

# Natural Areas Report

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## Natural Areas News and Information Exchange

The North Woods in autumn is a beautiful sight. For several days last October, Forest Service Research Natural Area Coordinators met at the Bartlett Experimental Forest in the White Mountains of New Hampshire, in a forest full of color. Three months later, the North Woods was glazed in ice, gripped by the worst ice storm in a hundred years.

There was no hint of the damage to come as the coordinators toured the oldest and one of the best studied Research Natural Areas in the region, The Bowl RNA. Over a dozen researchers described their work in the RNA, and its connection to studies in the Northeastern Research Station and throughout northern New England.

The environmental history of this area is one of great change, from Pleistocene ice sheets to colonial deforestation. In this issue of the *Natural Areas Report*, we feature the legacy of a quarter century of research conducted at The Bowl RNA, explore how RNAs can be integrated into ecosystem management of national forests, and take a look at the challenges presented by the 1998 ice storm.

## A Legacy of Research in The Bowl RNA

Knowledge acquired from forests that have never been logged can provide clues to the long-term effects of resource use. Very few uncut forests remain in the northeastern United States; The Bowl Research Natural Area is one of the few.

The Bowl is a 607-hectare cirquelike watershed located in the White Mountain National Forest (WMNF) near Wonalancet, New Hampshire. Within the Bowl, a 206-hectare RNA (as well as an additional 445-hectare proposed expansion) has been the site of a long history of environmental research. The steep cirque walls and deep tills of the RNA were formed by glacial action during the Pleistocene. Significantly, there is no evidence of logging or fire in the area. Many trees there are 400 years old or older.



The Bowl artist: Lucy Tyrrell

History of research at The Bowl parallels research developed at two nearby Experimental Forests: Bartlett and Hubbard Brook. The following is a small sample of recent studies at this remarkable site, written by the scientists who work there. Included are contact addresses for more information about each project.

### An Evaluation of Nutrient Cycling Processes and Remote Sensing Applications

• Mary Martin (mem@unh.edu) and Scott Ollinger (svo@unh.edu) of UNH Complex Systems Research Center, Richard Hallett (rah@unh.edu) and Marie-Louise Smith (mlsmith@shooter.sr.unh.edu) of Northeastern Research Station.

The goal of this project is to develop tools whereby sites such as The Bowl RNA can be used as ecological index sites

to evaluate the impacts of forest management alternatives. This study expands on and synthesizes existing monitoring and research activities at The Bowl. Currently work is being carried out to measure soil nutrients, tree growth, and foliar chemistry across a range of site qualities and land-use histories. These data will be used in conjunction with

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## The Bowl RNA, *continued from page one*

remotely sensed AVIRIS imagery of these forest canopies to develop GIS tools to predict spatial patterns in soil parent material composition, forest canopy nutrition, and forest health. This project will extend the use of these data to a modeling effort using PnET, a model that integrates field and remotely sensed data collected on nutrient cycling, foliar chemistry and productivity, and stream water chemistry in a landscape-level assessment of nutrient cycling. The Bowl will be used as a control area to evaluate effects of management practices on nutrient cycling in other areas of the WMNF. Comparison of results from The Bowl to results from other areas under different forest management regimes will provide information that can be used in making management decisions for other northern hardwood forest stands in the WMNF that are sensitive to nutrient depletion. Soil, foliage, and tree cores will be archived and made available for other research efforts. This study will enhance our knowledge of nutrient cycling in areas that have experienced minimal direct human disturbance.

### Regional Sugar Maple Decline Network

- Richard Hallett (rah@unh.edu) and Scott Bailey (sbailey/ne\_du@fs.fed.us) Northeastern Research Station

Declines in sugar maple growth, vigor and reproduction have recently been noted in the northeast. Depletion of available soil calcium pools has been documented at some sites and is one possible factor in sugar maple decline. This study utilizes plots developed by several related studies to evaluate sugar maple condition as related to site quality on a regional basis. Spatial patterns in soil properties and in maple conditions are being examined through sampling of soils

and trees and through the development of a parent-material mineralogy model. Tools to predict spatial patterns in site quality and sugar maple response are needed to further evaluate the potential role of nutrition in decline and develop response strategies usable by forest managers. The Bowl RNA is part of a regional network of study sites.

### Lichens as indicators of ecological continuity

- Steve Selva (sselva@maine.edu) University of Maine, Fort Kent

As part of an ongoing effort to assess the continuity of forest ecosystems in northern New England and Maritime Canada, several of the Forest Service's Research Natural Areas and Candidate

continuity of northern hardwood stands at The Bowl, Mountain Pond, The Cape, and Mount Horrid; of spruce-fir stands at Alpine Gardens, Cone Pond, Gibbs Brook, Nancy Brook, and Shingle Pond; and of red pine stand at Owl's Head. The data show that, not only do epiphytic lichen floras become richer over time (with older stands harboring more rare species), but that the total number and presence of particular Caliciales species is, in itself, an indicator of continuity. Commonly called the "stubble lichens" because of their small size, species in the fungal Order Caliciales are frequently overlooked, hence underreported. Of the 35 species I have reported for Maine north of Mount Katahdin, for example, 23 represent new records for the state and one is a new record for the northern hemisphere. As perhaps our most sensitive biomonitors of forest ecosystem health, lichens in the Order Caliciales are also one of the forest's most elusive inhabitants. On the basis of the occurrence of 20 or more of 30 indicator species, the Research Natural Areas at The Bowl, Mountain Pond and Nancy Brook are confirmed as "ancient forest sites," a stage of succession used here to describe the oldest of the old-growth. For example, 23 ancient forest indicator lichen species were found at The Bowl, including 13 Caliciales species, which represents the largest assemblage of Caliciales species collected at any of the hardwood stands investigated to date. These were from among a total of 101 lichen species recorded for the entire stand.

### Long-term monitoring in The Bowl RNA

- Wayne Martin (wmartin/ne\_du@fs.fed.us) Hubbard Brook Experimental Forest and Northeastern Research Station

In 1974, a survey recorded the species and diameter of trees, aspect, slope, and elevation of 218 circular plots within a 100 x 100 meter grid established throughout the entire Bowl below 915m elevation. The estimated basal area of all trees and shrubs big enough to be measured was 28 +/- 1 m<sup>2</sup> per hectare and 241 t/ha of total biomass



Research Natural Areas in Vermont and New Hampshire have been investigated. Patterned after a study by Francis Rose in Britain, the study uses indices of ecological continuity that are based upon the percentage occurrence of ancient forest indicator lichen species found at each site. The study examines

estimated using the equations by Whittaker. However, since other scientists were working in the RNA at the time, fewer plots were measured there than in the rest of The Bowl. The original plots were not permanently marked, but the starting point of the grid was marked. In 1994, 327 plots were measured throughout the Bowl, including the additional plots located in the RNA. In 1994, the estimated basal area of all trees and shrubs big enough to be measured had increased to  $32 \pm 1 \text{ m}^2$  per ha and  $251 \pm 9 \text{ t/ha}$  of total biomass.

Additionally, from 1973 through 1975, streamwater samples were collected from Wonalancet Brook and several of its tributaries for chemical analyses. Remeasurement found that stream chemistry has changed very little over the 20 years.

#### RNA-Related Work

• Gary Wade

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Northeastern Research Station

One of my interests is in bringing RNAs fully into use by the Forest Service as reference areas actively used in a program to monitor the effect of forest management practices on local and regional biodiversity. These practices include individual tree selection, patch cutting and group selection, shelterwood cuts, preservation of stands in desired future condition, and forests used for various forms of forest recreation. My approach is to use complete botanical inventories of forest stands to determine management effects on all species at the scale at which we manage forest stands. To date, most studies of management-related changes in forest stands have been plot studies yielding fine-grained data on stand structure and species associations. Plot studies, however, do not capture all species, and over time plot data do not allow inference of species introductions or extinctions—these may occur outside of permanent plots. Complete inventories do allow study of flux over time, but single inventories do not allow comparisons of floras in the context of the inherent variation among watersheds and forest stands. Complete inventories in three or more stands of similar forest type and history tell us how much variation to expect within that forest type and they allow us to compare types within their ranges of variability. Such inventories combined with sampling studies will provide necessary information for practicing adaptive ecosystem management. They can provide early warning of global change effects, need for management practice

changes, and justification of practices which may still lack objective, quantitative proof of effectiveness across scale.

#### Wildlife research completed in The Bowl RNA

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Northeastern Research Station

To date, wildlife habitat research in The Bowl RNA has investigated: 1) avian community and habitat structure of mature, over-mature, and old-growth northern hardwood stands; 2) small

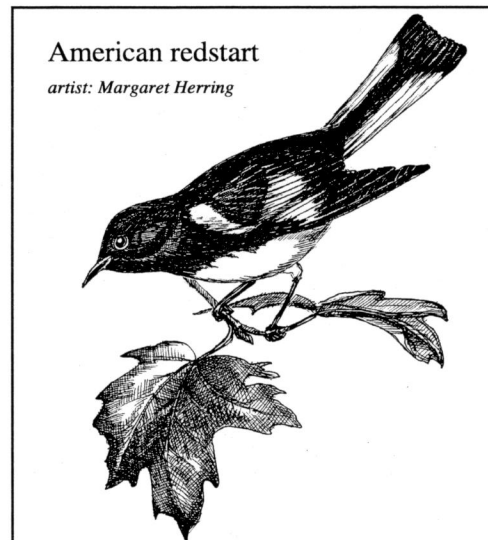
mammal community and microhabitat characteristics in old-growth northern hardwoods; and 3) forest habitat associations of bats.

Forest stand development (structure and microhabitat features) plays an important role in describing avian occurrence and abundance in northern hardwoods stands. Red-eyed vireo, ovenbird, black-throated blue warbler, black-throated green warbler, and American redstart were common species. Conifer inclusions in various stages of development also influence avian occurrence and abundance.

Longer term studies are necessary to understand the high year-to-year

variability of small mammal community occurrence and abundance due to food availability, weather, and predation, and to observe patterns of small mammal activity with respect to microhabitat features not adequately described at the stand level.

All nine species of bats that occur in the northeast have been observed in the White Mountain National Forest during the summer. A systematic survey using Anabat II ultrasonic detectors sampled flight and foraging activity in four age classes (regeneration, sapling/pole, mature sawtimber, and over-mature) of both hardwoods and softwoods. Prototype software was able to objectively discriminate all echolocation passes of non-myotis bats to the species level and all echolocation passes of myotis bats to the genus level in a statistically predictable manner. The highest levels of flight activity on the forest were in over-mature and regenerating hardwood age classes and regenerating softwood age classes. Lowest flight activity was observed in sapling/pole and mature hardwood and softwood age classes. Highest level of foraging activity was observed in softwood regeneration. A much lower rate of foraging activity was observed in hardwood regeneration, sapling/pole, and over-mature age classes. Softwood sapling/poles, mature, and over-



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## *1998 Ice Storm in the Northern Forest Lands*

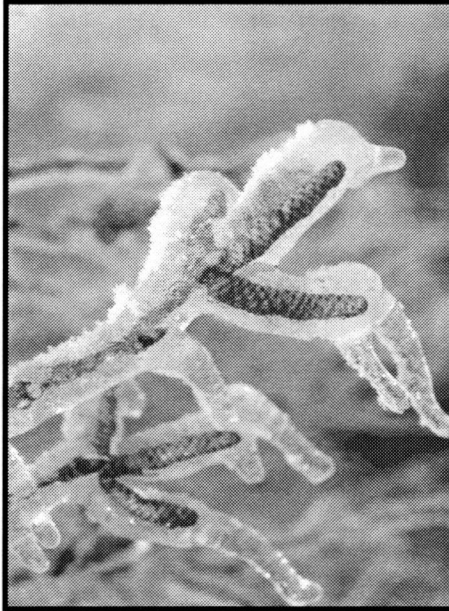
In January, a combination of cold weather and days of rain blew through parts of New England and southern Canada, coating the region in the worst ice storm of the century. Up to three inches of ice coated trees, roads, and power lines. The weight of the ice buckled trees, snapped branches, and left thousands of people without heat or lights for almost two weeks. In the US alone, 37 counties across four states were designated federal disaster areas.

The economic effects of the ice storm will be felt for years to come. Thousands of community shade trees need to be replaced and thousands of miles of hiking trails and access roads need to be cleared. Broken trees have less value for lumber, and damaged sugar bushes will take years to recover.

The affected areas include most of the Northern Forest Lands across southern Maine, New Hampshire, Vermont, and New York. About 20 percent of this forest, some 5.3 million acres, experienced severe damage.

In the weeks following the storm, foresters from each state and National Forest began to assess the damage to the forest. They flew low-level aerial surveys over much of the region, sketching damaged areas onto topo maps to obtain preliminary understanding of the scope of the damage. Ground checking began this spring and summer to determine the severity and pattern of the damage.

The Forest Service provided funding for the initial assessment. The region will also receive \$48 million, part of a Congressional package that includes funds for regions of the country affected by unusual el Niño weather. The money will help fund programs in stewardship, urban forestry, rural development, and



forest health monitoring.

Although short-term economic effects of the storm are staggering, few studies have followed an event of this nature over a long period of time. Funding for forest health monitoring will be used to measure the long-term effects on the forest, expanding a program begun in New England in 1990. A portion of the established plots are sampled each year to obtain information on tree condition. This year, all plots in northern New England that were impacted by the ice storm will be evaluated for damage. The established protocols for Forest Health Monitoring will be followed, and some additional information related to ice damage will be collected. New sites in New York, scheduled to join the program next year, have been identified and will be initially visited this year to help determine long-term trends in tree condition and recovery.

Additionally, the Forest Service Northeastern Research Station will begin long term study of the storm's effect on forest resources. Forest Inventory and

Analysis has an extensive plot network of sample sites located throughout the ice damaged areas, and has recently completed forest surveys in Maine, New Hampshire, and Vermont. A resurvey of some of these plots will serve to adjust the data initially collected following the storm, so that more accurate measures can be made of individual state resources.

Ground-based data collection will assist photo-interpretation of large-scale aerial photography in the region. Information collected from ground plots could be directly correlated to aerial photo classification to determine the relationship between aerial observation and ground-based observation. This report will refine our understanding of how to use large-scale imagery to assess forest damage and ground plots.

New York and the states of northern New England have been engaged for years in a process to assess and protect the northern forest. In many ways, partnerships are already in place that will be necessary to restore the forest following the ice storm. The states and the federal foresters are working together to link restoration and recovery efforts to existing goals, such as those developed by the Northern Forest Lands Council, and to use existing partnerships to develop cohesive approaches to stewardship. Ten years after the Northern Forest Lands Study was begun, a collaborative, bioregional approach to forest stewardship seems possible.

For more information, contact the Ice Storm Recovery Team, USDA Forest Service Northeastern Area State and Private Forests, PO Box 640, Durham, NH 03824; 603-868-7704.

Scenes from the 1998 Ice Storm



## Conservation Opportunities under the Farm Bill

A fundamental shift in the relationship between agriculture and the government is occurring with implications for natural areas managers. For decades the main goals of USDA policy were to stabilize prices, underwrite risk, promote high production, and secure a low cost food supply. But more recently two other ideas have gained hold. The first is that a global free market should be established without extensive government subsidy systems. The second is that farmers can produce more for society than food and fiber — they can produce environmental goods for which, perhaps, they should be compensated.

These new ideas are embodied in the 1996 Farm Bill. The Farm Bill established new conservation programs and redirected existing programs. These programs are now available to landowners. The Conservation Reserve Program purchases easements and rents land for the purpose of protecting environmentally sensitive areas. Offers from landowners are ranked and accepted according to environmental benefits with an emphasis on wetlands, ecological restoration, and buffers. Up to 36.4 million acres may be enrolled in this program at any one time.

The Environmental Quality Incentives Program provides cost-share support to owners of agricultural land to install or adopt conservation measures. The program is funded at \$200 million per year. Landowners enter into contracts for five to ten years and receive payments up to \$10,000 per year. Priority for funding is given to specific geographic areas that have been

identified within each State based on water quality and other resource problems.

The Wetlands Reserve Program promotes the restoration and protection of wetlands through three mechanisms — permanent easements, 30 year easements, and restoration cost-share contracts. Up to 975,000 acres may be enrolled under this program. The Wildlife Habitat Incentives Program is a cost-share program targeted specifically at enhancing wildlife habitat. A total of \$50 million through the year 2002 is available to support this program.

The conservation programs of the 1996 Farm Bill are administered by the USDA Natural Resources Conservation Service (formerly the Soil Conservation Service). NRCS is an agency of 11,000 people dedicated to working one-on-one with private landowners to promote conservation of natural resources. NRCS staff work in 2,500 field offices in close partnership with local Conservation Districts and other local entities.

Managers of natural areas may be able to participate in these Farm Bill conservation programs. But more importantly, these programs provide opportunities to work collaboratively with other landowners in the area to solve natural resource problems that may affect ecological systems across the landscape. To learn more, contact your local NRCS field office.

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## Research Natural Areas Are More Than Set-Asides

Ideally, the network of Research Natural Areas (RNAs) established and managed by the USDA Forest Service is a cornerstone of ecosystem management. Because RNAs are managed to maintain the biological diversity and natural processes within representative national forest ecosystems, they can serve key roles as control or reference areas for monitoring effects of management on similar ecosystems. In addition, they provide sites for nonmanipulative research that yields information useful to managers. Yet, too often, these lands are considered merely as "setasides" or "locked up" lands that only benefit researchers.

RNAs are far more than set asides, although they indeed are lands that are set aside as special. Managing RNAs for other than consumptive uses does not mean the land isn't useful to national forests. RNAs and other natural areas are an essential component to the successful implementation of ecosystem management on national forests. Here are a few examples of how RNAs might be more fully integrated into ecosystem management and thus can be more useful to national forests:

**Build a network of RNAs based on ecological land classification.** The Forest Service has adopted the National Hierarchy of Ecological Units to relate management options to mapped units that share similar climate, geology, soils, and potential vegetation. By establishing a network of RNAs, which represent the full array of ecological units (such as landtype associations) occurring on national forests, these RNAs can then be used as reference or control ecosystems for monitoring effects of management or for manipulative research conducted elsewhere on the same ecological unit.

A regional RNA assessment based on ecological land classification is now underway in the Forest Service's Eastern Region through cooperative agreement between the Regional RNA Program and the Midwest Regional Office of The Nature Conservancy. The assessment summarizes (1) what ecosystems exist on national forest lands, (2) which ones are currently represented in RNAs and other protected areas, and (3) what gaps in representation exist in the network of reference ecosystems. This information will be available to guide selection of new RNAs to fill these gaps.

**Consider RNAs as landscapes.** Some RNAs are small and unique. While these areas contribute to the overall protection of biodiversity, they are unlikely to serve as reference

areas because they are not representative of communities being managed intensively. A few large RNAs (100's to 10,000's of acres) are better able to represent landscape patterns and serve as control areas than many smaller RNAs. The current emphasis on RNA establishment for ecological representation in the Eastern Region is to select several large RNAs that contain several ecosystems or ecological units. Seven of the 42 established RNAs are more than 1,000 acres, and 15 are more than 500 acres.

**Design patterns of land use at the landscape scale.** Land planning on national forests benefits all land uses if it concurrently allocates areas for intensive recreation, timber harvest, and wildlife habitat while planning for ecological reference areas. RNAs are more useful as reference areas if their functional size is increased by assigning compatible land uses next to them, or by providing corridors to other natural areas. Best management practices can be developed for intensively managed areas based on information obtained in reference areas if land is allocated to both types of areas on the same landscape. By clustering intensively managed areas, total outputs won't be reduced, yet will be less costly in terms of reduced landscape function caused by fragmentation.

Landscape analysis and design is being used in Wisconsin, where forestwide land planning on the Chequamegon and Nicolet National Forests considers the full spectrum of land uses. RNAs, special areas, old growth, and wilderness are planned concurrently with other management areas to provide core areas of biodiversity within each ecological unit.

**Develop monitoring programs for land stewardship that use RNAs as reference areas.** One of the objectives of RNAs is to monitor the effects of resource management techniques and practices by serving as a control or baseline. For adaptive management to be successful, the effects of a particular management activity should be evaluated not only against the management objectives but also in comparison to a control area that did not receive the same treatment. As an example, when monitoring the herbaceous flora after a selective harvest, the herbaceous flora should also be tracked in an area not harvested. This will help determine if other factors not related to the harvest, such as effects of deer browse or exposure to atmospheric deposition, are influencing the herbaceous cover.

Monitoring the number of land snail shells (live, empty, and broken) in the leaf litter at Atwood Ridge RNA before and after a prescribed burn has enabled managers on the Shawnee NF (Illinois) to respond to concerns about possible effects of the Forests' prescribed fire program on land snail density and mortality. Results indicate that fire does not affect snail mortality as much as soil moisture. Tionesta RNA on the Allegheny NF (Pennsylvania) has been surveyed for stream habitat and fish to compare with reaches of the same stream flowing through harvested areas.

**Reap the benefits of research in RNAs to improve resource management.** RNAs are great laboratories and libraries of information about ecosystem structure, composition, and function. Nonmanipulative research and monitoring in RNAs yield information about similar ecosystems that are more intensively managed, help determine how to retain features important in ecosystem function or structure, and elucidate habitat requirements of rare plants and animals.

An inventory of invertebrates, specifically ground beetles, conducted by researchers in Michigan's Nawaygo Prairies RNA will aid in monitoring invertebrate populations during the restoration of nearby red pine plantations that are being converted to prairie. This restoration of plantation to prairie will be considered a success by the Huron-Manistee NFs if native prairie specialist species, including invertebrates now found only at Nawaygo Prairies RNA, recolonize the area. Research on mammal populations in relation to forest floor characteristics in unharvested areas (Dukes RNA) and harvested areas elsewhere on the Hiawatha NF in Michigan contributes to the management of northern hardwood and conifer-hardwood ecosystems.

**Use RNAs as a showcase for biodiversity protection and ecosystem management.** Low impact educational activities conducted in RNAs can help increase awareness of how RNAs relate to the national forest's management of natural resources. Some RNAs include existing hiking trails well suited for visitors to enjoy low impact recreational pursuits such as hiking or birdwatching. For example, a conservation biology class from the University of New Hampshire has hiked the trail into The Bowl RNA to discuss conservation issues.

**Recognize connections with other program areas.**

Ecosystem management considers ecosystems as a whole. RNAs relate to many program areas that are integrated in ecosystem

management, such as timber, wildlife, wilderness, threatened and endangered species (TES), recreation, and fire. For example, research conducted at Memorial Grove Hemlocks and Tucker Lake Hemlocks RNAs on the Chequamegon-Nicolet NFs (Wisconsin) provides the timber program with information on structure of coarse woody debris in old-growth hemlock-hardwood forests. Research on invertebrate availability in the breeding habitat of the Piping Plover at Pointe aux Chenes candidate RNA on the Hiawatha NF contributes to the TES program.

**Use RNAs as an information resource.** Several RNAs in the Eastern Region are large enough to be representative of several common ecosystems, including Tionesta (Allegheny NF, Pennsylvania), McCormick (Ottawa NF, Michigan), Ozark Hill Prairie (Shawnee NF, Illinois), Keeley Creek (Superior NF, Minnesota), Nancy Brook, and The Bowl (both White Mountain NF, New Hampshire). Tionesta and The Bowl, in particular, have received widespread use and recognition by managers and researchers alike for their function as reference areas. As noted elsewhere in this issue, The Bowl's reference watershed of northern hardwoods has been used in a variety of ways to conduct comparisons with similar ecological areas under different management elsewhere on the forest.

Key to any RNA's usefulness to natural resource management is its ability to provide information that is not available from more intensively managed landscapes. How can we determine the effect of forest management on stream habitat unless we have an example of a stream in an area not managed for timber harvest? How can we determine if the levels of nitrogen runoff in a harvested area are relatively high or low unless we have an unharvested watershed for comparison? How can we learn ways to better retain properties of unharvested watersheds, unless we can study what these ecological properties are? How can we assess the impacts of ATV use on soil erosion, unless we have areas in which soil erosion is measured in the absence of such vehicular use? RNAs, as an information resource, provide managers the opportunity to ask and answer questions about ecosystem management, and thereby allow managers to be more informed when making management decisions.

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## The Bowl RNA, *continued from page three*

mature age classes were observed with the lowest foraging activity in the two year survey.

### Nitrogen Cycling

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This study uses natural abundance of  $^{15}\text{N}$  as a tool to assess the history of nitrogen cycling and loss. Although most work on nitrogen saturation involves long-term stream chemistry monitoring, using  $^{15}\text{N}$  allows a one-time soil sampling to gather information. A site with high nitrogen loss (and implicitly high nitrification) would have elevated  $^{15}\text{N}$ . This is because microbes discriminate against  $^{15}\text{N}$  in all transformations of N, so

nitrification produces  $^{15}\text{N}$ -depleted nitrate and  $^{15}\text{N}$ -enriched soil organic matter. In a leaky site, the remaining soil organic matter should become enriched over time.

In this study, we looked at three sites across a nitrate loss gradient: Cone Pond, Hubbard Brook and The Bowl (in order of increasing N loss). Our preliminary results do indeed suggest that the  $^{15}\text{N}$  tracks the nitrogen loss history of the sites. There also appear to be strong differences in the N cycling patterns in the spruce-fir, versus hardwood, areas. The hardwoods had higher  $^{15}\text{N}$  suggesting higher rates of nitrification and N loss. The Bowl represents a high point of N loss, and has been a tremendous addition to this study.

## Natural Areas Report

Editors: Sarah Greene  
Margaret Herring

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