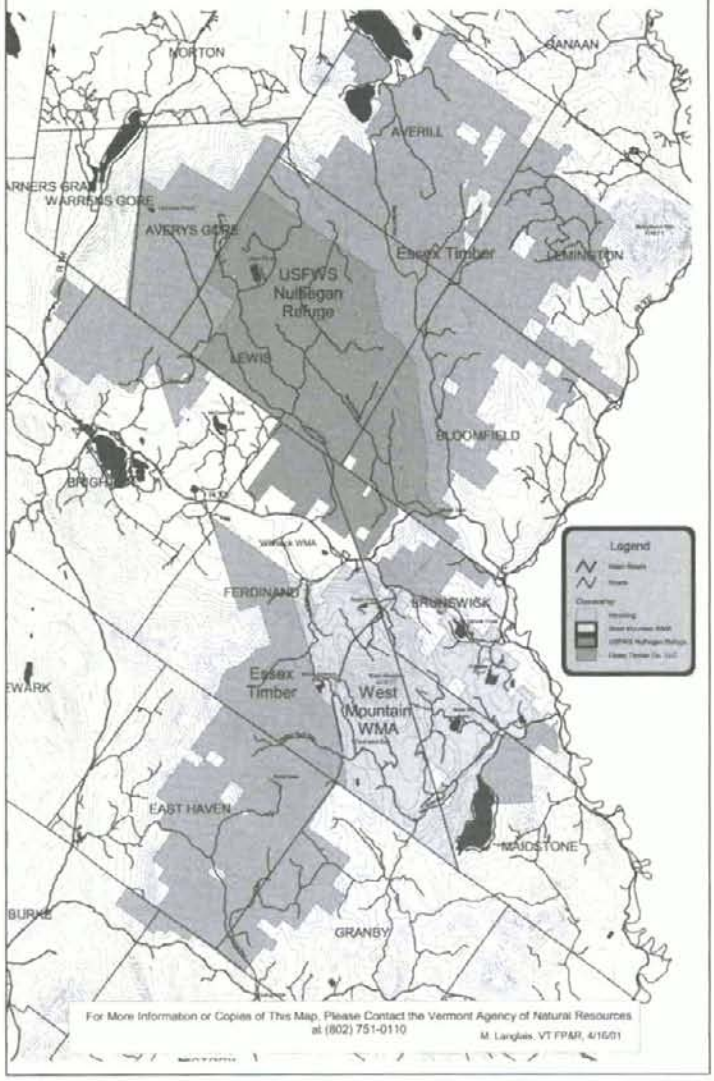
The issue of sufficiency of data on the rivers led to VNRC's withdrawal of the ORW petition in 1999. "We believe that the Water Quality division's data collection confirms our initial analysis in 1998," said Kelly Lowry, VNRC Water Program Director. "The Nulhegan system is Vermont's most ecologically intact watershed. This fact should not be lost in the complexities surrounding the management planning in the former Champion lands. We are currently evaluating a return to the Water Resources Board with our revised petition, to assert that Vermont's last free-flowing river system be protected and maintained as an ORW."

West Mountain Wildlife Management Area

Planning for the future of the West Mountain Wildlife Management Area (WMA) (the 22,000 acre parcel of the former Champion lands owned by the state of Vermont) is well underway. In July, the Champion Lands Steering Committee held two public meetings to share information on the progress thus far in the planning effort. The committee was also soliciting input from the public on key topics, including the management direction that is being considered for the West Mountain WMA. Additionally, public imput is being requested for access and recreation plans covering both the state and private parcels.

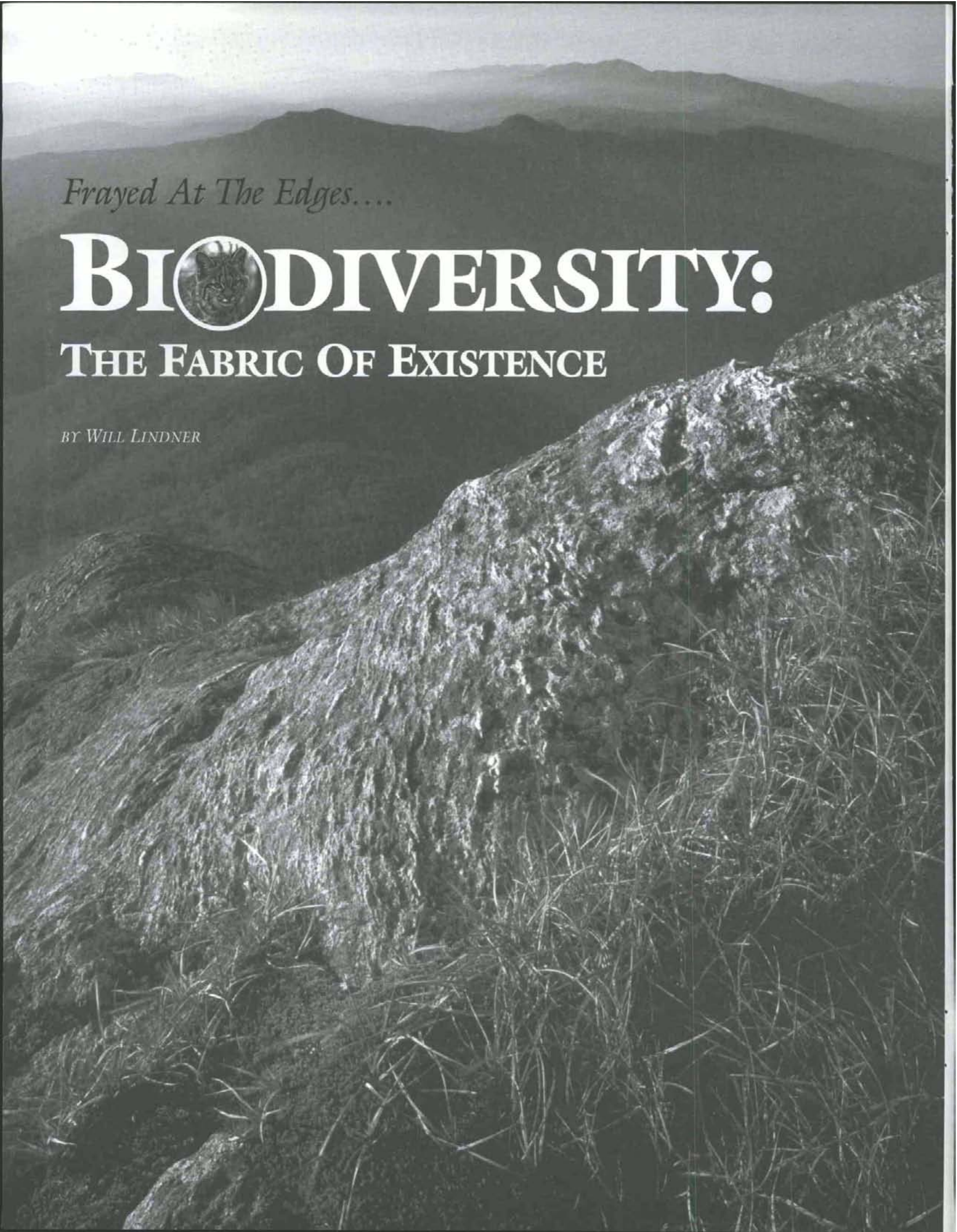
West Mountain, owned by Vermonters, makes up one sixth of the entire 133,000 acres (thanks to the Mellon Foundation, which generously contributed $4.5 million). The conservation easement covering West Mountain WMA outlines the primary purposes under which the property will be managed: 'conservation and protection of biodiversity, wildlife habitat, natural communities and native flora and fauna, and the ecological processes that sustain these natural resources'. In light of the recent pre-draft public meetings, it is very important that VNRC members write to the Agency of Natural Resources (ANR) to show support for the greatest degree of ecological protection on West Mountain.

WEST MOUNTAIN WILDLIFE MANAGEMENT AREA AND OTHER FORMER CHAMPION LANDHOLDINGS



The draft management plan for West Mountain WMA is expected in September. Once released, the Steering Committee will be holding public meetings around the state to solicit public input. While the "pre-draft" public comment period closed on July 15, you can always email your comments or questions to eleary@fpr.anr.state.vt.us at the ANR. Do yourself, and our public lands, a favor by reading the detailed planning documents on the web site noted below. We'll need your help in the fall when the public must turn out to show support for the protection and long term ecological recovery of West Mountain WMA. Please call VNRC if you have questions or comments.

For detailed information about the West Mountain WMA, including information about ecology, access, and recreation planning for the "Former Champion Lands," go to: www.state.vt.us/anr/fpr/lands/westmt/index.htm.

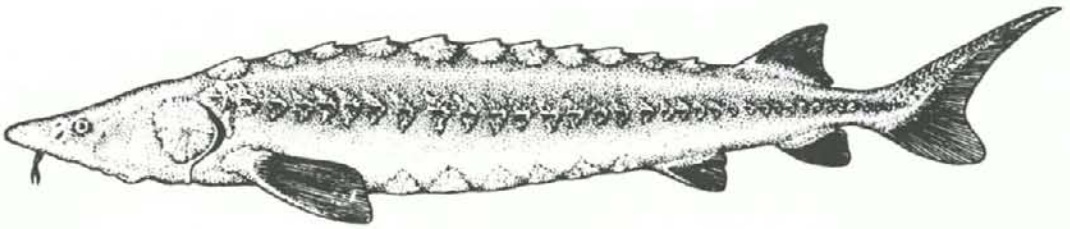


Frayed At The Edges....

BIODIVERSITY:

THE FABRIC OF EXISTENCE

BY WILL LINDNER



If there is such a thing as permanence, then the land we inhabit is permanent. It predates us by millions of years, and the chances are great that the land will remain, perhaps millions more years, after we are gone.

Twenty thousand years ago Vermont was covered by a glacier that extended well into the North American continent. Perhaps a mile below the surface of that glacier, and frozen beneath its immense weight, lay the present-day Lake Champlain and the areas that would become the settled communities on the lake's eastern shore. With a change in climate, the glacier began melting and retreating toward the Arctic, a process that took thousands of years and unleashed torrents of water across the newly exposed, radically disarranged surface of the earth. The depression we call the Champlain Valley became a vast lake, much larger than the lake we know today.

As the glacial melt plummeted from the highlands into that original reservoir (which modern scientists call Lake Vermont), it carried rocks, boulders, soil and sand. The heavier objects rolled to a stop as the riverbeds flattened out, but the finer materials remained suspended in the water until it reached the quelling lake. Then those materials, too, dropped and settled, fanning out at the mouths of the rivers and forming "sand plains."

The process was fairly complete by 13,500 years ago. For a relatively brief period (about 2,500 years) Lake Vermont became a salt sea, watered from the Atlantic through the glacially depressed St. Lawrence Valley, but eventually the basin and ocean were separated again and a freshwater lake — our Lake Champlain — was formed. This newer lake lay in a smaller basin, so the sand plains from earlier millennia now lay inland from the lake.

In time they became forested and evolved into a distinct "natural community" (defined by Vermont scientists and authors Elizabeth Thompson and Eric Sorenson as "an interacting assemblage of organisms, their physical environment and the natural processes that affect them"). Oak and pine species flourished, along with heath, in an environment that hosted, as Thompson and Sorenson write, "a disproportionately high number of rare (plant and herb) species, perhaps more than any other natural community" in Vermont.

Meanwhile, wetlands were forming in the low-lying areas adjacent to the lake and its riverine tributaries, and these too became "natural communities" of exceeding diversity — a characteristic they retain to this day. Sorenson and Thompson, in their book, *"Wetland, Woodland, Wildland; A Guide to the Natural Communities of Vermont"* also write about these: "Of the 153 threatened and endangered plant species in (Vermont), 54, or 35 percent, are closely associated with or are found exclusively in wetlands."

The same holds true for animal species — the mammals, birds, reptiles, amphibians, fish, mollusks, insects and amphipods that depend on wetlands. Twenty-one percent or nine of the 42 species classified as threatened and endangered in Vermont, live in or depend largely upon these areas.

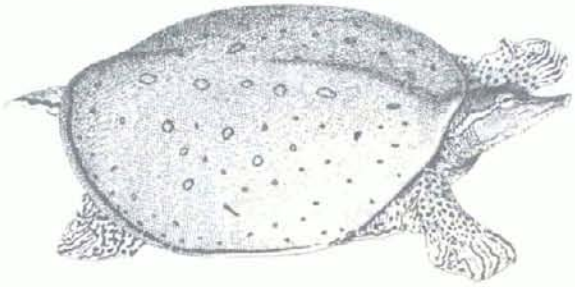
Eventually human inhabitants arrived in the Champlain Valley. For some thousands of years they lived harmoniously with the sand plain and wetland environments, but in the long run their arrival signaled bad tidings for these sensitive natural communities, which are emblems of the very formation of our continent. The land once frozen beneath the glacier became Chittenden County and its component parts — places like Burlington, Colchester, Essex and Williston. Like Americans everywhere, the citizens of those communities came to think of wetlands merely as "swamps" — messy flaws of nature — so they filled and dredged them to build subdivisions and highways. The 300-acre Munson Flats wetlands in Colchester, for example, are now

Lake sturgeon
State Endangered

Overfishing, dams and habitat degradation have depleted the once-plentiful Lake Champlain population.

Western chorus frog
State Endangered

This frog once existed over much of Grand Isle and Franklin Counties. Recent declines are dramatic and mysterious with only two frogs located in Alburg in 1988 and 1999.



Spiny softshell turtle
State Threatened

The Eastern spiny softshell turtle is sensitive to pollution and found only in Lake Champlain's larger northern tributaries.

To inventory every parcel of Vermont's natural environment and its myriad inhabitants, the Non-Game and Natural Heritage Program has a full-time staff of five.

bisected by asphalt.

Likewise, the sand plains became a prime site for development. Housing was plopped into the area to take advantage of desirable conditions for septic systems, and the sand plains began their descent into oblivion. They once covered some 15,000 acres in the Chittenden basin, but have dwindled to 650, highly fragmented, acres. The final straw could be the Circumferential Highway — Vermont's answer to Boston's "Big Dig" — which the state Agency of Transportation has been constructing, piecemeal, since 1982.

The 'Circ' represents an attempt to build our way out of the traffic congestion that we have built ourselves into. But the price, said Bob Popp, could be the ultimate loss of sand plain habitats.

"They've already been carved up (into) four areas," said Popp, a botanist with the Vermont Non-Game and Natural Heritage Project. "The 'Circ' is going to skirt around the second-largest parcel and go right through the middle of the third-largest parcel."

If the segmented highway finally comes together, the sand plains that link us to the last Ice Age will slide into virtual disintegration. We will have accomplished this feat of mismanagement in just a couple of hundred years — a nanosecond in geological terms.

EACH STRAND MATTERS

One might reasonably ask what of value is lost when 15,000 acres of sand plain is pared to 600 disjointed acres, or when "swamps" — inhospitable to human beings — are altered for domestic or agricultural use. (More than one-third of the state's historic wetlands are now gone).

The answer lies in the dozens of rare plants — yellow panic grass, slender mountain-rice, long-spiked three-awn, whorled milkwort — found in these communities. With each one on the verge of vanishing, we stand to lose a strand from the tapestry of our Vermont environment.

And each strand matters. The strands provide the biological diversity that sustains life on the planet, including ours, and we discard them at our peril. Scientists agree that "biodiversity" is essential for providing our fundamental needs, including breathable air and potable water, food, natural flood control, genetic materials for medicines, open areas for recreation, and even spiritual sustenance. Famed biologist Edward O. Wilson once described biodiversity as the world's "most valuable but least appreciated resource."

The Vermont Natural Resources Council has recently launched a comprehensive effort, with two important partners in Vermont's conservation community, to protect and restore native species and natural communities to which their survival is linked. In addition to VNRC, the Vermont Biodiversity Collaborative includes the Conservation Law Foundation (CLF) and the National Wildlife Federation's Northeast Natural Resource Center (NWF). The three organizations are working to raise the public profile of biodiversity — by educating their members and others about the importance of this widely encompassing concept and seeking to incorporate expanding scientific understanding to enforce existing laws — thereby establishing effective protections for biodiversity.

It's easy to take biodiversity for granted; many people don't even know what the term means (a public survey once indicated that people assumed it was some strategic military weapon).

That's an important place to start.

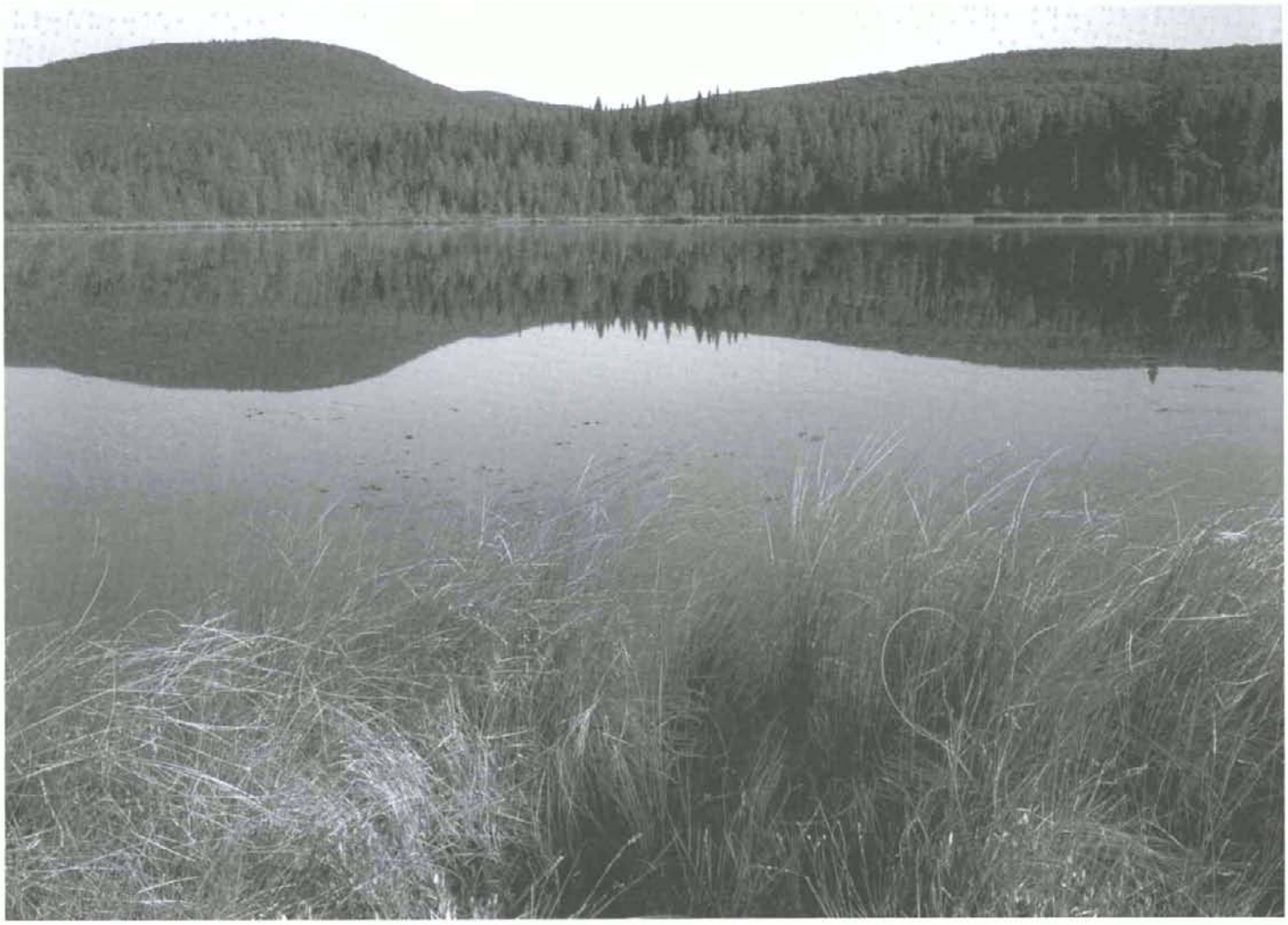
"In making biodiversity conversation a dinner-table topic, we take a step forward in protecting the natural assets of Vermont," said Job Heintz, VNRC Director of the Forest and Biodiversity Program and staff attorney.

With many people only dimly aware of the concept of biodiversity, we are seldom cognizant on a personal level when species actually cease existing. The losses, and their cumulative effects, are subtle. An example is a river system affected by hydropower. In the riparian boundaries of the impoundment (above the dam), and in the streambed below, the only species that survive are those like caddis flies and worms, which can tolerate severe fluctuations of water level. Mayflies and other more sensitive species disappear. The ecosystem becomes less complex and less productive.

Unimpacted by the development of human communities, the natural world is richly diverse. But as humanity encroaches — directly, by developing wild lands, or less directly by building logging roads deep into the woods or severing connectivity between large blocks of protected lands — species flee or thin out, and indigenous natural systems become oversimplified.

In the extreme, ecosystems literally die. Even systems that still appear to exist may have lost their pulse. CLF attorney Chris Kilian is particularly dismayed at the condition of formerly healthy lakes in New York's Adirondack Mountains, where the waters are empty. The lakes were ruined by acid precipitation from midwestern power plants. It's a lesson, Kilian says, that needs to be burned into our consciousness.

"Twenty years ago people were saying, 'It looks like those lakes are dying.' Now," said Kilian, "you can go to dozens of lakes that had thriving trout populations but are absolutely sterile."



Blake Gardner

Moose Bog, Ferdinand Township, Vermont. Listed in the Fragile Area Registry.

Acid rain doesn't respect state borders. Vermont lakes and ponds, such as Somerset Reservoir and Haystack Pond, are facing the same peril, and a new report, "Acid Rain Revisited," published by the Hubbard Brook Research Foundation, reveals that the high-elevation forests around those waters might be the next to succumb. (See the interview with Hubbard Brook scientist Kathleen Lambert in this issue of the *VER*). Damage to red spruce has long been observed, but if failing regeneration and productivity of Pennsylvania Sugarbush is any indication, Vermont's prized sugar maples are also at risk. Acid precipitation doesn't just bathe leaves and needles in a cloud of poison; even more ominous is its effect on the chemistry of forest soils. Altered by metals and other deposits from the acid atmosphere, the soils fail to nourish, and in fact impede the growth and reproduction of valuable tree species.

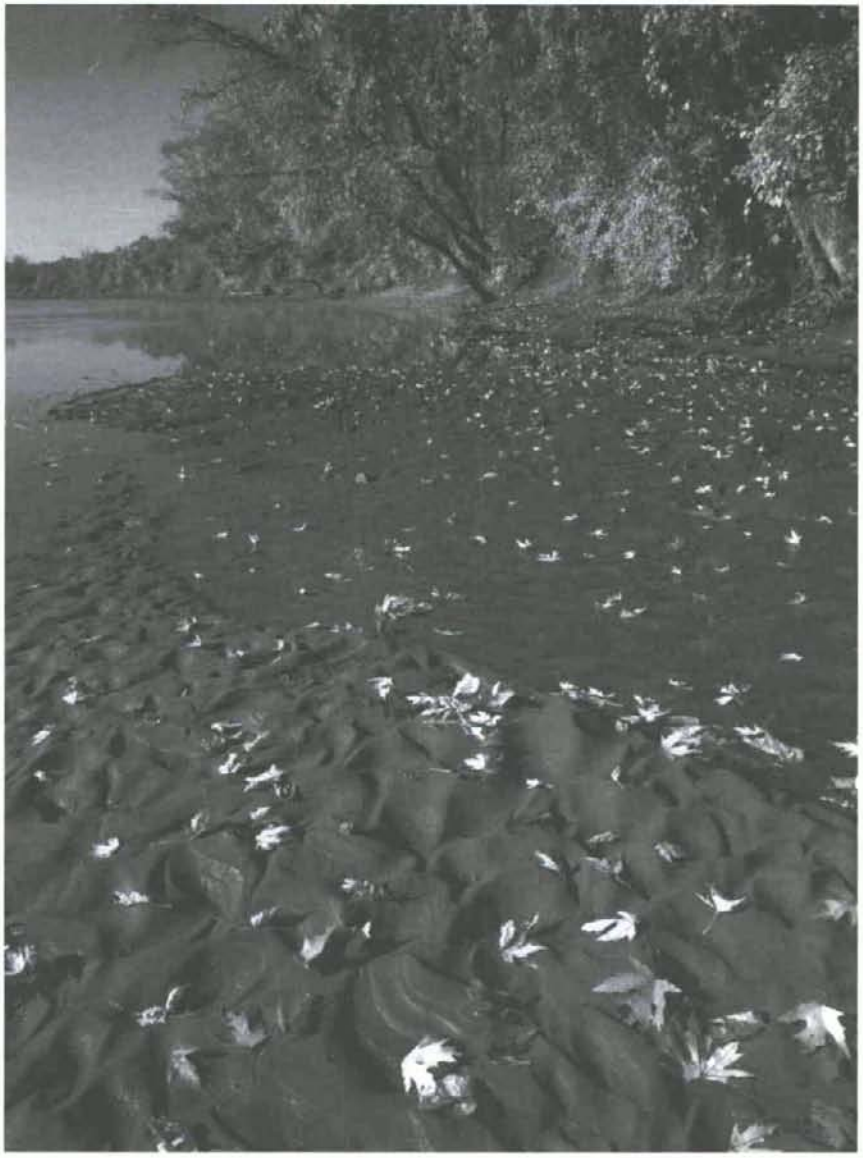
Lose the trees and you sacrifice animal populations. The fabric of existence further unravels.

"Losses of species are tragic," said Kilian. "They represent an irreversible loss of something that is beyond our power to really understand, but which has an inherent value that most people appreciate intuitively."

It is possible, though difficult, to craft an appreciation of biodiversity that surpasses the intuitive and aesthetic, and speaks the sacred language of the "bottom line."

"We tend to discount biodiversity and ecosystem functions in cost-benefit analyses," said Rick Paradis, director of the Natural Areas Center at the University of Vermont. "How do we price clean air? But a study performed by an ecological economist attempted to put a price value on such functions, and they came out quite high. Those values, applied to a parcel of land, can far exceed the one-time value of resources that are extracted and sold."

Ultimately, though, the will to tread carefully in the world requires embracing a vision of the planet's limits. It's an ecological vision that needs to be reduced to a local plane. We know that wetlands must be separated from human activity if they are to thrive and perform their natural functions



Connecticut River

(including functions valuable to humanity in a very practical sense, such as natural flood control and water filtration.). But as VNRC Water Program Director Kelly Lowry observed, we have a hard time giving them the distance they need.

"Different species found in wetlands have different thresholds," said Lowry, "but most studies support a 300-foot buffer, as a minimum, to protect breeding waterfowl. Under the pressures of development it's tough to retain that kind of buffer, but education is a big piece of the collaborative project — reminding people of the importance of maintaining the wetland diversity that's there."

VNRC doesn't intend to leave it to chance. Lowry said one thrust of the Vermont Biodiversity Collaborative will be to seek to increase protections of these natural areas through the state's wetland rules, administered by the Vermont Water Resources Board. Those rules provide three classifications of wetlands, with Class One being the most protected and Class Three being little more than a recognition that the wetland area exists. The size of the mandated buffering area is a component of the rules.

"There are only two wetlands in the entire state that have the Class One (status)," said Lowry. (Indeed, there was only one until VNRC petitioned successfully last March to have the Northshore Wetland, near the mouth of the Winnoski River, so-designated.)

VNRC and its partners will seek to step up wetlands conservation by appealing for increased use of the Class One and Class Two designations. Said Lowry, "These areas should be recognized as irreplaceable and exceptional in Vermont's natural heritage."

COLLECTING INVENTORY

Fully appreciating the biodiversity that surrounds us is a demanding exercise of the human imagination.... there are so many plant and animal species, such biological and geological complexity.

An important first step is to translate the seemingly infinite into the perceptibly finite. If we can somehow quantify nature's contents, we can keep track of them and measure humanity's effect for good or ill.

This work — Herculean even in Lilliputian Vermont — has been shouldered by the Vermont Non-Game and Natural Heritage Program. Originally chartered in all 50 states by the Nature Conservancy, Vermont's program was subsumed in 1989 by the state Agency of Natural Resources (ANR), and now resides within the Department of Fish and Wildlife.

For this perhaps most-daunting of ecological efforts — identifying and inventorying every parcel of Vermont's natural environment and its myriad inhabitants — the Non-Game and Natural Heritage Program (NGNHP) has a full-time staff of five.

That's five.

With exceptions as rare as some of the species it charts, the NGNHP receives no state funding. The considerable public revenues generated by hunting and fishing licenses go to tending the tiny minority of species that people can hook and shoot. NGNHP gets its money primarily from the "chickadee checkoff" — the voluntary contribution some Vermonters make when they file their state income taxes.

For the most part, though, it is money enough, said NGNHP Director Steve Parren (whose duties, besides administering the $400,000 program, include inventorying and monitoring Vermont's entire populations of non-game birds, mammals and turtles).

"We're more limited by the size of our staff than by money," said Parren.

He can't add staff because the Legislature must approve such additions, and at budget time the Non-Game and Natural Heritage Program doesn't seem to make it onto the Administration's priority list, or the State House's radar screen. Parren therefore supplements his staff with short-term contractors and volunteers, and he can hire temporary assistants. But it's hard to maintain continuity and accountability when adjunct staffers are readily lured away by real jobs that offer real benefits.

To sort and examine the pieces of Vermont's environmental puzzle, locate, identify and quantify virtually every element of Vermont's natural environment, the NGNHP has refined its tactics. Formerly, it performed countywide inventories, looking for rare species.

"Now," said Popp, "our focus is on natural-community inventories. We look for a type of natural community, repeated around the state, and assess their condition. This year it's red maple swamps. When we're done we can say, 'These are the best or the worst red maple swamps in the state, for these reasons.'"

To the extent possible — a variable dependent upon landowner cooperation — the research includes private as well as public lands. This comprehensive information can then be used by state and federal agencies in their resource-conservation work, and by private organizations like the Nature Conservancy for making land-acquisition decisions. Theoretically at least, trouble spots are identified and their stressed species rescued, and "hot spots" — healthy, functioning environmental systems that represent the best nature has to offer — can be protected.

Focusing on natural communities provides what Eric Sorenson, a zoologist with the Natural Heritage Program and co-author of *"Wetlands, Woodlands, Wildlands,"* calls a "coarse filter" approach to protection and conservation.

"There are so many species that we can't begin to understand the life histories of all of them," said Sorenson. "Some of them we don't even know. The coarse filter hypothesis is that if we protect the high-quality, most apparent examples of natural communities, in settings where the forces of nature can dominate, we are likely to (protect) most, though not all, of the total species that are present."

This is one of the great benefits of defining subsets of the environment, like the 80 natural-community types defined by Sorenson and Thompson, which are given names like Seep, Serpentine Outcrop, Rich Fen, Lakeside Floodplain Forest and Black Spruce Swamp. They present an ordered way to inventory plant and animal species, and a barometer by which the health of individual sites can be measured.

Such a system, given the state's attention and support, might have enabled New York to save its Adirondack lakes at the first sign of decline of trout, toad or even invertebrate populations.

'Not covering the bases'

But there lies the rub. This comprehensive classification system is only as valuable as the commitment to protection that it inspires. Despite their efforts — which are applauded and praised by Vermont's advocacy and conservation community — Parren, Sorenson and Popp do not feel they've made the necessary inroads into Vermont's consciousness.

"Our program is so small that we're not covering all the bases," said Popp. "We're supposed to be doing monitoring (of species) in addition to inventorying, trying to get back to sites to see how species are doing. But we're always behind. Usually I only get out (to investigate species losses) after the fact.

"What we end up doing in this program, basically, is documenting the loss."

To VNRC's Heintz, the image of these biologists, zoologists and botanists simply documenting the extinction of plant and animal species is intolerable. In addition to public education about the importance of biodiversity, Heintz' priority for VNRC is to hold the state accountable to conservation laws already on the books — particularly the Vermont Threatened and Endangered Species Act (TESA) — and to ensure that the state provides adequate staff resources to catalogue and protect rare and/or endangered species.

"A recent Vermont Fish and Wildlife document states plainly that 'there are no staff or funds committed to implementation of the Endangered Species Law,'" said Heintz. "In our view, the single most-pressing conservation need rests in fully funding and fully staffing the Non-Game and Natural Heritage Program. NGNHP has to go from month to month, hunting and pecking just to get the inventory work done.

"It's bad enough that TESA exempts agriculture and forestry, two major sources of habitat degradation. But add to that the administration's failure to implement TESA, and you have a horrible situation both for the people and the natural heritage of Vermont. The lawmakers of 30 years ago, who said these species ought to be protected, should be outraged.

"The bulk of the energy spent has been on just listing the species that are on the brink. The state has categorically failed to stop the decline of species before they become threatened with extinction."

There are 194 species listed under TESA, yet no regulatory mechanism exists to effectively deal with recovery of these species. To date, Heintz said, the ANR has drafted just five plans — for the peregrine

Dwarf wedgemussel
Federally Endangered

Found only in the Connecticut River drainage. Freshwater mussels are considered the most endangered group of animals in North America.

...it's hard to maintan continuity and accountability when adjunct staffers are readily lured away by real jobs that offer real benefits.

Calypso orchid
State Threatened

The Calypso orchid is found in mature, cold cedar swamps in northeastern Vermont.

falcon, the loon, the pine marten, the osprey and the common tern.

"Not a single recovery plan has been completed for plant, insect, mollusk, amphibian, reptile or fish species. Considering that more than 150 species on the lists are plants, the situation is definitely grim," said Heintz.

"So far (recovery) has been done species by species. Without a formal planning process, including public involvement, there is no administrative mandate for conservation and recovery plans to be initiated in the first place, and thus there is no methodology for providing species with a legally enforceable guarantee of survival.

"The state needs to take the initiative to design a strategy that will lead to the eventual restoration, maintenance or delisting of these species. We recognize that this is a big job, but we're trying to encourage the agency to do what it's supposed to do. We know they can't do all 194 species at once; they will have to prioritize. We've had suggestions about that, and about tax incentives that will encourage the support of landowners. The fact is, though, that the opportunity — the obligation — to protect endangered species and fragile, natural areas has been sitting in the books for decades while Vermont continues to experience sprawl that only acts as a deterrent to comprehensive action.

Other legal strategies for VNRC and its Biodiversity Collaborative partners to pursue include pressing state agencies, of every ilk, to reveal how they have historically complied with the TESA.

"The agencies are supposed to review all the programs they administer for consistency with conservation goals," said CLF's Chris Kilian, noting that he was concerned that some agencies and departments might not even be aware of that obligation. "We're going to file requests for information about their compliance. Then we'll see what we get."

If the agencies are not responsive, the next venue could be Vermont Superior Court, where the collaborative could ask the court to enjoin agency activities until they cooperated.

"The state has categorically failed to stop the decline of species before they become threatened with extinction."

Job Heintz

MATH AND THE MASSES

However, the march of sprawl and Vermont's patterns of development present a real conundrum for any protection initiative we might undertake. Vermont owns some 300,000 acres of land, and the federal government owns more in the Green Mountain National Forest. Managers of those areas are incorporating the inventory work done by the NGNHP and the Vermont Biodiversity Project (which links the resources and expertise of the Nature Conservancy, academic ecologists, state environmental officials and others).

But to turn the corner and make Vermont a place where bio-protective policies impact the state as a whole, private lands must be taken into account.

"Somewhere between 19 and 20 percent of Vermont's (territory) is managed as conservation lands," said Paradis, of UVM's Natural Areas Center. "But much of it is in higher elevations and in the Northeast Kingdom. Not much is in the Champlain Valley, or Franklin and Addison Counties. If you were to overlay a map of conservation lands over a map of biodiversity hot spots, they would not match up very well."

Publicly protected areas tend to be the colder, less fertile, less exploitable — in sum, less developable — lands. And while protection of biological diversity should be factored into stewardship of every acre of every watershed, diversity is greater, on the whole, on those desirable lands where private ownership is the rule.

"There will be challenges in that," said Paradis. "We will have to develop new and interesting ways to work with land owners and special interests."

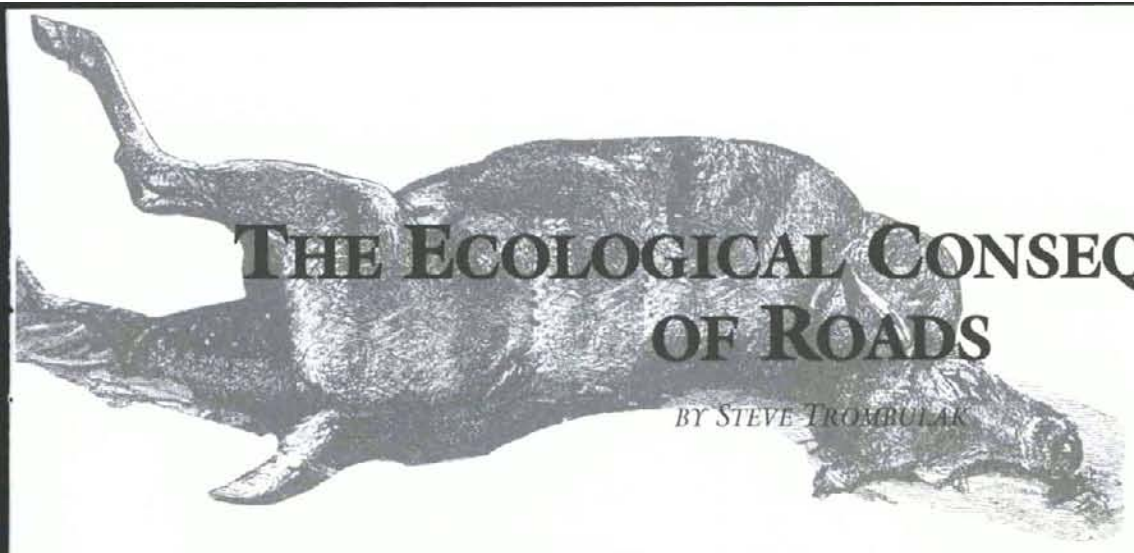
However, Jim Andrews a herpetologist (he studies reptiles and amphibians) and research associate at Middlebury College, pointed out that development in Vermont is eroding the opportunity to protect biodiversity.

"The Environmental Protection Agency, in its Fall 1999 regional report, noted that between 1982 and 1992 in Vermont, 6,500 acres per year were lost to development," Andrews said, "and the rate was accelerating. Using principles of sustainability in forest management, we can pace our harvest of trees and plant as many as we cut down. You can take fish from a lake and then restock it.

"But land is not a renewable resource. We are not generating 6,500 acres of land each year.

"Do the math," said Andrews. "Sooner or later some of the species are not going to have the habitat they require, and those of us who enjoy the standard of wildlife biodiversity we see in our state are going to see it disappear."

Our greatest hedge against that erosion of species, upon which we may be more dependent than we realize, is to make biodiversity a value cherished by all Vermonters — dinner table conversation, as VNRC's Job Heintz puts it. In the coming years, that may be the greatest challenge facing Vermont's environment.



The Ecological Consequences of Roads

by Steve Trombulak

Among the most widespread forms of modification of the natural landscape during the past century has been the construction of roads. As environmentalists try to understand the forces that degrade ecosystem health, it is important that we understand the ecological effects of roads of all types, from dirt roads to interstate highways. Roads of all kinds affect terrestrial and aquatic ecosystems in seven general ways: (1) construction mortality, (2) collision mortality, (3) altered behavior, (4) physical alterations, (5) chemical alterations, (6) spread of exotic species, and (7) increased human effects. These effects overlap somewhat; for example, roads may spread exotic species because they disrupt communities and change physical habitats. Despite the difficulty of categorizing the basis in every example, these seven categories provide a useful framework for assessing what we know about the ecological effects of roads.

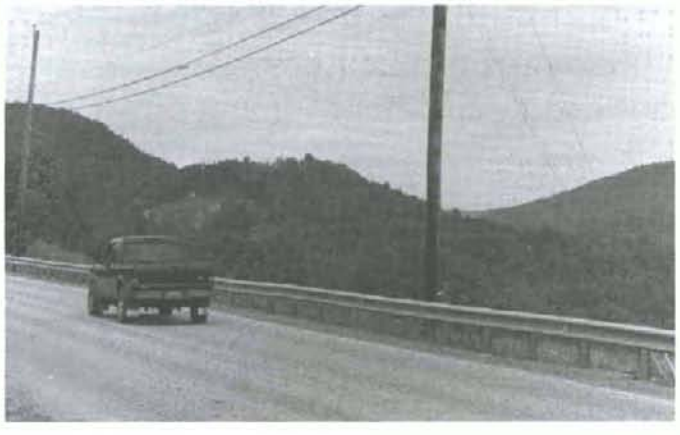
1. Mortality from Road Construction

Road construction kills any stationary or slow-moving organism in the path of the road. The exact level of mortality has never been calculated, but the magnitude cannot be trivial. The U.S. Department of Transportation reports 13,107,812 kilometers of road lanes of all types in the conterminous United States; with an average width of 3.65 m per lane, they have destroyed over 4,700,000 ha of land that formerly supported plants and animals. The actual number is higher because this estimate does not include shoulder pavement and land adjacent to the roadbed that is cleared during construction.

Construction may also physically injure organisms adjacent to the path of construction. Construction of logging roads, for example, has resulted in damage to trees and a decline of up to 30% in forest productivity per rotation. Construction also alters the physical conditions of the soil underneath and adjacent to the road, increasing soil compaction relative to undisturbed sites and likely decreasing the survival of organisms that are not killed directly.

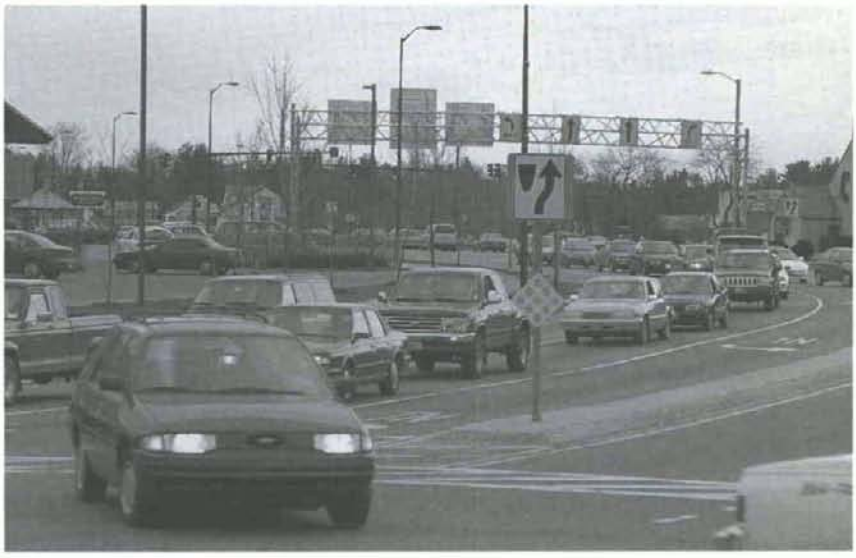
2. Mortality from Collision with Vehicles

Few, if any, terrestrial species of animal are immune to vehicle collision. Mammals ranging in size from moose to armadillos are the best documented roadkills, probably because they are more noticeable. Roadkill among many other less-obvious species include many species of birds, snakes, toads, and a wide range of invertebrates, especially insects. The effect on a population's demography



can be substantial, and can be one of the major causes of death in a population. Migratory species are especially vulnerable, particularly those that are inconspicuous and slow-moving like amphibians, since they are forced to cross roads to move from one habitat type to another.

Mitigation measures have been used with different amounts of success. For example, wildlife underpasses in Florida have been only partially successful in reducing roadkill of Florida panthers. Roads are likely to be a persistent source of mortality for many species. In general, mortality increases with traffic volume. However, some species are less likely to be killed on high-speed roads because they usually have vegetation cleared back from the



road's shoulder, creating less attractive habitat and greater visibility for both animals and drivers.

3. Modification of Animal Behavior

The presence of a road may modify an animal's behavior in several ways. Roads cause animals to shift their home ranges. A number of large mammals, including bears, elk, deer, and mountain lions, shift their home ranges away from areas with high road densities. Scavengers like Black Vultures and Turkey Vultures, on the other hand, prefer areas with greater road densities, probably because of the increase in roadkill.

Roads alter patterns of animal movement. Caribou in Alaska preferentially travel along roads that lead in the direction of their migration. Although the road may enhance movement, it results in increased mortality from vehicle collisions and predation by wolves. After calving, female caribou with calves avoid roads. Reluctance to cross roads is also seen in many rodents even when the road is narrow and covered only with gravel. Black bear almost never cross interstate highways in North Carolina, but will cross roads with less traffic volume. Roads can act as barriers to gene flow, leading to significant genetic differentiation among populations.

Roads may affect an animal's reproductive success. Nesting success of Bald Eagles decreases near roads, and Golden Eagles and Sandhill Cranes selectively nest away from human disturbances, including roads. Mallards, on the other hand, prefer road right-of-ways for nesting, because of a lower level of predation there.

Roads may alter escape responses. Pink-footed Geese, Lapwings, and Black-tailed Godwits in Europe are more easily disturbed when feeding near roads, flying away from humans sooner when feeding in areas with roads. Roads can also affect an animal's physiological state. For example, heart rate and energy expenditure of bighorn sheep increase near roads independent of any traffic.

4. Disruption of the Physical Environment

Roads transform physical conditions on and adjacent to the road, creating changes that last beyond the time of the road's construction. Soil density on closed forest roads continues to increase and can persist for decades; logging skid trails in California over 40 years old have soil that is 20% more compacted than soil in nearby areas that have not been used as trails. The heat stored on the road surface creates heat islands. Animals, such as small birds and snakes, preferentially aggregate on or near warm roads, increasing their risk of being hit. Roads through forest communities increase the amount of light on the forest floor.

Road traffic creates and spreads dust, which when settled on plants can block photosynthesis, respiration, and transpiration, as well as cause physical injuries to plants. These effects can alter plant community structure, especially those dominated by lichens and mosses, and can be a source of nutrients and contaminants to aquatic ecosystems.

Roads can directly alter the development of aquatic ecosystems. Because of the energy associated with moving water, physical impacts often propagate long distances from the site of a road. Changes in hydrodynamics and sediment deposition can change channels and shorelines many kilometers both down- and up-stream of a road crossing. The nature of such responses is not predictable; it may depend on the sequence of flood and sedimentation events after the alteration is made. Roads on floodplains can redirect water, sediment, and nutrients between streams and wetlands and their riparian ecosystems, affecting water quality and ecosystem health.

Road crossings may act as barriers to the movement of fish and other aquatic animals. Many headwater populations of salmonid fishes persist today as fragmented headwater isolates, largely because of migration barriers that fail to provide for fish passage. Riverine fishes actively move into seasonal floodplain wetlands and small valley floor tributaries to escape the stresses of main channel flood flows, but valley bottom roads can block access to these seasonally important habitats. Persistent barriers may select for behaviors that do not include natural migration patterns, potentially reducing both the distribution and productivity of a population.

Roads change the hydrology of slopes and stream channels, altering surface water habitats. Roads intercept shallow groundwater flows, diverting the water along the roadway and routing it to

surface water systems at stream crossings, changing the timing and routing of runoff. Hydrologic effects persist as long as the road remains, often long after abandonment and revegetation of the road surface.

Changes in water flow may cause unusually high concentrations of runoff on hillslopes and trigger erosion through channel cutting and debris flows. Once erosion occurs, it can affect fishes and other biota far downstream for long periods of time. Roads are responsible for the majority of hillslope failures and gully erosion in steep, forested landscapes that are logged. Because most of these more catastrophic responses are triggered by intense storm events, lag times of many years may pass before the full impacts of road construction are seen. Chronic effects also occur; the surfaces of unpaved roads can route fine sediments to streams, lakes, and wetlands, increasing the turbidity of the waters, reducing productivity and survival or growth of fishes.

5. Alteration of the Chemical Environment

Many heavy metals derived from gasoline additives and deicing salts are put into the roadside environment, and exhibit four clear patterns: (1) The amount of contamination is related to traffic volume. (2) Contamination decreases away from the road, but once metals reach flowing water, transport distances increase substantially. (3) Heavy metals accumulate in both plants and animals. (4) Concentrations in the soil decline where use of leaded gasoline has been stopped and surface water flow carries the metal ions away. However, after they leave the terrestrial environment, the metals may cause additional harm to aquatic biota.

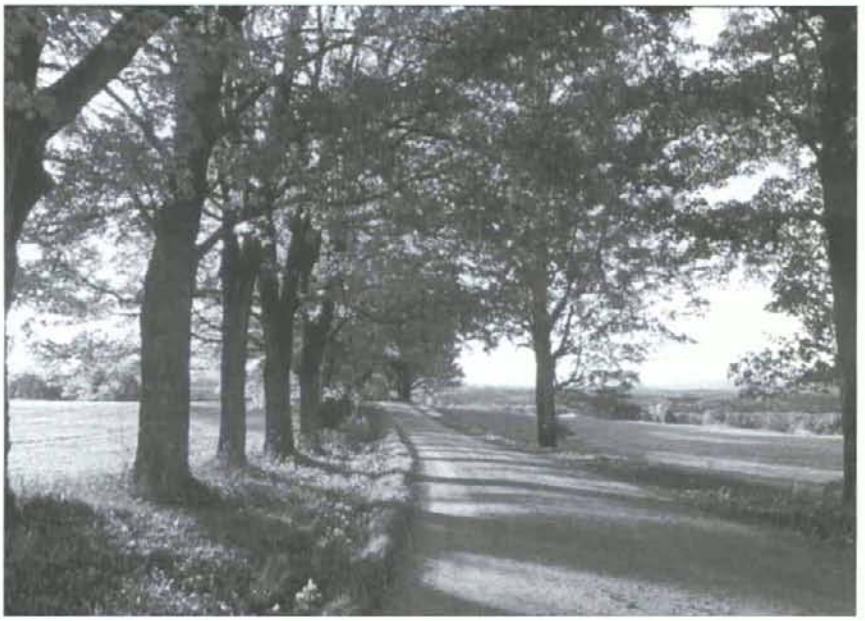
De-icing salts, particularly NaCl, alter soil pH and chemical composition. The impacts to aquatic biota of surges of salt from road runoff have received little study. Deicing salts elevate chloride and sodium concentrations in streams and lakes, which can alter aquatic vegetation and disrupt ecological dynamics.

Organic pollutants like dioxins, polychlorinated biphenyls, and hydrocarbons are in high concentrations along roads. Ozone concentrations are elevated where exhaust accumulates. Roads spread nutrients to aquatic ecosystems; the buffering role normally played by riparian vegetation is circumvented through direct runoff of sediment where roads abut or cross water bodies. Water moving on and alongside roadways can be charged with high levels of dissolved nitrogen and phosphorus. Because roads deliver nutrients that originate in the upslope area, the nutrient burden is probably largely controlled by surrounding vegetation and land use.

Changes in the chemical environment by roads results in a number of consequences for living organisms. First, the chemical composition of plants changes in response to pollution, including increased concentrations of chemicals produced by plants to resist the toxic effects of pollution and salts, as well as decreased production of chemicals necessary for plant function. Second, organisms may be killed by chemical exposure. Virtually all measures of soil biota diversity and function decline in contaminated soil. Third, growth and health of many plants are depressed, even to the point of death. Pollutants may decrease plant health by damaging roots, mycorrhizae, and leaves, and by changing salt concentrations in plant tissues. Secondary effects on plant health include decreased resistance to pathogens. Fourth, plants and animals may accumulate toxins at levels that pose health risks for humans who consume exposed organisms. Fifth, increased concentrations near roadsides of some pollutants, particularly salt, attract large mammals, putting them more at risk of being killed by vehicles. Sixth, changes in the chemical environment create selection pressures that result in evolutionary changes to both plants and animals.

6. Spread of Exotic Species

Roads provide dispersal corridors for exotic species in three ways: providing new habitat, stressing or removing native species, and direct transportation. It is often difficult to distinguish among these factors. Soils modified during road construction can help spread of exotic plants along roadsides. Some exotic plants are found preferentially along roadsides and in other disturbed habitats. The spread of exotic diseases and insects is helped by increased density of roads and traffic volume. Road construction that alters canopy structure of forests promotes invasion by exotic



understory plants, which affects the animal communities. Some roadside verges have been invaded by maritime plants because of their ability to tolerate saline soil. Feral fruit trees are found preferentially along roadsides, and some populations are maintained solely by seeds in fruit waste thrown from vehicles.

7. Changes in Human Use of Land and Water

Roads facilitate increased use of an area by humans, which themselves can exert many diverse and persistent ecological effects.

Roads open up areas to illegal hunting. Excessive hunting pressure reduces population sizes of many game species, including bear, lynx, and wolves. Roads also increase illegal fishing in streams and lakes. Native fish populations in previously inaccessible areas are often vulnerable to even small increases in fishing effort. Visitors to some areas increase when roads make them more accessible, leading to increased passive harassment of animals, as well as damage to plants. Passive harassment can influence heart rate and energy expenditure. For example, the nearby presence of humans causes a 20% increase in mean heart rate in bighorn sheep. Roads are often built into areas to promote logging, agriculture, mining, and development. Such changes in land cover and use result in major and persistent adverse impacts on the native flora and fauna of all ecosystems.

Numerous studies have shown declines in stream health associated with roads. However, because the nature of land use within a region tends to be highly correlated with road networks, it is difficult to separate the direct effects of roads from those of the associated land use activities. For example, trout biomass and streambed habitat quality decline in relation to both the number of road crossings and to the proportion of area logged. Roads are an index of the magnitude of this effect on fish, but it remains unclear to what degree the ecological responses result from roads themselves, and thus might be attributed to aspects of road design or placement that could be mitigated.

What's Down the Road

Roads have diverse and deeply systematic effects on many aspects of both terrestrial and aquatic ecosystems. Roads lead to a "hyperfragmentation" of terrestrial and aquatic ecosystems as their effects resonate substantial distance from the road itself through terrestrial habitat fragmentation and downstream habitat deterioration. Hyperfragmentation is the result of a spatial footprint of ecological impacts that propagate across the landscape differently in terrestrial and aquatic ecosystems. Even where just a small percentage of the land's surface is directly occupied by roads, ultimately few corners of the landscape remain untouched by their off-site ecological effects. The breadth of these impacts cannot be appreciated unless one takes a broadly transdisciplinary view of ecosystems and biological communities.

Road design, management, and restoration need to be much more carefully tailored to address the full range of ecological processes and species that are potentially affected. Monitoring is also necessary to ensure that projects have robust ecological benefits and minimal adverse effects, and that they are cost-efficient relative to their actual benefits. Of course, such assessments require time and money that are often not available. Most funds used to remediate existing problem roads are earmarked for actual field operations, and are not available to support assessment. Few of the experts building roads or "restoring" them have been trained to recognize and address the full spectrum of ecological issues identified here. Moreover, by their very nature roads simply have systematic, endemic ecological effects that, even if recognized, cannot be overcome. If a broad view of the ecological impacts of roads reveals a multiplicity of effects, it also suggests that it is unlikely that the consequences of roads will ever be completely mitigated. Thus it is critical to retain remaining roadless or near-roadless portions of the landscape in their natural state.

Steve Trombulak is the Albert D. Mead Professor of Biology and Environmental Studies at Middlebury College, and he is a former member of the VNRC Board of Directors (1991-1994). This article was adapted from: Trombulak, S.C., and C. Frissell. 2000. A review of the ecological effects of roads on terrestrial and aquatic ecosystems. Conservation Biology 14: 18-30.

Acid Rain Revisited

An Update on the Health of New England's Forests

In New England and the rest of the Northeast, there may be no single, greater threat to biodiversity than acid rain. A trip to any of a score of high-elevation lakes in the Adirondack Mountains in New York provides abundant proof. There, because of acid deposits from emissions from midwestern power plants, the waters are still, vacant, dead.

But that's only part of the species loss attributable to acid rain. Studies in Vermont and New Hampshire beginning in the 1970s established significant and mortal crown and branch damage to high-elevation red spruce. The federal Clean Air Act later imposed effective regulations on power plant emissions, and many Vermonters took comfort in the belief that the Act had addressed the most egregious pollutants in acid rain. For the citizens, all we had to do was wait for our forests to recover.

In 1999, however, the Hubbard Brook Research Foundation — a pioneer in acid rain research in the 1970s — took a new look at recent research into acid and acidifying emissions, trends in acid deposition, the ecological effects of acid depositions, and the process and likelihood of ecosystem recovery from acid deposition. The report focuses on the Northeast and relies heavily on long-term data from the Hubbard Brook Experimental Forest (HBEF). The results were made public this year in a scientific journal as well as a Science Links™ publication (geared toward lay people) titled "Acid Rain Revisited." Not only do the findings argue against complacency about acid rain, they also reveal new layers of implications related to acid precipitation.

Those findings go to the heart of biodiversity. They reveal impacts upon forest soils that threaten the life and regeneration of spruce, maple, ash and other tree species which provide both ecological (cleaning the air, providing habitat) and economic (tourism, forest products, industries) services.

Yet the Hubbard Brook Research Foundation has also provided a valuable — and hopeful — public service by scientifically projecting the results of various policy options now being debated by policy makers, individuals and advocacy groups.

In May, Kathleen Fallon Lambert (KL), executive director of the Hubbard Brook Research Foundation, discussed "Acid Rain Revisited," and the implications of the study's findings with VNRC. Representing VNRC were Director of Forest and Biodiversity Programs Job Heintz (JH) and VER contributor Will Lindner (WL). The interview took place in the Foundation's offices in Hanover, New Hampshire. The following transcript has been edited for space limitations.

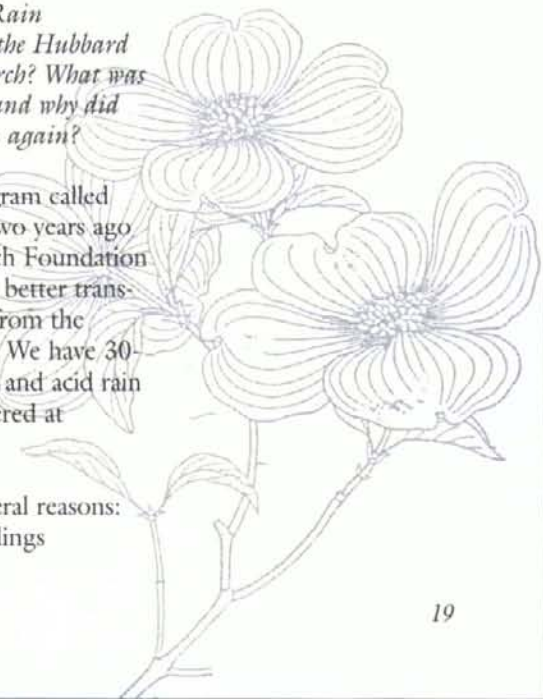
WL: *Kathy, would you please give us some background on the report titled "Acid Rain Revisited," which was published by the Hubbard Brook Research Foundation in March? What was the period of time for the research, and why did you research the subject of acid rain again?*

KL: This report grew out of a program called Science Links, which we created two years ago when the Hubbard Brook Research Foundation was thinking about how we could better translate and disseminate the research from the Hubbard Brook Ecosystem Study. We have 30-plus years of research (behind us), and acid rain in North America was first discovered at Hubbard Brook.

This report seemed timely for several reasons: There had been new scientific findings

Flowering dogwood
State Threatened

Flowering dogwood exists at the northern edge of its range in Vermont. The North American population is threatened by disease.



Most people thought there was enough buffering capacity in the soil not to see major changes due to acidification. In the last five or six years that's been shown not to be true.

generated from Hubbard Brook; the Clean Air Act was up for reauthorization; and four or five bills had recently been introduced in Congress calling for reduced emissions from power plants. That told us there were both public-policy interests and scientific reasons to revisit acid rain. So we pulled together a team of 10 scientists from the Hubbard Brook Ecosystem Study and beyond in the Northeast region, to consider the state of the science, what's been learned over the last 10 to 20 years on this topic, and how it bears on policy decisions that might be coming down the pike. We worked with this group of 10, pulling together existing data sets from across the region.

We set out to answer four basic questions: What is the status of emissions and acid depositions?; what have we learned about the impacts?; how do the ecosystems recover from this disturbance?; and what is the prognosis under the various legislative proposals for recovery in the Northeast?

After about two years of work and a lot of scratching our heads and battling it out, we submitted a paper to the journal BioScience. The objective, from the start, was to produce both a peer-reviewed journal article and a report that was accessible to a broader audience. The hard work really began when we tried to translate the BioScience paper for the public, the media and policy makers.

WL: *Tell us about the Hubbard Brook Experimental Forest. Maybe you can provide us some background.*

KL: Sure. The Hubbard Brook Experimental Forest is central to this study because it has the longest-running air-quality and water-quality data set to work from.

WL: *Where is it precisely?*

KL: It's in the White Mountain National Forest in the towns of West Thornton, Campton and Woodstock, New Hampshire. It started when the U.S. Forest Service set aside 7,800 acres in 1955 for research purposes. (The work) expanded in 1963 when three professors from Dartmouth College joined the effort and added their own expertise, and it has been going and expanding ever since then.

With long-term measurements of water chemistry and precipitation chemistry, scientists working at the Hubbard Brook Experimental

Forest were able to document that rainfall was more acidic than you'd expect in this part of the world, and that it was caused by the burning of fossil fuels. In 1972 they published the first paper in North America connecting fossil fuel burning with acid rain. That research was pioneered by Gene Likens together with Herb Bormann and Charles Driscoll.

JH: *Are these scientists still active with HBRF?*

KL: Both Gene and Herb are on the Board of Trustees for the Foundation. And all three scientists still conduct research at Hubbard Brook and other sites. Herb and Gene were instrumental in founding the Foundation because they had a strong conviction that there is a social contract between scientists and the public through public funding. Part of the give-back is to share your research results.

WL: *When was "Acid Rain Revisited" released?*

KL: Our press conference was March 26.

WL: *So this is the newest stuff?*

KL: This is the newest stuff, and this is the first stuff for the Science Links program. Part of our objective has been to raise the profile of the Science Links program and establish ourselves as an organization that can bridge the gap (between science and public understanding). This was our first attempt, and I think it was

useful to policy makers and the public. We recently evaluated media coverage of acid rain and found that there was a peak in coverage in the late '80s and early '90s, when the Clean Air Act amendments dealing with acid rain were first passed. Then there was a huge lull through the '90s. With the release of this report and other acid rain activities, there's been another peak in (attention to)acid rain in the media. We hope that our work has contributed to that rise.

JH: *You talked about the social contract, which I think is fantastic — your interest in sharing research results in a way that the public can understand. The question that came to my mind was whether "Acid Rain Revisited" (might be called) an advocacy piece? Are we talking about scientists becoming advocates?*

KL: We spent a lot of time considering our role in this larger issue of science, policy and advocacy. We set out to provide the best possible information about policy outcomes, (having) decided that our role was to quantify the consequences of specific policy options to the extent possible. We tried to stop short of then advocating which policy option should be chosen. That gets out of the scientific realm and into politics, economics, social values, legal issues... things we don't consider to be our expertise.

WL: *Were you concerned that people would find your studies less credible if they could be seen as advocating some kind of policy reaction?*

KL: What we see is that there is important role for advocates and that they need good information to base their positions on. We see our role as providing that scientific information. Our clout and credibility hinge on maintaining our scientific "objectivity."

That said, I think it is critical that advocates then use this information wisely in policy debates, and advance policies that will lead to a cleaner and safer environment.

JH: *Are there other objective scientific organizations like HBRF engaging in this two-step process (a peer reviewed journal article, followed by a report designed for a broader audience)?*

KL: We looked around to see what other scientific institutions were translating and disseminating their results to the public before we started Science Links. Actually, it was a two-year process of just looking at who was doing what; is there a need for this? We looked at groups that do similar work, but there's not an entity I know of that has the long-term research experience and data collection that Hubbard Brook has accumulated, and has made a commitment to synthesis and translation.

WL: *What was the reason to revisit acid rain specifically as a scientific issue?*

KL: The biggest reason was the advance in understanding of the impacts of acid rain on soils.

In 1996, Gene Likens published a paper in the journal Science reporting a loss of calcium from soils at Hubbard Brook. There was one sentence in his paper that simply stated that concurrent with this loss of calcium there has been a leveling off of biomass in the forest. Simply by placing those two findings essentially side by side and not actually connecting them, it set off a growing interest: Okay, are these two findings actually (related)? Although that question hasn't been answered precisely, from a scientific perspective, there was reason to take another look. Also, the long-term data from Hubbard Brook provides the perfect set-up for evaluating the effectiveness of the 1990 Clean Air Act amendments. The data were clear: There has been a minor improvement in the acid level of streams at Hubbard Brook, but they are still very acidic and the improvement was not as significant as was anticipated. Together — the growing interest and knowledge in the precipitation-soil-terrestrial connection and the acid levels of streams — these findings presented a strong case for revisiting the issue.

WL: *It seems that this work looks at the soil more closely than previous studies. Instead of the image of the branches of trees being enveloped in acid clouds and that being the cause of their trauma,, this looked at the issue from a different perspective — or possibly an added perspective.*

KL: I think that's true. Probably 10 or 20 years ago most scientists and most people thought there was enough buffering capacity in the soil in the Northeast not to see major changes there due to acidification. In the last five or six years that's been shown not to be true in a lot of areas.

JH: *Can you explain what you mean by buffering capacity?*

KL: In any volume of soil there's a certain amount of base cat ions that are exchangeable, or

The problem hasn't gone away. Rainwater and streams are still acidic. The Clean Air Act was helpful, but it hasn't led to the level of recovery that was anticipated.

Green dragon
State Threatened

Green dragon is related to jack-in-the-pulpit and is found only in rich, forested lowlands.

available, to plants at any given time. These base cations are sort of like the Tums or antacids of the ecosystems. The source of this buffering capacity depends on a lot of things, but generally includes the replenishment of base cations from the death and decomposition of organic material such as organisms and vegetation, as well as the weathering of bedrock.

The other source of base cations can be atmospheric deposition. While generally not considered a natural source, base cations can come into an ecosystem from the air in the form of fine particles. Interestingly, as our air has gotten cleaner, the input of base cations as fine particles in the air has decreased.

Based on a rough understanding of soil processes, it was thought that, well, there is a high enough base cation content in soils of the Northeast to basically protect them from acid rain. At Hubbard Brook — and Hubbard Brook is considered to be relatively sensitive — that is not true. Acids have actually leached calcium and magnesium (base cations) from the soil, washing them into drainage waters and out of the system so that they are no longer available to plants. Since the regeneration of base cations through the breakdown of mineral soil and bedrock is so slow, it has not kept up with the rate of depletion and the total base cation content in soils at Hubbard Brook has decreased over time.

Anything that reduces consumption of fossil fuel will reduce an individual's contribution to air pollution and acid rain. Fossil fuel burning is the source of the problem.

There are a couple of ramifications of this depletion. Calcium and magnesium are important to tree health, and they're also important to keeping the acid-basis status balanced in the soil, in a healthy zone. With the loss of about half of that calcium in the last 50 years at Hubbard Brook there is reason to believe that there are important consequences for trees.

JH: *Consequences which (according to your report) include susceptibility to freezing injury in red spruce suffering from calcium depletion, and extensive mortality among sugar maples in Pennsylvania from deficiencies in base cations coupled with other stresses.*

KL: Right. But getting back to your question — what was our impetus in terms of this report? This report doesn't present much in the way of new data. It was really meant to synthesize (data), because what's very typical of the scientific world is that many journal articles will be published on a subject and each will present an individual finding in isolation. This is the way science and knowledge progress, but it means that someone working on the policy side of the issue may have to read dozens of articles simply to get up to speed on the science. Rarely is the information pulled together in one place, to give you a compete picture of the issue. Just as most scientists don't have the time to sit through the numerous policy meetings it takes to nail down a strategy, most policy analysts don't have time to find and read 20 scientific papers on the issue.

So we thought, given where the policy issues are and given new findings, we could step back and pull this all together and present a comprehensive picture of this issue. By doing that we may learn something interesting about the science. And certainly we can be helpful to people out there working on the issue.

What we've basically tried to say when we talk to the public and the media is that the problem hasn't gone away. Rainwater and streams are still acidic. The Clean Air Act was helpful and did push things in the right direction. We have seen reduced sulfur dioxide (SO_2) emissions and reduced deposition. But because of this advanced understanding of the whole impact, it hasn't led to the level of recovery that was anticipated. Using the model projections of Hubbard Brook, deeper cuts will lead to faster and greater recovery.

WL: *Deeper cuts of the same kind, or different cuts?*

KL: Good question. What we looked at were cuts in sulfur dioxide emissions from utilities. We focused on that because that was largely what the policy makers were looking at. However, there is another major component of acid rain, which is nitrogen oxides. Even though they are very important in the process of acidification there isn't currently — and there is not, to my knowledge, expected to be in the next 10 years or plus — a cap on nitrogen oxide (NOx) emissions. So there could be increased generation from new power plants, more vehicles, more miles traveled. All those things put the nitrogen oxide emissions trajectory of level-to-increasing.

WL: *It looks like there are two paths: the path we have taken, which addresses sulfur, and a path that would address other emissions. Why was sulfur the focus? And what "emissions" need to be addressed? Where does all the nitrogen come from?*

KL: There are two answers to the first question — why focus on SO_2? There's the policy answer and the science answer.

The policy answer is that NOx is kind of like non-point source pollution; it comes from a lot of different places that move around a lot. From that view, it made a lot of sense in the '90s to focus on these big power plants that hadn't cleaned up and that produced a great deal of the sulfur dioxide. From a scientific perspective, there's a clear relationship between emissions of SO_2 and sulfur in precipitation as rainwater. For example, we can show based on Hubbard Brook data that a decrease in one unit of SO_2 emission leads to a unit decrease of sulfate in stream water. There is no such clear relationship when it comes to nitrogen.

Ten years ago everyone knew that SO_2 was only part of the problem. Now of course we've learned about a whole cascade of effects of nitrogen that go beyond acidification, such as ground-level ozone, regional haze, eutrophication of coastal waters and (impact on forests). These issues create a stronger imperative to deal with nitrogen.

JH: *Can the science progress to the point where you can draw similar connections regarding nitrogen?*

KL: That's exactly what we're focusing on in our next Science Links project. It's definitely going to be harder, because the science isn't as mature.

JH: *My understanding is that the science, as nitrogen relates to ground-level ozone formation, is well established in terms of the public health impacts. From the Vermont perspective, we don't have large, stationary sources that are pumping out sulfur dioxide. The biggest contribution we're making every day — because we drive everywhere — is the nitrogen oxide contribution. The public-health impact is obvious; smog and ozone. But is it safe to conclude that it's also having some impact on the soils, in the trees?*

KL: In a different way, but yes, it's safe to conclude that it has a detrimental impact. Let me link the two questions. About 60 percent of the sulfur dioxide comes from power plants and 40 percent from other sources. It's about flipped with NOx. About half or more of NOx comes from vehicles and the remainder from power plants and other sources. The fact is that the nitrogen cycle is far more complicated than the sulfur cycle. There are many different forms of nitrogen and a given nitrogen molecule can be converted into nitrate, nitrite, or a gas such as nitrous oxide. Each of these forms of nitrogen moves through an ecosystem in a different way and has a different impact. Therefore, it is more difficult to connect a unit decrease in nitrogen oxide emissions with a unit decrease in stream acidity than it is with sulfur dioxide.

JH: *For background, last year in Vermont there were over six billion vehicle miles traveled. Considering the population, that's striking.*

WL: *And considering the size of the state...*

JH: *The sulfur dioxide issue isn't necessarily something that people can change their behavior and do something about it. But now you're saying that we can conclude that nitrogen oxide is impacting our forests, soils and waters in the same way. If people were to drive less and carpool more, that kind of thing, certainly it would be beneficial to the public health. Is it also likely to be beneficial for our forest, waters and soil?*

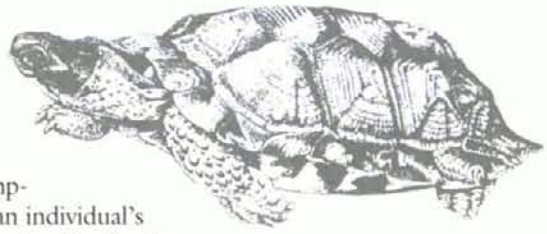
KL: Some forests may benefit from nitrogen inputs, because some forests are nitrogen limited. If there is a site that was heavily clearcut in the past (that could) lead to the loss of nitrogen from that watershed. In this instance, the forest may need nitrogen to reach its growing potential. However, in other cases, too much nitrogen can be detrimental.

What's trying to be understood now (is) what's the distribution and extent of forests that need nitrogen versus those that may become nitrogen-saturated? One sign of saturation is the leaking out of nitrogen from the forest into streams.

In terms of what everyday citizens can do to reduce their contribution to acid rain and its related impacts, anything that reduces consumption of fossil fuel will reduce an individual's contribution to air pollution and acid rain. As you know, anything that burns fossil fuel contributes to this problem, whether it's driving cars or consuming electricity. Fossil fuel burning is the source of the problem.

WL: *Much of the discussion of acid rain focuses on red spruce. In Vermont we live and die by the sugar maple. Could you address the impacts on trees that Vermonters might not expect to be as affected by acid rain?*

Once you lose all the bases like calcium and magnesium, the next cation to become mobilized is aluminum. And that isn't such a friendly element.



Wood turtle
State Special Concern

Wood turtle populations are declining all over New England from habitat loss. The turtles spend much of their time on land, making them susceptible to death and injury from road traffic.

With an 80-percent reduction of SO_2 from utilities, we foresee those conditions changing from being acidic to relatively non-acidic in 20 to 25 years.

KL: It gets back to the soil question. Sugar maples and ash are trees that like very fertile conditions. It's been documented in Pennsylvania that the loss of calcium and magnesium from the soil and from foliage because of acid rain has made those sugar maples more susceptible to stress.

All forests and all trees experience stress and disturbance, but we've basically, across a wide area, reduced the ability of many trees to rebound. Over time, what's been (observed) in Pennsylvania is the loss of crown cover, the dieback of twigs and branches, and premature coloration of leaves. The crown is what tree needs to photosynthesize and live, so under extreme conditions the multiple-stress syndrome can cause crown loss and lead to a greater percentage of dead trees.

The challenge now is to see how widespread is that? Many of the soils in Pennsylvania have supported sugar maples for 200-plus years but are now less able to support them.

There's no reason to think that sugar maples in (New England) wouldn't have a similar response if soils were sufficiently depleted. There are beginning to be places, pockets, where symptoms of decline are showing up. We have seen branch or twig dieback on what otherwise looks like it should be a vigorous tree at Hubbard Brook.

JH: *Are the trees regenerating? Has anybody looked at that?*

KL: Yes. In Pennsylvania they have found that levels of regeneration are greatly reduced. What they had to try to separate is how much of that is due to deer browse. They did enclosure studies where they kept the deer out, but they still saw poor regeneration.

JH: *This is one of those keystone issues for Vermont—fall foliage, tourism, the maple syrup industry.*

KL: This is sort of a social commentary, but it's amazing to me how a lot of environmental issues seem to impact people on the margin of our economy who can't afford much of a reduction in (income). I fear this may be the case in the forest industry. When it comes to impacts on forest production, there are a lot of things we can't control, a lot of forms of natural disturbance that we can't do anything about. But reducing the risk of decreased productivity associated with air pollution is something we can and ought to be able to address.

WL: *In summary, Kathy, how would you describe the major findings of this new Hubbard Brook study?*

KL: If you consider that acid rain has been around since the Industrial Revolution, we'd have to go back before the '40s to find out what was the pH of the rainfall before it was affected (and became) acidic. Since we've been measuring rainfall in Hubbard Brook, it's been acidic. It's gone from about a little over 4.0 — like 4.1 — to ranging around 4.2 or 4.3.

JH: *It hasn't gone to the fives or sixes that whole period of time?*

KL: No. And this covers the last 30 years. It's improved a little bit, and that's important, but its still very, very acidic. That was the first message we wanted to communicate.

Second, since 1970 actually, since the very first Clean Air Act, sulfur dioxide emissions have decreased. That is very real. But NOx emissions have been steadily climbing, and without a cap they are probably only going to continue to increase.

WL: *If you're not seeing much change in the acid rain level, does that mean the Clean Air Act has been effective only to the extent that it has kept acid rain from getting worse?*

KL: I think with respect to SO_2 it did more than keep it from getting worse. The SO_2 emission reductions are significant and have had a beneficial effect.

The third major finding is that acid rain has had a greater environmental impact than had been earlier projected. The vulnerability of the soil turned out to be greater than expected in some areas, leading to increased risk to trees. We point to the impacts on the soil, the loss of those base cations.

And because of the way the soil chemistry works, once you lose all the bases like calcium and magnesium, the next cation to become mobilized is aluminum. And that isn't such a friendly element. It ends up being immobilized and dissolved in organic form. You have sort of a double whammy for forest soils — what acids can do and what aluminum can do. For sugar maples, the aluminum is starting to appear as a greater part of the problem than the acidity alone.

Last, we showed that the deeper the cuts in SO_2 emissions from utilities, the greater and faster the recovery from acid rain is likely to be. However, even with an 80-percent decrease in SO_2 emissions from the 1990 Clean Air Act requirements, it will probably take several decades from the chemical conditions in the soil and streams to improve to a level where they are adequate to support biological recovery.

JH: *How does aluminum affect the environment?*

KL: In its organic form aluminum is not harmful. Under acidic conditions, aluminum can be converted into dissolved inorganic aluminum which, when it's mobilized, affects the roots of the trees and hinders their ability to take up needed water and nutrients.

(When this inorganic aluminum passes from the soil to the water) it also has a very negative effect on fish. It's a really ugly process. It basically disrupts the salt balance in the fish and causes the blood to become too thick for the heart to beat, and causes heart attacks in the fish.

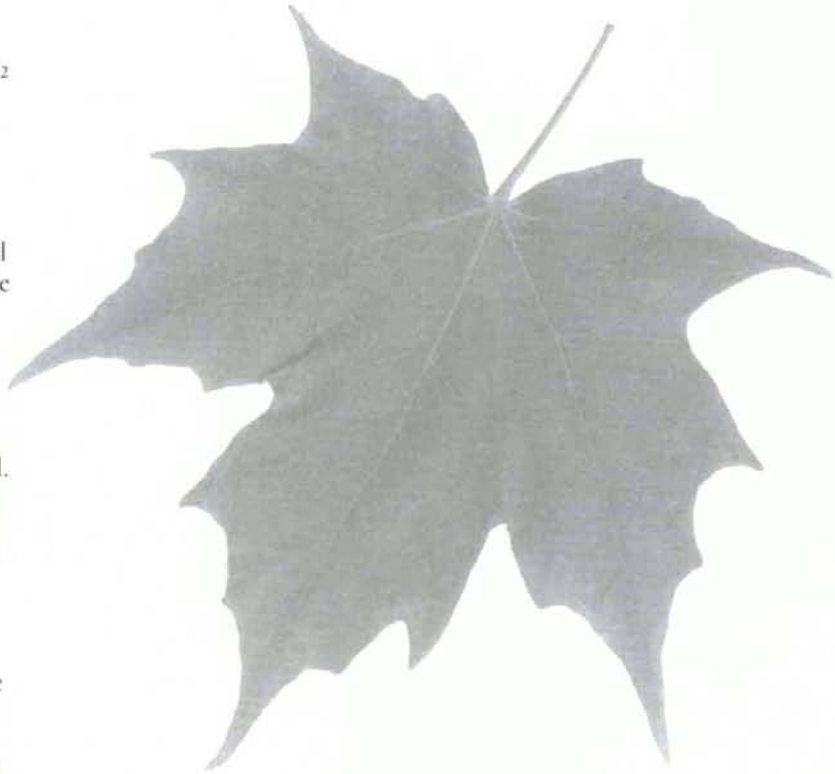
JH: *Someone's out there studying dead fish and proving that they had a heart attack?*

KL: One of the co-authors on this report. What they did was biopsy the fish. They caged the fish in the stream, but they didn't subject them to artificially high levels. They just caged these fish during spring snow melt so that they experienced what would happen in the stream, and many of them died. This is a problem beyond the Northeast.

Again, that's an effect most people are not aware of. And it shows the interaction between what's happening in the soil and trees and what's happening in the surface water. What we're trying to say is that there are fundamental changes in the chemistry in the whole cycle (that produce) harmful effects. We try to deliver that message as clearly as possible.

JH: *What would the trout do if you didn't have them caged? Would they move away from the pulse?*

KL: They'll try to move downstream, and usually what happens is they're subject to greater predation, there's high energy losses. Also, sometimes there aren't places to go. There are habitat barriers to movement.



JH: *Given sufficient volume of water, can the fish outswim the pulse? Is that how they survive? Does the pulse of inorganic aluminum dilute in the water over distance?*

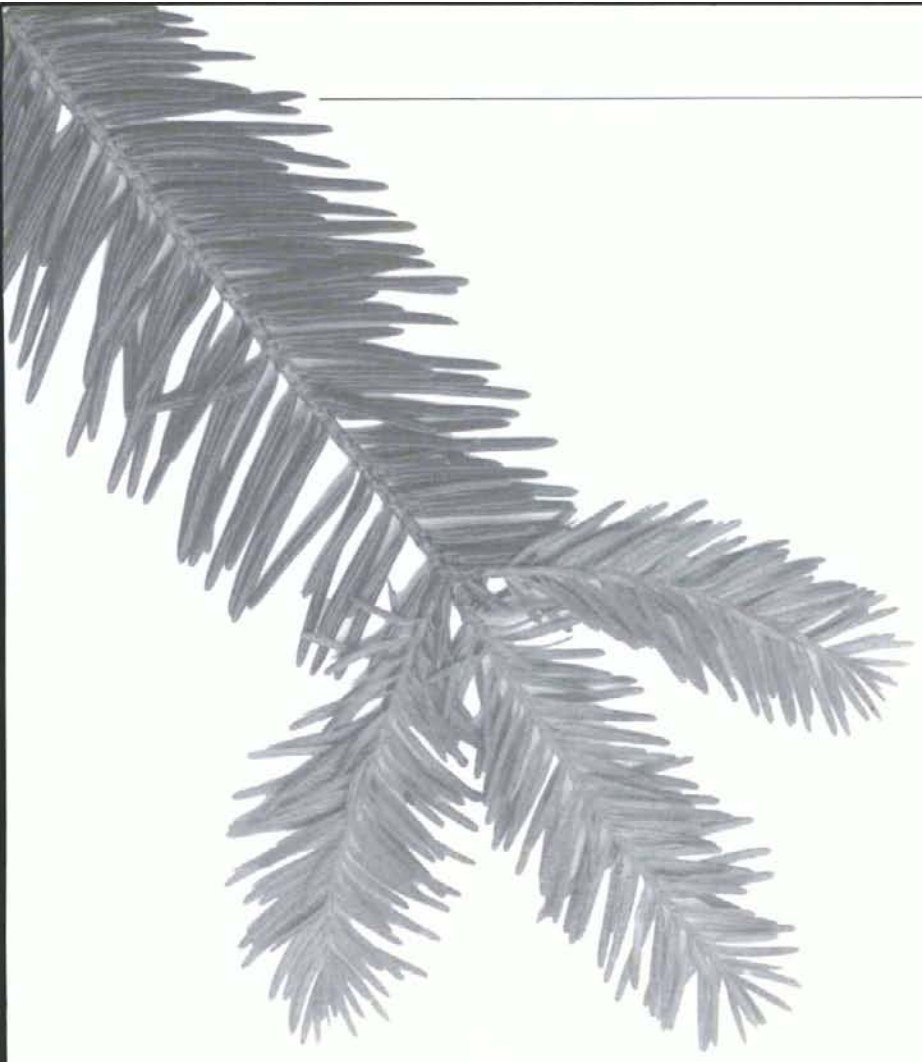
KL: Yes. Then you end up with sections of streams that are fishless. Under natural conditions those small headwater streams are good habitat for lots of reasons. They're well oxygenated; you have that flowing, cascading water, great pools. Where they have to go may be not as good as where they were.

JH: *After all these findings, how did you address the issue of ecosystem recovery?*

KL: The first thing we did was to outline indicators of recovery: What are we actually going to be looking for, and measuring, to know if the ecosystem's recovering?

First we looked at the chemistry; the easiest thing to measure. We looked at the bases in the soil and said okay, if the soil-base saturation was, in this case at 20 percent, that's good; if the pH of the stream is 6.0, that's going to be good for the fish; if the calcium-to-aluminum ratio is greater than 1.0 there should not be an adverse aluminum effect.

So we said okay, if the ecosystem reached these chemical thresholds, then the conditions would be right for the biology to recover.



Then we tried to project forward in time and look at the likelihood of recovery under various emissions scenarios. If you take Hubbard Brook as an example, how long would it take, or what would it take, to actually restore the chemistry of the stream water and of the soils so that the fish and other aquatic organisms could come back, and trees could again become healthy? That's where we use a model to look at the different scenarios.

It's pretty clear that inputs of strong acids have to be reduced to get the ecosystem to recover. That's (essentially) sulfur dioxides and nitrogen oxide. So given what we think is going to happen with nitrogen — which is that levels may be staying the same but probably increasing — let's look at decreases in SO_2. We looked at the different power plant bills (introduced in Congress) and said, what different options are being considered?

Based on our analysis of the bills, we choose to run the model with current conditions, with an additional 40-percent reduction in SO_2 from power plants, and with an additional 80-percent reduction. So we looked at 80 percent and said, okay, let's look at all the chemical indicators that we said are important for recovery and try to track them over the next 50 years and see how they'll change at Hubbard Brook under different scenarios.

Certainly it was intuitive, but it was still nice to be able to demonstrate on paper that the deeper the cuts in sulfur dioxide the greater the extent and rate of recovery. It's also true that the sooner the ecosystem recovers, the fewer areas are likely to have been damaged.

So to get to the punch line, one of the things that people relate to the most is pH, or acidity, of water. We need to be seeing it around the high fives or six to get the type of recovery we'd like to see at Hubbard Brook. With the 80-percent reduction of SO_2 from utilities, we saw those conditions change from being acidic to relatively non-acidic in 20 to 25 years.

JH: *At 80 percent, two decades at least?*

KL: Yes, because of how long it takes for things to change in soil, and the chemistry of the stream is a reflection of the chemistry of soil. Even after we've reduced the inputs of sulfur and nitrogen, it's going to take a long time for that to work itself out and recover chemically. Then, using literature, I tried to estimate how long it would take for the biology to come back. Basically, the macro-invertebrates would take three-plus years, the fish would recover in those sensitive areas where they have declined in another 10 years or so, and trees that have been impaired would need an even longer period to recover.

WL: *That's interesting. People, I think, expect to see an impact in their lifetimes, but we have to get away from that thinking, don't we?*

KL: I think that's very true. As I've started to have these kinds of discussions I've come to realize that we need to have a really big imagination. We just did a study at Hubbard Brook where we added 50 tons of calcium to the whole watershed. It's a 50-year experiment, so the scientists who started it won't be the scientists who finish it.

JH: *Senator Jeffords Clean Power Bill calls for drastic reductions in carbon dioxide, mercury, sulfur dioxide and nitrogen oxide emissions from stationary sources. Considering that only forty percent of nitrogen oxide pollution comes from power plant emissions, NOx pollution will continue to escalate unless we change our behavior.*

In your scenario, for further reduction timetables for sulfur dioxide, is it then safe to assume that if Vermonters cut back on the NOx contributions that the time frame for recovery could be shortened?

KL: If it's enough reduction of NOx. But there are other reasons to reduce NOx.

JH: *Public health is reason number one.*

KL: You're right. And as SO_2 goes down and the relative contribution of NOx, goes up, NOx is likely to be an increasing proportion of the problem of acid rain.

Here's one of the important pieces with NOx. NOx is more important to reduce in order to eliminate acid pulses than SO_2. Pulses often come in early spring and fall. At these times of year, outside of the growing season, the leaves aren't out so the trees aren't growing and taking up nitrogen. Therefore, in terms of reducing episodic acidification (of surface water), which has the greatest effect on fish, (reducing) nitrogen is very important. That connection should be better understood.

JH: *In terms of human activity in Vermont, how can we gauge the connection between changing our transportation habits and reductions in NOx emission?*

KL: I think the simplest approach is that the major local source of NOx is the emissions of motor vehicles. That's a clear, simple statement.

What I can't tell you clearly is what's the unit gain for the unit cut. It's great that we can do that with sulfur; people probably don't understand how huge it is that you can actually predict (the results of specific reductions). But just because we can't predict that yet with nitrogen — at a comparable level of accuracy and precision with sulfur — this doesn't mean that there is not a clear rationale for reducing NOx emissions as part of an overall strategy against acid rain and other air pollution issues.

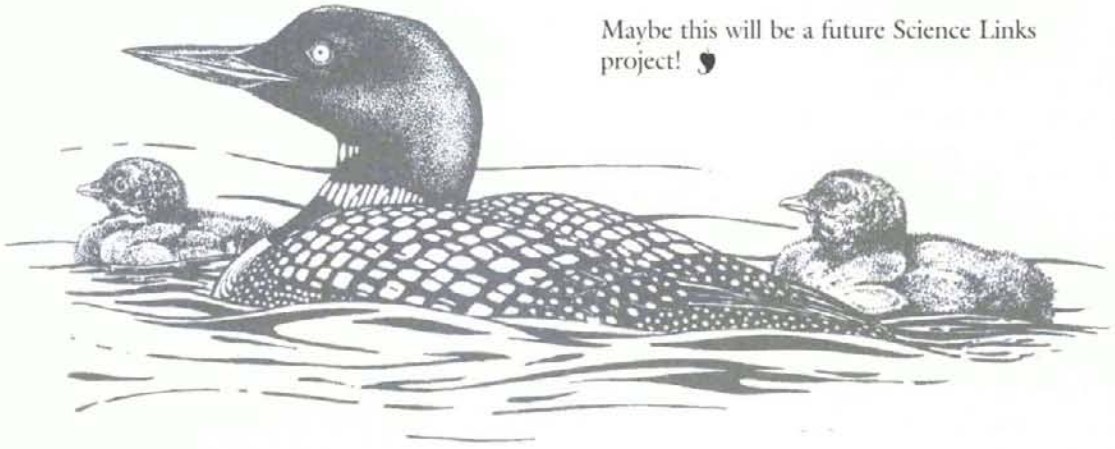
JH: *One final question. A recent publication by the US Forest Service and Vermont Department of Forest, Parks and Recreation (titled "Forests in the Green Mountain State: A Half Century of Change") states that "measures of health indicate these trees are in good condition." When working with the forest products industry to better understand the acid rain impacts on the forests, how do we square up these two divergent messages?*

KL: I haven't studied the report in detail, but I suspect that it may not have looked at data from the most recent year (1998-2001) and it may not have considered the factors that you would have to consider in order to detect forest health impacts from acid rain. In some areas, particularly low elevations, symptoms of multiple stress related to acid rain are just beginning to be detected. In addition, I don't know to what extent the report looked at the populations that would be considered vulnerable to acid rain — namely high- and mid-elevation red spruce and base cation accumulating hardwoods such as sugar maple and possibly ash.

Last, in order to get a quantitative sense of the potential for decline related to acid rain, it is necessary to look at the soil conditions.

It would be very interesting and beneficial for scientists and managers to work together to develop a field index of soil "health" that would be relatively easy to measure and compare across sites. This would provide a better sense of the extent to which Vermont trees may be vulnerable to declines in productivity.

Maybe this will be a future Science Links project!



Common loon
State Endangered

While there were 30 nesting pairs in Vermont last year thanks to better protection efforts, mercury from air pollution threatens future successful chick hatching.

COMBINING HEAT AND POWER:
Save Energy and Reduce Emissions

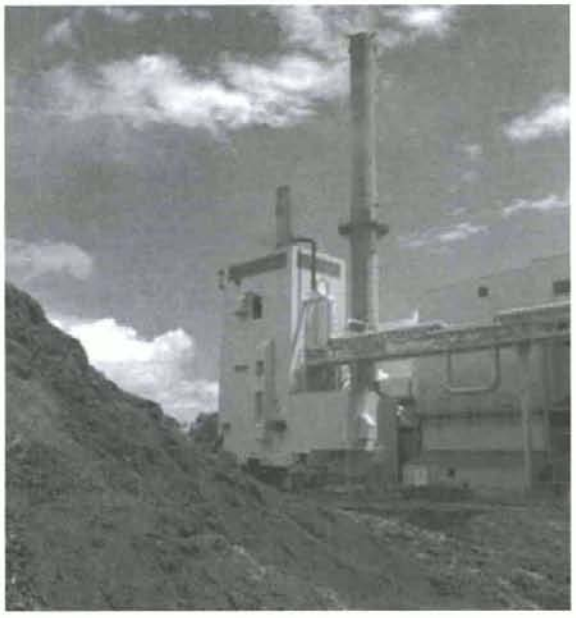
BY KIM KENDALL

The Burlington Electric Department, the University of Vermont and Fletcher Allen Health Care have created an opportunity for a community energy system in Burlington. This system would lower long-term energy costs for customers like UVM and Fletcher Allen and reduce carbon emissions by 32,000 tons per year. This reduction would be accomplished by replacing fossil fuel consumption with local biomass fired by the McNeil electric generating station in Burlington.

So what is community or district energy? It's a system to distribute heating energy to many buildings throughout a community using a central heating plant and a network of buried pipes. According to the International District Energy Association, "A standard power plant generates electricity, but nearly 60% of the energy consumed to produce that electricity is considered "reject" heat that is not used. District energy systems provide a way to "tap" the reject heat and use it more effectively to heat customer buildings in a city or on a campus or in industrial processes." This concept is referred to as "combined heat and power" and works in sync with a community energy system.

"The principle of combined heat and power is a major step toward the efficiency of our resource use," said Scudder Parker, Director of Energy Efficiency at the Vermont Department of Public Service. According to Parker, combined heat and power allows you to reduce all forms of energy — not just electricity. A community energy system, for example, would use excess heat from the McNeil plant to offset fossil fuel use up and down the streets of Burlington.

According to Mary Sullivan, Marketing/Communications Specialist at the Burlington Electric Department, a community energy system will help the City of Burlington meet its goal of reducing greenhouse gas emissions by 10%. In 1998, the City Council passed a resolution to set a target for 2005 of reducing greenhouse gas emissions in Burlington by 10% below 1990 levels. Burlington's Climate Action Plan describes the strategies that the City will use to meet the goal. The Plan considers the benefits of a community energy system, fueled by sustainably harvested biomass, the greatest single measure to reduce the City's greenhouse gas emissions.



According to Sam Krasnow, economic consultant, projects like community energy have benefits that are usually difficult to quantify and not factored into the decision-making process. For example, an economic decision to burn more fossil fuels has human health costs attributable to air pollution and environmental costs from the impacts of acid rain, global warming and mercury contamination. These costs are called externalities. Externalities are the costs associated with a particular economic activity that are experienced by individuals or society as a whole. Externalities occur when individuals are not compensated economically for incurring these costs.

Sam is helping VNRC calculate the cost savings of reduced pollutant emissions that a community energy system will achieve in Burlington. He is actually calculating the dollar value of "reduced environmental degradation."

The information will help decision-makers examine the true costs and benefits of a community energy system.

"Community energy is not a new thing; it's been around for a long time," according to Loren Doe, Director of Commercial Services at the Burlington Electric Department. In fact, most major cities including Boston, Montreal and New York City have community energy systems. Scandinavian countries have been reaping the economic and environmental benefits from community energy for even longer.

However, one of the things that makes the proposed community energy system in Burlington somewhat unique is that it is fueled by waste wood from forest thinning operations, sawmill residues and urban waste wood used by the McNeil Plant. Wood biomass is renewable and produced locally. According to John Irving, McNeil Plant Manager, "two thirds of the wood used by the McNeil Plant comes from Vermont." The McNeil Plant makes an important contribution to the Vermont economy. Fossil fuel use, on the other hand, sends millions of dollars out of state.

One thing that customers of a community energy system can count on is the stability of wood prices demonstrated over the last 15 years by the McNeil Plant. Currently, UVM uses primarily natural gas for heating. Natural gas prices fluctuate widely and were particularly high last winter.

There are other benefits. If downtown Burlington were to connect with the system, each downtown business would no longer need individual boilers. The elimination of large boilers would significantly free-up retail, restaurant, office and storage space in downtown Burlington.

Local Conservation Groups:

COLLECTIVE VOICES TO PRESERVE BIODIVERSITY

BY VIRGINIA RASCH

"There are some who can live without wild things, and some who cannot."
—Aldo Leopold

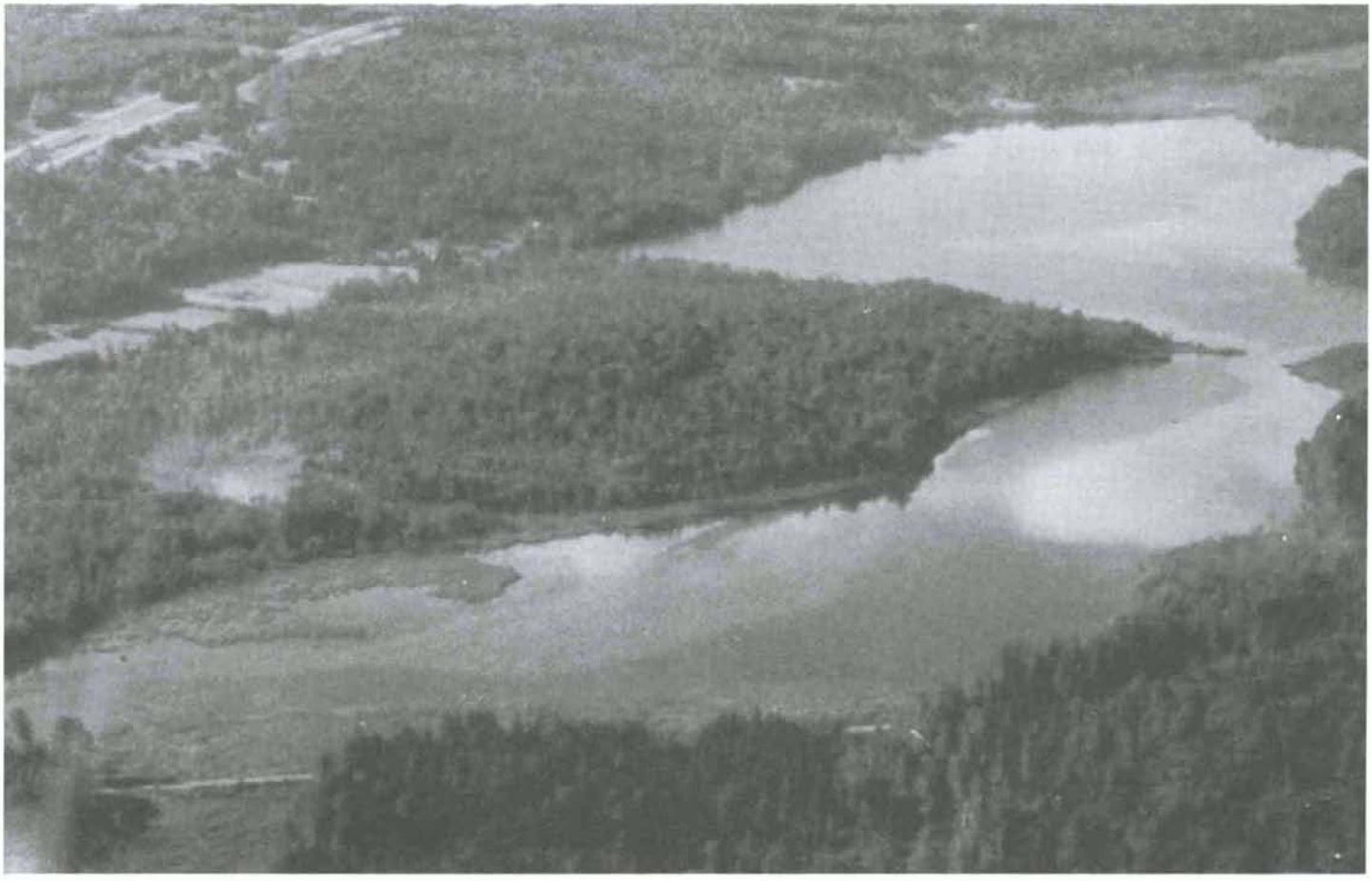
Folks who cannot live without wild things are a large part of the citizenry of Vermont. They also are critically important in helping to preserve our state and regional biodiversity.

Getting together with like-minded people — whether in municipal conservation commissions, local land trusts, watershed groups, or wildlife tracking groups — is a powerful way to make a difference. Through direct actions and public education, these local groups can protect biodiversity in a myriad of ways.

One of the most important is in data collection by inventorying the species and natural communities in our towns. We need to know what we have and where it lives, especially the species that are rare, threatened, or endangered.

Data collection should be followed by protection strategies, especially land conservation projects to preserve our most important resources. For example, local land trusts work with regional and statewide land trusts to accomplish this important work.

An excellent mechanism for promoting and funding land conservation is to form a local conservation fund. A local conservation fund is a dedicated fund set up by



Aerial view of Berlin pond.

Collective Voices

continued from page 29

the municipality to be used to conserve land and waters for conservation purposes such as agricultural, forest, wildlife, scenic, recreational, or natural area use. Sometimes, property is bought outright, and other times development rights are purchased.

These conservation funds may be funded through several sources, including town appropriations and voluntary contributions. Over twenty-five Vermont municipalities have established these local conservation funds.

To preserve biodiversity, we need to preserve important and/or large parcels as well as corridors and buffers that many wildlife species depend on. Thus, we must have the foresight to see beyond town boundaries, such as the visions displayed by watershed groups. Another valuable protection strategy for aquatic resources is to reclassify outstanding wetlands to secure greater protection.

Some of the conservation work that needs to be done is not easy or is downright controversial. For example, getting into the fray over where to allow motorized recreational uses is often necessary to help preserve biodiversity, but can also bring up many divisive issues in a community.

Promoting smart growth and fighting sprawl are other, challenging parts of the equation for local activists, for example, for citizens for responsible growth groups (CRGs). Our downtowns and village centers need to be attractive and desirable places to live so we can leave large tracts of land for natural areas as well as sustainable working landscapes of agriculture and forestry.

Local citizens are also needed in the watchdog and advocacy roles for stewardship of the state and federal lands that fall within our town borders. Although some of these lands should be managed for multiple uses, other sections should be set aside as ecological reserves or wilderness areas.

Ecological education of the townspeople is an important but often overlooked role for local conservation groups. This includes promoting stewardship on private lands: partnerships with private landowners are critically important to accomplishing our conservation goals.

Raising public awareness of exotic, invasive species can be fun work! Hats off to the Weathersfield Conservation Commission that designed a float, called Invasion of the Bio-Snatchers, that featured ten invasive species to educate parade goers at a recent field day.

We need to work together to create a culture of conservation. We need all Vermonters to appreciate the diversity of living species in our state, from the top predators to the bottom-dwelling mussels. As Leopold wrote, "If the biota, in the course of aeons [sic], has built something we like but do not understand, then who but a fool would discard seemingly useless parts? To keep every cog and wheel is the first precaution of intelligent tinkering."

Virginia Rasch is the executive director of the Vermont Conservation Commission. She is also a VNRC board member.

For more information about conservation commissions or local conservation funds, contact Virginia Rasch at 802/223-5527; ilovermont@aol.com.

On the Ground Success:

THE BERLIN POND WATERSHED PROJECT

BY VIRGINIA RASCH

The hands-on work of preserving biodiversity is one of patience and partnerships. One great success story is the preservation of a significant portion of the Berlin Pond watershed.

The Irish Hill Ridgeline is the prominent feature for nearly eight miles along I-89. This unspoiled mountain offers panoramic views and four season recreational trails. At the eastern foot of the Ridge lies the 260-acre Berlin Pond, which serves as the drinking water supply for Montpelier and parts of Berlin.

Irish Hill at Berlin pond.

Berlin Pond is unique in that it is the only large pond remaining in central Vermont that is largely preserved in its natural state. Over a century of restrictions on access and activity have turned the Pond and its surrounding wetlands and forestlands into a unique natural area.

The Pond and its environs are rich in biodiversity, with state significant plants, animals, and natural communities. Of most value are the diverse types of wetlands. These wetlands attract migratory waterfowl and provide nesting habitat for many species of birds, including nesting loons and pied-billed grebes. In 1998, the Vermont State Office of the National Audubon Society designated Berlin Pond as an Important Birding Area. A rare aquatic plant (Potamogeton strictifolius) lives in the pond.

From northern white cedar swamps to moose and osprey, the watershed including Irish Hill Ridgeline and Berlin Pond is certainly worthy of preservation. The idea to protect the Berlin Pond watershed originated with the Berlin Conservation Commission. In 1995, the Berlin Commission worked with the Montpelier Conservation Commission to write a grant to the Lake Champlain Basin Program for a study of Berlin Pond's natural habitat. An illustrated report was produced by Jeff Meyers, executive director of the Vermont River Conservancy, which outlined the importance of preserving the area.

During 1996 and 1997, neighborhood meetings and slide shows were held to elicit public comments regarding the long-range goals for Berlin Pond.

In 1998, the Berlin Conservation Commission took two steps to further their conservation goals: the town formed a local conservation fund, and the Commission worked with conservation-minded citizens in Northfield to help them form the Northfield Conservation Committee so that the two groups could work on projects that cross town boundaries.

Thus in 1999, the Berlin Commission's interest in conserving the Irish Hill Ridgeline began a collaborative effort among the conservation commissions/committees in Northfield, Montpelier, and Berlin. Fortuitously, an opportunity arose to purchase land on the ridgeline, and the Irish Hill Ridgeline/Berlin Pond Watershed Conservation Project was born.

The land conservation work has been accomplished in three parcels totaling 550 acres. The land was under development pressures, including a proposed major housing subdivision.

With significant help from the Vermont River Conservancy, grant funding from several foundations and private donations were received.

The conserved land serves to connect other forestlands publicly owned by the State of Vermont, the Town of Berlin, the City of Montpelier, and the Town of Northfield. One of the parcels was conveyed to the State of Vermont as an addition to the Boyers State Forest. The third parcel was purchased by the Vermont River Conservancy in 2000 and donated to the Town of Berlin, subject to a conservation easement held by the Vermont Land Trust. Together, the conserved parcels on the Irish Hill Ridgeline connect to Berlin Pond, thus conserving valuable movement corridors for wildlife.

And the project ideas don't end here—a Berlin Pond Site Conservation Plan Advisory Board was formed and is drafting a conservation plan; and volunteer crews have worked to clear trails on the Irish Hill Ridgeline, with the long-range goal of acquiring conservation easements to protect a ridgeline trail from Irish Hill in Berlin to Paine Mountain in Northfield.

Jeff Myers can be contacted at 802/862-7362, or meyers@together.net.

Peter Zilliacus: A Remembrance

By Stephen J. Holmes

Recalling the years that I know in the life of Peter Zilliacus is a bit like sitting down to enjoy a classic piece of literature or, as Peter would have it, savoring a glass of fine wine. To be sure, my relationship with Peter represents only the tip of the iceberg—which he must have known quite literally in his native Finland — of a full, rich life.

We met in 1983, when I became Executive Director of the Windham Regional Commission in Brattleboro. Peter's tiny office was next to mine on the third floor of the old Dunham Boot factory in the heart of the downtown. My earliest memories were of casual encounters, in and about the office, with a gentle, quiet, unassuming, somewhat enigmatic, man with an elfin grin. Over time I discovered that Peter was doing bookkeeping and tax preparation for individuals and non-profit organizations.

One day Peter walked into my office with a stack of papers in his hand and asked me if I wanted to be on the Vermont Travel Information Council for the southeastern district. Peter was the Chair, and there were two vacancies that he needed to fill. Over the next four years, Peter and I (he didn't fill the other vacancy) were the "sign czars" of Windham and Windsor counties, giving thumbs up or thumbs down to dozens of requests for those black and white business directional signs that are special to billboard-less Vermont. It was during those informal meetings discussing sign locations that our friendship took root, and bits and pieces of his fascinating life were revealed to me.

Others may want to write of his birth in England, education in Finland, war service for Finland on the Russian Front in World War II, flight to Sweden and then to America. They might also talk of his culinary prowess in restaurants in Vermont and Sweden, his years on Wall Street and his love of travel to exotic places, cross country skiing and sailing. At one point he told me he held citizenship in three countries: England, Finland and the U.S.

Where I came to know Peter best was in his deep love for Vermont and its natural resources and his lifelong commitment to citizen activism. In the late sixties, as a town official in Dover and as a member of the Windham Regional Commission, Peter was at "ground zero" in the debate over uncontrolled growth and environmentally damaging development that led Governor Deane Davis to visit the unplanned second-home developments that were proliferating in Dover and Wilmington. An early advocate for the initiatives that led to Act 250, Peter was tapped by Davis in 1970 to be the first Chairman of the District 2 Environmental Commission, a post he held for seven years.

Peter Zilliacus receiving environmental stewardship award from Senator Jim Jeffords — April 22, 2000.

Following his years of public service administering the new Act 250, Peter became very active in a variety of organizations that sought to protect the environment and strengthen the voice of citizens in environmental laws, particularly Act 250. We served together on the board of the Conservation Society of Southern Vermont. Peter was also instrumental in founding a Brattleboro-based citizens group that stood for responsible growth and was active as a party in high-profile Act 250 cases such as the C & S warehouse case.

In the summer of 1993, Peter and a group of over thirty other citizens sat on hay bales at Don Avery's Cady's Falls Nursery to figure out if there was a way for individuals and small neighborhood groups to support each other in the Act 250 process when they were facing large scale, environmentally disruptive developments in their communities. Out of that meeting, the Citizen Participation Network was born, and Peter was one of the driving forces, serving as its Treasurer.

Throughout the 1990s, I had the good fortune to work closely with Peter on several campaigns related to Act 250: supporting the Environmental Board in 1993-94; rulemaking in 1995 and 1999; and nearly annual defense of the law in the legislature. Peter was one of the first people I would call in each of these instances, and he was unfailing in his commitment to strengthening the law and a citizen's right to fair hearings. As a former Act 250 administrator, his words were some of the most powerful testimony before legislative committees and Environmental Board hearings.

So it was with deep pleasure that I had

the opportunity to work even closer with Peter when he agreed to join the VNRC board in the summer of 1997. He became a member of the Policy Committee and eventually rose to Chair of the committee, for which I provide staff support. It was always fun to work with Peter on strategies to advance VNRC's policy objectives. He often called to sound me out on new ideas he had, or to "do his homework" as he was preparing for a meeting or for testimony in the statehouse. We often sought each other out at gatherings, such as standing together in the light rain chatting at the VNRC Earth Day 2000 celebration just before he received the Environmental Stewardship Award from Senator Jim Jeffords. He had taken the new commuter rail up from Shelburne and was so excited about its future.

I recall with fondness my visit to Wake Robin in September 2000 as Peter was preparing for his trip to Iceland. I don't know if he knew at the time how sick he was, but he never let on if he did, and he was as feisty and playful as I'd ever seen him. We talked for about two hours about an eclectic assortment of topics: Iceland, Volvo accidents, skiing, mercury in the Lake, the upcoming elections, VNRC, citizen advocacy, and I gave him a copy of "Ishmael" to take on his trip.

The last time I saw Peter was at Wake Robin a few weeks before he passed away. He and his daughter, Marjorie, son-in-law Malcolm, Elizabeth Courtney and I talked about some of Peter's favorite subjects: the environment; citizen advocacy; Act 250. He remembered that he wanted to give me back the book I had given him to read on his trip to Iceland (although I sensed that he had been having too much fun touring to finish it.) We gave each other a big hug, and I said "Good bye, dear friend." I know I had tears in my eyes, but as I turned one last time to see him giving his farewell from behind the open door, I could see the twinkle in his eye, the elfin smile and with a jaunty wave of his hand: "See you."

"Yes, we will see you"—
Peter Zilliacus: World Citizen —
Lifelong Activist —
World Class Environmentalist.

A Biodiversity Conservation Plan for Vermont?

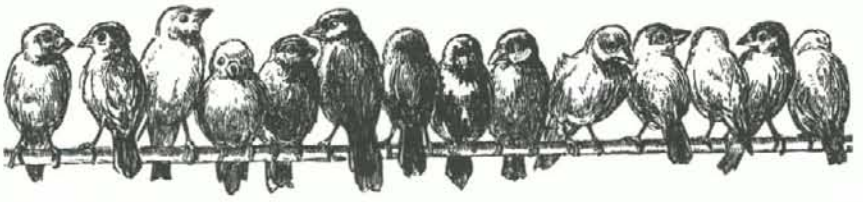
continued from page 3

greater protection of property rights.

Though there are some sources of money for biodiversity conservation at the state and national level, such as the Vermont Housing and Conservation Fund, and the federal Land Conservation, Preservation and Infrastructure Fund, a much more comprehensive, long term funding mechanism is needed. In other words we need to revive CARA, the Conservation and Reinvestment Act, which came within a few votes of passing in the last Congress. Prospects have improved somewhat with the recent, dramatic change in leadership in the Senate. With the newly Independent Senator Jim Jeffords Chairing the Senate Environment Committee, and increases in public pressure on the Bush Administration to improve its environmental record, there just might be a window of opportunity to get some meaningful funding for state-led biodiversity initiatives.

There was a time when Vermont would be out front on an issue like this. But we still have a chance to catch up.

Patrick Parenteau is a professor of law at the Vermont Law School.



Link Up with the *Conservation Network*!

Join a team of informed individuals who make a difference for environmental protection.

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Please return this form to:
The Conservation Network, VNRC, 9 Bailey Avenue, Montpelier, VT 05602.
For more information, call Patrick Berry at (802) 223-2328.
E-mail: pberry@vnrc.org

Welcome Mali!

Mali O'Brien is a student at Smith College in Northampton, Massachusetts. As a summer intern at VNRC, her focus will be on energy efficiency. She will be researching initiatives taken by other states to enact legislation promoting renewable energy, energy efficiency and green buildings. VNRC will work with state government to help state buildings meet standards laid out by the U.S Green Building Council. Complying with these standards can result in significant economic and environmental benefits, and gives the state an opportunity to set a good example in energy conservation.

Mali and staff scientist Kim Kendall will also be working with Vermont Businesses for Social Responsibility and Efficiency Vermont to develop a program that would provide professional offices with more efficient light bulbs at a reduced cost. According to Richard Cowart, director of the Regulatory Assistance Project, the American Council for an Energy Efficient Economy (ACEEE) has identified over 100,000 megawatts of energy savings that could be implemented through a number of low-cost methods, one of them being more efficient lighting for commercial buildings(See Cowart interview in the *Winter 2001 VER*).

Mali has a strong interest in the environment and wilderness recreation and, when home from Smith College, resides in Montpelier with her family and dog.

Mali O'Brien

Meet VNRC's New Mollie Beattie Intern

Alexander Leventon Metcalf is a recent graduate of Juniata College in Huntingdon, Pennsylvania. He graduated with a Bachelor of Science degree in Environmental Science. He is also a Long Trail End-to-Ender (1996). During the summer, Alex will be working with Pat Berry and Kelly Lowry to increase public involvement in the issues important to VNRC and its members. The basin planning process currently underway at the Department of Environmental Conservation (DEC) will be a focal point for this effort. Look for him in the White, Lamoille, and Poultney watersheds!

In addition, Alex will be developing a Geographic Information System (GIS) for VNRC. This system will allow VNRC staff to view spatial data with a computer, create new data layers for specific projects, analyze spatial and temporal relationships between data layers, and create maps for a variety of applications. Both of these projects will increase the ability of VNRC to understand our natural resources and mobilize Vermonters to protect them.

Alex currently lives in Randolph, where he was raised, and plans to stay in Vermont working in an environmental field and continuing his education.

Alexander Leventon Metcalf

Welcome Seward!

VNRC would like to welcome Seward Weber to the board. We are happy to have Seward on the board — especially in light of his extensive VNRC background!

Seward moved to Vermont in 1971 to serve as the executive director of VNRC — a position he held until 1984. During that time, he spent one year on a fellowship at the Yale School of Forestry and Environmental Studies. In 1985, Seward became the Director of the Mohonk Preserve, a 6,000-acre natural area in New York, and was there until his retirement in 1993.

Seward has been actively involved in volunteer work, including service on the boards of the Vermont Audubon Council, and the Vermont Land Trust and the Vermont Alliance of Conservation Voters. Prior to moving to Vermont, he held several administrative positions in higher education. He received a bachelor's degree from Dartmouth College and a master's degree in City and Regional Planning from the University of North Carolina. He and his wife, Susan, manage their woodland property in Calais and have recently protected it with a conservation easement.

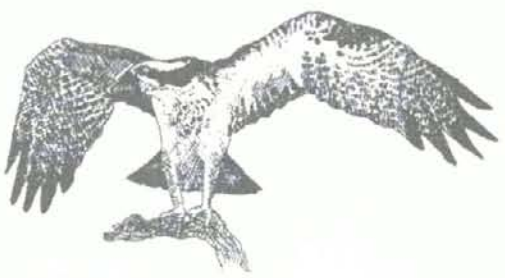
Join VNRC Online!

If you have access to the Internet and want to save paper and postage, you can renew your membership at VNRC's web site.

VNRC now has a secure form you can submit via the Internet to join, renew or donate using a VISA or MasterCard.

Are you interested in joining VNRC's activist network? Receive the most recent action alerts and updates about the 'hot' environmental issues. Make your voice count!

Go to www.vnrc.org for more information!



HEADS UP!

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VNRC has a $20 introductory rate, with a regular membership of $35. Besides helping the leading statewide environmental group preserve Vermont's valuable resources, your membership includes:

- Invitations to local events and meetings
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Call us at (802) 223-2328 in Montpelier or (802) 864-9600 in Burlington, or visit us on the web at www.vnrc.org

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COME CELEBRATE THE EARTH CHARTER WITH VNRC!

Join VNRC and friends in the celebration of a sustainable future for Vermont!

One of VNRC's longtime supporters and good friends, Steven Rockefeller, has been working with others around the world in the creation of the Earth Charter, which outlines a set of values and principles for a sustainable future. It is Dr. Rockefeller's hope that the Earth Charter will be adopted by the United Nations General Assembly early next year.

VNRC has established a working alliance of Vermont non-profit organizations embracing the four "E's" of sustainability: environment, social equity, economy and education. This alliance, called the E4, will present Dr. Rockefeller with a resolution in support of the General Assembly's adoption of the Earth Charter.

Mark your calendars for Sunday, September 9th from 4:00 pm to 7:00 pm at the Coach Barn at Shelburne Farms.

Invited guests include Senator Jim Jeffords, Representative Bernie Sanders and Senator Pat Leahy.

A light buffet will be served in the courtyard.

USE YOUR TAX REFUND TO HELP VERMONT'S ENVIRONMENT!

Wondering what you're going to do with your tax refund from the Bush administration? Consider sending a message to the politicians in Vermont and down in Washington about your priorities, and at the same time, do something positive for Vermont's environment!

We have many opportunities to use the tax refund check to help clean up our waters, forests and communities. Get involved! Collect your neighbors together and use your refunds to start a conservation commission in your community.

You don't have a lot of time? Then think about giving the refund — or a portion of the refund — to a local or statewide environmental group that's working hard to protect Vermont's natural resources.