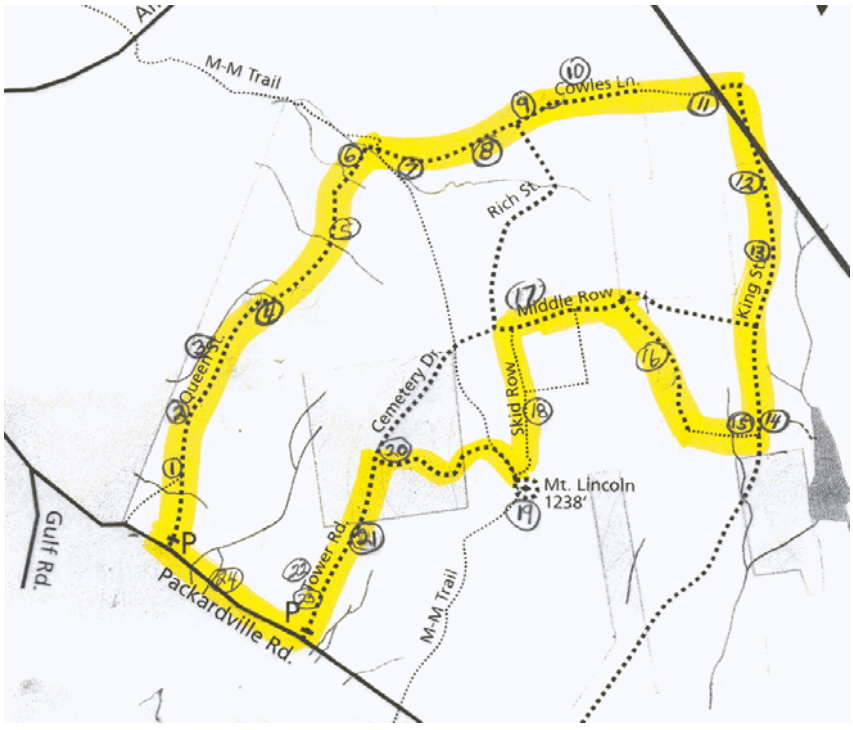
WILDLIFE HABITAT AT CADWELL MEMORIAL FOREST
A SELF-GUIDED INTERPRETIVE TRAIL

Department of Natural Resources Conservation

University of Massachusetts Amherst

This trail was designed to introduce students in WFCON564, Wildlife Habitat Ecology and Management (UMass-Amherst) to a number of key elements of habitat for selected wildlife species found at Cadwell Forest. The information described in this tour book also provides the students with the background they need to develop stand and forest management plans for certain wildlife species as a part of the class. The trail includes 24 numbered stations with the approximate location of each station indicated on the map below. Each station is numbered with a 3" x 5" card visible from the trail. The number of each card corresponds to the numbered information listed in this booklet. The trail is designed to begin at the north parking area on Packardville Rd., but if you start at the south parking area, simply reverse the direction of the tour. If you are using one of the booklets available at the Trail Map Box at either area, **please return the booklet to the Trail Map Box when you have completed the trail so others can use it**. You should allow about 2 to 3 hours to complete the trail.



1. On the left side of the road is a metal post marking a sampling plot. This is one of 114 sampling plots distributed in a grid across Cadwell Forest. In 1983 and 1993, all of the trees and shrubs were measured within each of the sample plots in order to assess the establishment, growth, and survival of forest vegetation on Cadwell Forest. Plots will be re-measured in 2003. Over 30 species of trees have been recorded on the Forest as part of these surveys. At this location note that the dominant tree species includes eastern hemlock. Because it is tolerant of shade and maintains a deep crown, it can provide cover for a number of bird and mammal species. Stands with large hemlocks often are selectively used by species such as black-throated green warblers and golden-crowned kinglets (left). An insect introduced from Asia, known as the hemlock wooly adelgid (right), has led to the widespread death of eastern hemlocks across much of Connecticut and it is now found in Massachusetts. These plots will be used to monitor the rate of mortality of hemlocks on Cadwell Forest.

2. Notice the height and diameter of the white pine trees at this point. The trees have grown rapidly and are approximately 90 feet tall. On the east side of the white pine directly in front of you is a hole in the tree. Because the hole is roughly rectangular in shape, it was probably created by a pileated woodpecker (left). Previous damage to the tree has resulted in a compartmentalized column of decay surrounded by sound sapwood. The woodpecker has excavated through the sound sapwood into the softened heartwood. Trees that are hollow or decayed serve an important role in forests by providing nesting and feeding habitat for a variety of primary cavity nesters, such as woodpeckers (they create their own holes for nesting), and many more secondary cavity-nesting species (they use holes created by decay or holes abandoned by primary cavity nesters). Flying squirrels (right) are a common secondary cavity nester on Cadwell Forest.

3. On the north side of the road is a white oak. White oaks are relatively uncommon on the forest; many were killed by defoliation from gypsy moth larvae during 1979-1982. On the south side of the road are many northern red oaks. All oaks produce acorns, but production is highly variable from year to year. Acorns are an important source of food for many species of birds and mammals (e.g., squirrels, mice, grouse, turkeys, raccoons, deer, chipmunks, etc.), and populations of many small mammal species change in response to the abundance of high-energy foods such as acorns. There are two broad groups of oaks (subgenera): the white oak group (e.g., white oak, chestnut oak), and the red oak group (e.g., northern red oak, black oak, scarlet oak).

Once flowers on a white oak tree (right) are pollinated, acorns grow, mature and fall to the ground, and usually germinate before snow falls that same year. Red oak acorns mature through two full growing seasons before falling, and then germinate the following spring. Consequently a late spring frost that may kill flowers on both species would affect production of white oaks later that year, but not affect the production of red oaks until the following year. A forest containing a mixture of red and white oaks helps to ensure that at least some acorns are produced each fall.

4. On the south side of the road is a wild raisin (nannyberry, left) bush marked with a tag. This plant is one of approximately 80 individual tree and shrub plants representing 25 species that have been checked at least once per week during the spring and early summer, every year since 1979. Observations are made on date of flowering, bud break, and leaf out. This "phenology" study has documented the fact that for a given plant, phenology events have varied by as much as a month from earliest to latest date over the period of the study. This information provides important clues to the response of vegetation to climate change and about the abundance and date of availability of food for wildlife.

5. For some wildlife species the value of a tree only begins after it has died. Walk about 50 feet into the forest on the south side of the road to the blue flag. Under the flag is a log. This log has been used as a drumming log by ruffed grouse (left). This is an elevated site where male grouse makes a drumming sound with its wings to attract a mate in the spring. Drumming logs are usually in a thicket with > 10,000 woody stems per acre. In the summer, red-backed salamanders rest under the log during the day. Eventually the log will become part of the organic layer of the forest. Second-growth forests such as this typically have 7-10 tons/ha of dead wood, which is much lower than would have occurred prior to European colonization of the region. High levels of dead wood in eastern forests are the product of death of large, old trees. Except for American chestnut (now only a sprouting species), most hardwood logs decay within 100 years. Recall that sites like this were pastures little more than 100 years ago, so there has not been enough time to grow trees of a size to produce dead wood at the levels seen before European settlers arrived.

6. Riparian areas are those vegetative communities that interact with a body of water. This stream is important for a variety of reasons in addition to providing habitat elements for species such as stream amphibians, water shrews (left),

and mink. The Forest provides water to Atkins, Quabbin, and Ludlow Reservoirs -- all public water supplies. Clean, clear water is in important product of Cadwell forest. It is also an aesthetic area adjacent to the Metacomet-Monadnock trail that extends for 117 miles from Connecticut to the top of Mt. Monadnock in New Hampshire. Disturbances to riparian forests from beaver activity, windthrow, fires, and timber harvesting, if severe enough, can lead to a reduction in overhead shade, and an avenue for introduction of sediment into the stream. Some level of disturbance is a natural part of forest dynamics, and indeed, some species rely on forest gaps in riparian forests and in the scour and plunge pools formed in streams containing gravels and fine sediments. In managed forests, stream integrity is usually protected by limiting the intensity of harvest near the stream. Trees at this site are about 90 feet tall. Shade is provided by these trees and branches overhanging the stream provide nesting habitat for Acadian flycatchers (left). Leaves falling from the trees into the stream provide a source of nutrients (allochtonous material). Should a tree fall into the stream, then hydraulic forces can lead to scouring of the stream bed, creating pools important to some species of fish and amphibians. I have marked with blue flags the distance of one dominant tree height from the edge of this stream so that you can visualize the functional riparian zone.

7. As pointed out at station 4, dead wood can be important to a variety of wildlife species. Here is a standing dead tree (snag) that has been used by a woodpecker (probably a northern flicker, left). What killed this tree? Thousands of trees die in Cadwell Forest each year. Most are saplings that have lost in the competition for light with larger dominant trees. A few die from disturbances such as wind, ice, fire, or tree harvest. Over the past 80 years, periodic outbreaks of gypsy moth larvae have resulted in mortality, and before that chestnut blight killed a dominant tree species. Currently some American beech are dying from beech-bark disease, and we anticipate widespread hemlock mortality from the wooly adelgid. Large trees that die and remain standing provide the opportunity for large primary cavity-nesting birds to excavate a cavity and, after having raised their young, abandon the cavity. Abandoned cavities are then used by secondary cavity nesters. Snags, though important to primary cavity nesters in eastern hardwood forests, are even more important in conifer forests where large dead limbs are less common on live trees (a dead limb can serve the same function as a standing dead tree to a woodpecker). How long to you think this snag will remain standing? When this snag falls over to become a potential drumming log, are there other large snags nearby that can be used by the flickers? In managed forests, providing dead wood on a sustainable basis is an essential part of sustainable forest management.

8. On the west side of the road is an even-aged stand that is mostly northern red oaks (right). Notice that most of the trees

are nearly identical in height and that the trees that are larger in diameter also tend to have larger crowns. Acorn production is related to crown size, so only a few trees in this stand would be expected to produce abundant acorns in any given year. Thinning this stand, or a disturbance such as a wind storm or ice storm, would allow the remaining trees to expand their crowns, grow larger in diameter faster, and more likely produce abundant acorns.

9. Follow the blue flags into the forest from the road. Here is a 1/3-acre opening created in 1989. Note that the forest is recovering, but that the area of early-successional forest is small, and representative of a large canopy gap in the forest. These sorts of openings scattered throughout maturing forests provide patches of insects, fruits, and browse that are important foods for many species of vertebrates. Most bird species feed their young insects, a high protein food, during the early stages of development. Wild turkey poults often feed on insects in recent openings, but this patch has re-grown to a point that it probably no longer would be used as a feeding site for poults. It also probably would no longer be used as a feeding site by deer and moose (left) that need high quality browse (woody twigs) in the winter. What species of trees and shrubs are regenerating in this opening? Why?

10. On the east side of the road a small pond has formed as the drainage was partially blocked by the road. Although this is certainly not a natural pond, it is functioning as a vernal pool that is heavily used by frogs and salamanders in the spring. There are a number of natural vernal pools (left) scattered across Cadwell forest. These pools contain water through part of the growing season, and then dry up later in the summer. By using these intermittent pools, amphibians can reproduce in the absence of fish predation. During dry years, some vernal pools may dry out before the amphibians are fully developed causing extinction from that pool. Indeed there is growing evidence that high levels of salamander reproduction occurs only once every few years in most vernal pools. Pools must be recolonized over time. The maintenance of a population through recolonization following localized extinctions is an excellent example of a metapopulation structure.

11. As you approach the powerline Right of Way (ROW), you are entering the property owned by Cowls lumber company. Please respect the rights of this private landowner. Notice that these stands have been managed to produce rapidly growing, high quality oaks. The resulting stand has trees with large crowns and

will likely produce more acorns than many of the oaks on Cadwell Forest. Walk along the powerline to the south. The powerline is maintained as a shrub-dominated strip and as such provides habitat for shrub-nesting associates such as eastern towhees (right). Grassland and shrub-nesting birds are, as a group, the most rapidly declining species in the northeast. Consequently areas of intense disturbance (e.g., following a hurricane, fire, or clearcut) provide the vegetative structure and composition needed by many of these species. Two factors must be kept in mind, however. First, some species of animals associated with early seral conditions are also cavity nesters (e.g., eastern bluebirds, American kestrels), and dead trees are one result of intense natural disturbances. Snags can be maintained in clearcuts, but there are no snags in this powerline ROW. Further, there are species of birds such as ovenbirds (left) that typically nest in mature forests and avoid abrupt edges where nest predation is higher and brood parasitism by brown-headed cowbirds is more intense. The adverse edge effect extends up to 300 meters into the adjacent mature forest for these forest-interior species. The powerline may appear to us to be about 50-100 m wide, but for forest interior species the powerline is functionally 600-700 meters wide.

12. You are now once again on Cadwell forest. On the north side of the road is a plantation of Norway spruce. Leave the road and walk into the stand. What do you notice? There is no understory vegetation, and the canopy is dense, letting little light to the forest floor. Such conditions can also occur in hemlock stands and dense stands of some other conifers. Although the diameter growth of the trees in this stand is reduced because of the inter-tree competition, the dense foliage provides cover throughout the year for a number of animal species. These stands provide thermal cover (warmer sites on cold winter nights and cooler sites on hot summer days) for large ungulates such as deer and moose (left), roosting sites for winter birds, and protection from deep snow for some species. Maintaining patches of dense conifers in a managed forest can be an important component of sustainable forest management.

13. This site is a chance to see clearly the legacy of previous land use. Along both sides of the road are large sugar maples that probably were once planted along the road. Imagine for a moment walking down the road with only those maples along the roadside next to the stone walls, and fields and pastures everywhere else. A small house stood on the north side of the road, the yard marked by a stone wall that probably was built to keep the livestock out of the garden patch near the

house. Across the road to the southeast was a barn and apple trees. But there were few if any oaks, red maples, ashes, elms, white pines or other tree species that we now see dominating this site. Forests recover from disturbance. Although this forest is young and lacks some of the components of the pre-European forests (e.g., American chestnut, large pieces of dead wood), what was once a farm is now habitat for fishers, moose, and black bears. The recovering forest also contains legacies of the farm not found in the pre-European forests. The sugar maples provide large cavities for species such as screech owls (left) and stone walls provide cover for deer mice and their predators such as ermine. What will the forests of western Massachusetts look like 150 years from now? Will our suburbs of today be abandoned as these farms were in the past? If not, what are the long-term cumulative effects of continued suburban development?

14. Scattered across Cadwell Forest are patches of red and eastern white pine that were established by seeding and now have various levels of stocking (number of trees per acre) to assess growth and development of the stands. These patches are too small to provide much more than a patch of cover for most species, but we can understand how management might affect habitat quality for animals if stands like these were established over larger areas. How variable are the tree heights in this patch? Tree diameters? Have any trees died? How large in diameter are the trees that died from competition with other trees? Are the snags created from competition large enough to be used by nesting woodpeckers?

    Walk through the pine stand and down the hill (follow the blue flags) and you will find a beaver pond. Beavers create lentic (pond) environments in lotic (flowing water) systems. In so doing the sites provide nesting and breeding habitat for species such as brook trout, pond-breeding amphibians, wood ducks, herons, and many other species that would not otherwise be found on Cadwell Forest. With the recovery of forests near streams over the past 150 years, and the passage of a ballot measure recently that banned the use of kill traps in the state, beaver populations are expanding rapidly. Such population expansion allows us to consider how streams in this region must have functioned prior to European settlement. These streams once likely contained large pieces of dead wood and stair-steps of beaver ponds that would fill with sediment and after years of occupancy by beavers, become wet meadows that would undergo secondary succession. We are only now beginning to see the recovery of these stream systems following forest recovery and beaver population expansion. Unfortunately beaver also cause economic damage (tree cutting, flooding) and raise concerns regarding human health (e.g., Giardia). As long as beavers and humans co-exist, some form of beaver control will be necessary.

15. During the Depression, the Civilian Conservation Corps established many acres of conifer plantations in this region, and many of these plantations were red pine. Red pine occurs naturally in a few places in Massachusetts, but most of these plantations were established outside of the natural range of red pine. There are a few species of animals well adapted to the relatively simple structure of these pine plantations (e.g., red-breasted nuthatches, left), but the diversity of species that can use these plantations is usually less than what would be expected in systems with more tree species. Forests with complex vertical structure tend to support more species than simple forests such as these plantations. Heavily thinning this stand and allowing some hardwoods to develop in a midstory layer would increase the vertical complexity of the stand and may allow a more diverse animal community to occupy the site.

16. This area was cut heavily following a gypsy moth infestation in the mid 1980s leaving widely scattered oaks to provide a seed source for the regenerating stand developing beneath it. These open-grown oaks now have wider, deeper crowns and are more likely to provide more acorns than they would have in a dense stand. Recall the height of the trees at station 2. How tall are these dominant trees compared to the northern red oaks at the first few stations? Why would trees be shorter here than at station 2? Why would they be taller than the trees at station 16? Forests have three dimensions and the volume of a forest can influence the numbers and kinds of species that can occupy it. What are the implications of increasing (or decreasing) forest volume per unit area?

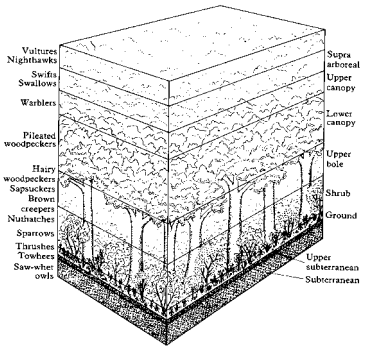


FIGURE 4-4
Schematic of nine layers of an advanced forest, with the birds that typically inhabit each. Some layers may be lost as a result of fire or practices such as grazing. Rock or soil type may reduce the potential soil layers.

17. The white pine at the edge of the road is the same age as the other pines in this patch that were part of the pine spacing experiment. It is the same height, but much larger in diameter than the other trees. Tree growth rates will be very slow because the patch is so dense. Look at the proportion of each tree that contains live branches. Most trees have < 20% of their height represented by a live crown, and crowns are narrow and compressed. If the stand is allowed to continue to develop, most of the trees in the patch will die from competition for light, and the remaining trees will grow slowly. If the stand were thinned now, we would not expect to see a rapid increase in tree growth until the crowns were able to expand, if they are able to recover at all. The trees have a low diameter to

height ratio and are vulnerable to wind throw and ice damage (there is a good example of ice damage to a jack pine plantation at the corner of Middle Row and Skid Row just up the road on your left). Although this dense stand can provide thermal cover for some animal species, patches such as this provide limited resources to most vertebrate species in the region.

18. During the winter of 2000-2001, an experiment was established to investigate the response of fruit-producing plants to tree harvest, prescribed burning, and the combination of cutting and burning. The production of blueberries, huckleberries, hazelnuts, and other fruits is greatest when plants receive full sunlight. These treatments should increase fruit production, but we do not know if the level of production will be greater with burning or cutting, nor how many years production might last under the two treatments. As you walk up the hill you can identify the burned plots by looking for charred stumps. There are three replicates of this experiment on Cadwell Forest.

Note the height of the trees here. There are several possible explanations for these short trees. First, most of the trees are scarlet oaks, not the northern red oaks seen farther down the hill. Nonetheless, scarlet oaks can grow much taller than we see here. Second, past disturbances such as grazing and fire may result in these trees being somewhat younger than those lower on the slope. Also, severe defoliation by gypsy moth larvae (left) on these dry, exposed slopes has contributed to poor growth, and the area was burned in 1975. But the most likely reason is that this is poor quality site. Site quality is indexed by measuring the height of the dominant trees at a specified age (usually 50 years) because tree height is not as effected by stand density as tree diameter (recall the pines at station 15). Trees near the top of Mt. Lincoln likely will never grow to a large size. Indeed, when the trees were harvested from this site, they were small and only useable as firewood. Over 20 cords of firewood were removed from the site as part of this experiment.

19. The highest point on Cadwell Forest is the top of Mt. Lincoln. Here, trees are short and the understory is dominated by blueberry, huckleberry, red maples and scarlet oaks. This open forest with ericaceous shrubs is indicative of a site where trees will grow slowly, but is an important site for species of animals that nest in shrubs or feed on the fruits. The area also has been heavily impacted by towers. Large towers such as these are a source of mortality to migrating birds. Birds migrate at night and under certain weather conditions fly low enough to impact the towers and support cables. The proliferation of towers in the northeast has raised concerns about the long-term impacts of towers on bird

mortality, but the overall impact of towers on bird populations currently is not known.

20. This cemetery contains Civil War veterans. The cemetery and the homestead to the west are located on Cowls Co. lands, and are further evidence of 19th Century land use practices. Note again the apple trees as well as grape vine around the old cellar hole at the intersection of Tower Rd. and Cemetery Dr.

21. As you descend Mt. Lincoln, site quality improves and trees are taller. The stand at this station was thinned heavily in the mid-1980's. Regeneration of white pine, oak and maple is now obvious. Compare the structure of this stand to the one across the road. Which stand provides more browse for hares, deer and moose? Which stand provides more nesting opportunities for red-eyed vireos (a canopy nester, right)? It should be obvious by now that everything that you have seen along the trail is 'wildlife habitat'. Indeed, the term 'wildlife habitat' is meaningless. Everything is habitat for something! And 'habitat' is NOT the same as a vegetative community or forest type. Each species has its own habitat requirements that can be described by the habitat elements that provide food, cover, water and space for the species. Habitat for deer differs from habitat for turkeys, which differs from habitat for spotted salamanders and humans.

22. Walk into the forest about 100 feet and you will find a circular fence. This is one of several sites on Cadwell that was part of an experiment established by Drs. Joe Elkinton and Bill Healy in the 1990's. The experiment was designed to assess the role of white-footed mice (left) as predators of gypsy moth larvae. Mouse populations increased during the year after an abundant acorn crop, and when mouse populations were high, they had a significant impact on gypsy moth larvae. Larvae were more abundant on oak trees inside the fences designed to exclude mice than outside the fences. The larvae impacted the growth and survival of the oaks that produced acorns that the mice relied on for survival during periods of low larvae availability. This was an excellent illustration of the interdependency of organisms in an ecosystem. The results of this work were published in the prestigious journal *Science*.

23. There is a lone Pitch Pine at this station. Pitch pines are not common on Cadwell Forest, but can be found north of here on the Montague Sand Plains, and they also are common along the coast. Pitch pines (left) regenerate in areas that have received a disturbance that creates bare soil (or ash), and removes overhead competition (e.g., cultivation, fires). Pitch pine will probably not be common on Cadwell unless areas are prescribed burned, but regeneration will only occur following burning if fires are even more intense than

occurred in the experimental area on the top of Mt. Lincoln. Disturbance is a key component of forest development and change that allows some plant and animal species to persist in a forest.

24. The final station is at this artificial wetland along Packardville Rd. The wetland was likely created by the rock wall that formed a dam on this small stream. Years of sediment build-up has raised the bed of the wetland and hence the water level. Note the large dead pine trees that have not yet fallen over. As water levels rise to saturate the soils, these trees were unable to survive. As sedimentation continues and the water level in this wetland continues to rise, additional trees likely will die along the margins. These large dead trees are often used by pileated woodpeckers and subsequently by wood ducks (left).

This concludes the self-guided tour. Clearly the tour had a focus on wildlife habitat and forest ecology. Every person "reads" a forest differently. A specialist in outdoor recreation walking this trail would notice the various types of passive and active recreation occurring on the forest, and the aesthetic qualities of some sites. A cultural anthropologist might focus on the number and sizes of farms that have been abandoned and comment in much more detail on the history of the site. A geologist could comment on the glacial history of the area. A botanist would see rare plants and plant communities. What did you notice along this trail that was not covered in this guide book?

Thank you for visiting Cadwell Forest. For more information about the Forest and the Department of Natural Resources at UMass-Amherst, please visit our website at: www.umass.edu/forwild/ Feedback on the value of this trail to our visitors is welcome.

Please return this book to the box containing the trail maps so others can take the same tour. Thanks!

Brenda McComb
Department of Natural Resources Conservation
University of Massachusetts-Amherst