

**WILDLIFE HABITAT ASSESSMENT
OF THE BECKET LAND TRUST'S
HISTORIC QUARRY**

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**Prepared by Molly Hale,
Wildlife Biologist
96 Oak Street,
Florence, MA 01062
(413) 585-0791**

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PART 1. INTRODUCTION

Summary

The Becket Land Trust Quarry property consists of 291 acres in Becket and Otis. This forested tract is dominated by beech, red and sugar maples, white ash, hemlock, and yellow birch. Red oak and black cherry are present in some areas. Most of the trees are in the pole size class (5-12" dbh), and many are of low quality because of past high grading practices and beech blight.

Surveys for rare animals and plants turned up one rare species, the Jefferson salamander, which breeds in vernal pools. I found evidence of 14 mammals, including bear, otter, moose, coyote and fisher, and 33 bird species were recorded, including nesting ravens and red-shouldered hawks.

The primary habitat values of the quarry property are its role as unfragmented forest interior, 7 vernal pools and a variety of other wetlands, several large piles of granite chunks that provide denning and nesting sites, the rock cliffs by the quarry pond, and the food value of hemlocks and oaks.

Habitat limitations are the small, uniform size class of the trees, the poor vigor of the beeches, the lack of ground and shrub level vegetation, few large live cavity and dead trees, and the proximity of Interstate 90, which borders the property to the south.

Management recommendations focus on protecting rare vernal pool species, creating forest openings to boost regeneration and develop a variety of vegetation layers, and enhancing oak and cherry growth.

Goals of the Study

The overall goal of this study was to determine the wildlife value of the Historic Quarry owned by the Becket Land Trust and to suggest management options that could be implemented to enhance biodiversity and protect any rare species found. The specific objectives were as follows:

- 1.) Assess the macro-habitat value of the whole property in relation to the surrounding landscape
- 2.) Describe the value of micro-habitat features and assess their presence on the property
- 3.) Describe the habitat characteristics and potential for each community type
 - a.) list rare species that could be present and non-rare species likely to be present
 - b.) look for rare species in appropriate habitat
 - c.) document all species actually observed by track and sign, spring bird surveys, and other observations
- 4.) Describe specific habitat characteristics of each forest stand and make any necessary modifications to the management recommendations in the Forest Stewardship Plan prepared by Bay State Forestry

Description of Study Site and Surrounding Area

I will refer to the area studied as BLTQ. This area is approximately 300 acres in size, mostly in Becket with a small portion in Otis. Bordered on the south by Interstate 90 in Otis and Bonny Rigg Hill Road in Becket, part of its eastern boundary lies along the Blandford town line.

The property's elevation ranges from 1320 to 1740 meters above sea level. Cushman Brook originates and flows for about 1/2 mile through the property, and includes both a rocky, upper perennial stretch and a slow-flowing section surrounded by shrub marsh. The brook is in the Westfield River watershed. The soil types are gently to moderately sloping and typically very rocky. The property's former use as a granite quarry has left behind several piles of large rocks that surround excavated depressions. The largest of these rock piles surrounds the main quarry pit and towers perhaps 60 feet high. Most of the quarry excavation pits now contain water for at least part of the year.

Upland vegetation community types on BLTQ are Northern Hardwood Forest, Hemlock-Hardwood Forest, and Acidic Talus Slope. Wetlands consist of Shrub Swamp, Vernal Pool, and Upper Perennial Stream.

BLTQ is included in land designated as Supporting Natural Landscape by the Massachusetts BioMap project. This designation is for land that is important for buffering and linking Core Habitat, where rare species occurrences are high. Prior to this study, no rare plants or animals have been documented on BLTQ.

The biggest threats to biodiversity in Massachusetts are outright habitat loss due to development, forest fragmentation by roads, and invasion by non-native species. Forest fragmentation can be a problem for wildlife because it introduces edge habitat into the forest matrix. This allows non-forest species to compete with, prey on, or parasitize forest-interior adapted species. It also causes increased human activity and is frequently a vector for the introduction of invasive species. Fragmentation of forest by roads also inhibits movement by some species and causes road mortality for others. The ultimate results are the loss of some wildlife species that require unbroken forest above a certain size threshold, inhibition of genetic interchange between populations, and decline in populations.

In many parts of Massachusetts invasive plants such as bittersweet, Japanese barberry and garlic mustard quickly form monocultures that replace native plant assemblages and can hinder tree regeneration. Non-native animals such as the hemlock wooly adelgid, European starling, and zebra mussel outcompete, parasitize, or prey on native species that have not adapted defenses against the invaders.

So far in Becket and bordering towns development, fragmentation, and invasive species are not big problems, but the nearby Sherwood Forest subdivision shows how habitat even in remote rural areas can be lost to development. Also Interstate 90 effectively prevents genetic interchange between non-flying wildlife populations on opposite sides of the road.

Invasive species do not appear to be a major threat in the region. Fortunately, few invasive species were observed on the BLTQ property. The one species found was *Phragmites australis*, the common reed. This aquatic invasive is present in parts of the Cushman Brook marsh, where it replaces the native cattail. *Phragmites* had also completely taken over a small marsh just east of the southern end of BLTQ.

I did keep an eye open for rare plants at BLTQ but found none. The forest type is very much like that which occurs throughout most of Massachusetts, so the plants here are widespread and common. There were no rich, mesic areas that sometimes occur within northern hardwood stands. Rocky outcrops are sometimes associated with rare plants, but did not appear to be so here. I did not search the interior of the marsh, so it's possible there could be some rare plants there.

When assessing the wildlife habitat needed to maintain viable populations, a large area must be considered. For some species, such as the turkey vulture, black bear, and fisher, even

individual animals need more space than this property alone can provide. For most other species, individuals may meet all their habitat needs on one property, but sustenance of a viable population of that species requires a much bigger area. Therefore, to assess the habitat potential for this area, it is necessary to have an understanding of the cover type and size class compositions for both the study property and the surrounding landscape. These fundamental landscape qualities determine the potential array of wildlife species that might use an area.

The landscape surrounding BLTQ (about 3,000 acres) is generally similar to BLTQ itself in terms of the proportion of forested to non-forested land. It is almost entirely forested, resulting from farm abandonment starting in the 1800s, and most of it has been logged one or more times since then. The reversion of farmland to forest here and throughout the state has been followed by the resurgence of several species that had become absent or rare during the era of widespread open farmland. These species include pileated woodpecker, wood thrush, black bear, fisher, moose, wild turkey, beaver, and possibly mountain lion. Large stretches of relatively unfragmented forest in this ecoregion provide valuable habitat for these and many other species. On the other hand, some species (mostly birds) that were abundant when the land was open 150 years ago are now declining or rare because they depend on vanishing grassy or brushy habitats.

To maximize biodiversity it is desirable to have a mix of forest and non-forest. While each has their unique associated species, the juxtaposition of these two basic habitat types provides much greater wildlife opportunities than either component alone. Throughout New England, 18 wildlife species use only upland forest. These include pileated woodpecker, wood thrush, black-throated green warbler, and northern flying squirrel. Twenty-three species use non-forest only. These include vesper sparrow, eastern meadowlark, and bobolink. But the numbers that use both forest and non-forest reaches 122. These include the northern black racer, turkey vulture, northern saw-whet owl, northern goshawk, gray fox and white-tailed deer.

In addition, the forest should have a variety of size classes and tree species assemblages, and the location and patch size of the species/size combinations needs to be considered on several different scales. For example, gaps created by individual tree selection, group selection, and small and large clearcuts all have value to a different set of wildlife species, while some species prefer uninterrupted forest with no gaps at all.

PART 2. MACRO-HABITAT ANALYSIS

To examine the wildlife potential of the land in relation to the surrounding area, I used the 2001 MassGIS orthophoto datalayer to determine the amount of forest, non-forest and wetlands in the approximately 3,000 acres that includes and surrounds the approximately 300 acres of the BLTQ property. The proportion I obtained was 96% forested, 1% upland non-forest and 3% water (see Table 1, middle column).

The proportion of forest, non-forest and wetland determines the “Habitat Opportunity Class”, or general wildlife potential, of this area (DeGraaf et al., 1992). The 3,000 acres falls into Habitat Opportunity Class 1 which is defined as being >90% forested and <5% wetlands. For Habitat Opportunity Class 1 DeGraaf specifies an optimum composition goal of forest cover types and size classes for the entire area, in this case the 3,000 acres (Table 1, right column). These composition goals show the distributions needed to achieve the best opportunities for biodiversity within the broad Habitat Opportunity Class 1. They are based on DeGraaf's synthesis of factors affecting species distribution, site capabilities and the effect of past land use on future productivity. The use of Habitat Opportunity Class goals is being pursued on Massachusetts Department of Fish and Wildlife lands, especially by creating more regeneration in upland openings and allowing some areas to reach and remain at the large sawtimber stage (see Kittredge and O'Shea 1999).

After determining the Habitat Opportunity Class, the next step was to estimate the deciduous/coniferous proportion for BLTQ (Table 1, left column) and for the surrounding 3,000 acres, again by using aerial photos. As shown in the first 2 rows of Table 1, the BLTQ property has slightly more deciduous and slightly less coniferous than the optimum. However the larger surrounding area has less deciduous and more coniferous than the optimum. Therefore the deciduous/coniferous proportion on BLTQ is acceptable because it helps compensate for an imbalance in the larger area.

Although not shown in Table 1, DeGraaf breaks down deciduous cover into three different types: aspen/white birch; northern hardwoods; and oak/beechn. Each of these categories has its own distinct habitat values. Aspen/white birch is a quick-growing early successional group; northern hardwoods are slower-growing late successional species and oak and beech are a key food source because they provide abundant hard mast (nuts).

Calculated values for each of these three deciduous categories were not estimated for BLTQ or the surrounding area because the forest inventory data collected for BLTQ by Bay State Forestry did not break down tree volumes by species, and these types could not be distinguished by aerial photos. However, by assessing tree species composition at 26 sample points at BLTQ, I was able to give a rough estimate of the proportions of these three deciduous types. Aspen white-birch stands are presently limited to only a small portion of the rock piles, much of which are unvegetated. Until more soil accumulates on the rock piles, any aspen or birch on these sites will be limited to a sparse cover of saplings. The total percent aspen/birch cover at BLTQ is certainly <1%. DeGraaf's optimum proportion of aspen/white birch is 5-15% of total cover.

For the hard mast category, DeGraaf suggests a minimum of 1-5% cover. This proportion is far exceeded on BLTQ where beech is a dominant species in stands 1, 3, and 4. Red oak is also scattered in stands 1 and 4, the two largest stands on the property. This means that the potential for hard mast production is very high.

Moving down Table 1 to non-forest cover, we see that DeGraaf recommends that 3-5% of the cover should be in non-forested upland (current or abandoned fields and pasture or silvicultural openings). None of BLTQ and only 1% of the surrounding area are in this category. Biodiversity would be enhanced if more such openings were created.

The next step was to assess size-class distribution. I did not analyze this data for the surrounding 3,000 acres because it would have been excessively time consuming to gather this information from the MassGIS photos. Instead I assumed that the size-class distribution for the surrounding area is similar to that for the state as a whole. For the BLTQ property itself, I estimated size class by walking the property and taking sample points within each stand. Regeneration through sapling sizes were not counted if they were overtopped by a canopy of a larger size class. With this data, I estimated the proportion of each stand in each size class. I then weighted these proportions by stand acreage to obtain a size-class distribution for the whole of BLTQ.

The size-class distribution for BLTQ is very narrow, with almost all of the trees within the Sapling-Pole or Small Sawtimber categories. Even within these two categories the distribution is narrower still, with most trees between 4 and 13" dbh. This situation is the result of

Table 1. Cover-type and Size-class Composition, by Percent

Cover-type distribution			
	BLTQ	3,000 acres including BLTQ	Optimal range for Habitat Opportunity Class 1
Deciduous	67*	42*	50-65
Coniferous	32*	54*	35-50
Total forest cover	99	96	
Upland openings (fields)	0*	1*	3-5
Wetlands	1*	3*	1-3
Total non-forest cover	1	4	
Size-class distribution			
Seedling Regeneration (<1.0" dbh)	<1 [^]	1 [~]	5-15
Sapling to Pole (1.0-10.9" dbh)	69 [^]	19 [~]	30-40
Small Sawtimber (11-21.9" dbh)	31 [^]	77 [~]	40-50
Large sawtimber (22 +" dbh)	<1 [^]	3 [~]	Up to 10
Total acreage	291	3000	

* Determined by aerial photos

[^] Determined by estimates from sample points

[~] Numbers used are those for statewide forest size-class distribution

previous timber removal in which virtually all the larger trees were removed, but the forest canopy remained continuous. The creation of canopy gaps through small group cuts or mini-clearcuts would have allowed regeneration and sapling phases to occur. The only area of Seedling Regeneration now present is the cleared area downhill of the vista. Large sawtimber is likewise scarce, limited to a few scattered mammoth red oaks and sugar maples in the vicinity of the bridge over Cushman Brook. Both these size classes should occupy a substantially larger area to provide the cover and food that would best benefit wildlife. For example, mast

production is substantially higher per acre where individual trees are big enough to have large, spreading crowns. Crowded pole and small sawtimber stands like those at BLTQ produce a much lower yield.

PART 3. MACRO-HABITAT MANAGEMENT GOALS

The previous section showed where imbalances in cover type and size class exist at BLTQ. To achieve the optimal cover-type and size class distribution at BLTQ, in the context of the surrounding area, the theoretical goals would be to increase the proportion of upland openings, increase the amount of aspen/white birch, and shift the size-class distribution to increase seedling and large sawtimber while reducing pole to small sawtimber. Not all of these ideas are recommended for BLTQ, however.

Even though the landscape has too little non-forested openings such as current or abandoned fields and pastures, the establishment of such **permanent** non-forest openings within BLTQ is inappropriate. This is not only because of the soil type and terrain, but because of the high habitat value of the landscape as unbroken forest interior. While the amount of non-forest upland is below the optimum range for the 3,000 acres, any additional fields or pastures should be placed on other properties adjacent to existing fields or along roads, to minimize the introduction of new forest edges into interior forest.

The goals I recommend for addressing cover-type and size-class deficiencies for the BLTQ property as a whole are as follows:

- a.) Increase the proportion of trees in seedling to sapling size classes
- b.) Maintain any aspen and white birch already present
- c.) Increase the number of large trees

a.) Increase the proportion of trees in seedling to sapling size classes

One practice that would be appropriate for BLTQ is the establishment of **temporary** openings to establish seedling and sapling size classes. A shifting mosaic of such openings over time creates a landscape with a variety of size classes but avoids the deleterious effect of an edge

because the openings are ephemeral. In this way the openings do not have the effect of fragmenting forest interior.

Young successional stands are scarce in the area surrounding BLTQ because this predominantly forested landscape lacks patches of agricultural land that revert to young aspen, birch, or pine after being previously cleared. Established forest that either is not cut or that is selectively cut to maintain a canopy of >70% will prevent the growth of saplings and dense herbaceous plants because of excessive shade. The trend toward less early regeneration is occurring on a large scale as farmland abandoned over the last century has grown up to resemble the forest surrounding it.

Many wildlife species, especially birds, are early successional specialists, and require dense sapling growth for feeding, nesting, and cover. The more complex the structure of vegetation in a forest, the more niches there are for wildlife. Some species can substitute dense patches of sapling growth in the shrub layer below a canopy of larger trees, but these patches are often inadequate because their area is too small or birds may not tolerate an overstory layer. Some of the wildlife that benefits from early successional forested habitat includes the ruffed grouse, willow flycatcher, American kestrel, several warblers, deer, moose, rabbits and hares, and the long-tailed weasel.

In the absence of human influence, such early-successional habitats were created in this region by windthrow, fire and disease. Windthrow and disease can each affect areas ranging from a just a few trees to several acres, while uncontrolled fires generally cover larger areas.

A core idea of ecosystem management is that land management activities should mimic the natural disturbance regime for that region. Management for regeneration should therefore aim to create patches in a range of sizes and maintain a continuous stock of regeneration by rotating cutting of new areas as the present ones mature.

I recommend making patch clearcuts ranging in size from 1/4 acre up to 3 acres, but only one or two of the larger openings should be made. Any cuts larger than 1/2 acre should be at least 1,000 ft. from a cluster of vernal pools in stand 4 that are used for breeding by Jefferson salamanders. See the Vernal Pool section in Part 4 for important details about this.

b.) Maintain and aspen and white birch already present

Aspen and white birch are species that generally take over abandoned fields or following fire. Because these activities are now infrequent in New England, the amount of aspen in the landscape has declined. Buds and catkins from mature aspens are a valuable wildlife food supply, especially for ruffed grouse. The bark, twigs, and foliage are desirable to rabbits, hares, deer, and moose.

Because aspen grows by suckering from roots, the use of silviculture to create aspen dominated stands requires that aspens are already present. At BLTQ an attempt to shift forest composition to include more of these species without large-scale clearing or prescribed burning would be unsuccessful. However, a limited amount of aspens and white birches may seed themselves in the larger patch cuts. Also, wherever these species are already present, they should be reserved from cutting to create seed sources for colonizing openings.

c.) Increase the number of large trees

For each of the forest stand types on this property, the potential number of wildlife species is higher for the large sawtimber size class than the for the small sawtimber size class. Large sawtimber is defined here as 22+" dbh but substantially bigger trees are even better. One reason is that many wildlife species have a minimum tree bole size that can accommodate them, and any species that uses small sizes can also use large sizes but not vice-versa. On a per-acre basis, large trees also produce more nuts and fruit than smaller trees, so food is more abundant. Once they eventually die, they are equally important as standing snags, and when they finally fall, they provide large woody debris on the ground that lasts for many decades. Examples of animals that prefer large sawtimber are wood ducks, most hawks and owls, the larger woodpeckers, and black bear.

Old growth forest provides even more ecological functions than scattered big trees. Old growth forest is a dynamic ecological system with a complex structure. It includes a patchy mix of dense canopy, tree-fall gaps where ground, shrub and midstory growth occur, abundant standing and down dead wood, and rich fungal flora in the soil. Some ecological conditions associated with this system are greater moisture and nutrient retention, thick uncompacted duff, and high biological diversity.

To increase the large sawtimber component, future cutting operations should always emphasize leaving a good number of trees that can ultimately reach sizes of from 20 to 30 or more inches dbh. Ideally, a whole section of BLTQ could be left permanently undisturbed to develop into old growth. A good place to do this might be the western source of Cushman Brook upstream and just downstream of the bridge. The ability of trees to reach very large sizes over a long period of time is evidenced by the few massive sugar maples and red oaks that still grow there now. This location is less susceptible to windthrow because higher terrain surrounds it to the north, west, and south.

PART 4. LOCAL HABITAT ANALYSIS AND GOALS

The first part of this report looked at BLTQ at a broad scale, in the context of the surrounding landscape. In this section, the focus is on smaller scale features. The value of each feature is described, the presence of the feature at BLTQ is assessed, and management recommendations are made where appropriate.

Vernal Pools

Description: Vernal pools are temporary pools that fill in the spring or fall with water from rain, snowmelt and/or high ground water. Although most vernal pools dry up for at least part of the year, some may dry up only every few years, and some may even have a shrunken pool of residual permanent water most years. The key factor from a biological standpoint is that vernal pools must not support a fish population. This occurs when pools are not permanently connected to other water bodies via a stream, and when the pool either dries up or the remaining water becomes so oxygen-poor that fish cannot survive there.

Without predation by fish, vernal pools can support a complex food web in which energy from the decaying leaf litter is utilized by specialized micro-organisms and invertebrates that in turn feed salamander and insect larvae, birds, reptiles and amphibians. These creatures then provide energy for terrestrial mammals, birds, and reptiles. The net result is that vernal pools provide a concentrated source of food energy that is ultimately transferred to the upland ecosystem.

One of the unique things about vernal pools is the amphibians that breed only in this specialized type of wetland. Mole salamanders are a group of species of large (5-8 inches long), stout-bodied salamanders that get their name because they spend most of their life in underground tunnels, emerging at night to feed. They migrate each spring to vernal pools to breed and lay eggs, then return to forested uplands to resume their terrestrial lifestyle. The eggs hatch and live as larvae in the pool for a few months, and if conditions are favorable, metamorphose into terrestrial adults before the pool dries up. These young adults then disperse from the pool to find a subterranean hiding place like their parents. The spotted salamander is the most common of the mole salamanders, while the Jefferson and the marbled salamanders are both rare species, state-listed as Special Concern and Threatened respectively. The marbled salamander's lifestyle is a bit different from the other two, migrating to dry vernal pool basins in the fall to lay eggs, then returning to the upland once the eggs are inundated by fall rains. The wood frog's migration pattern is similar to the spotted and Jefferson salamander's.

As their life history attests, vernal pool amphibians' upland habitat is just as crucial to their survival as the vernal pools. According to diverse radio-tracking studies, spotted salamanders travel a mean of 210-630 ft.¹ from vernal pools to their upland burrows, Jefferson salamanders travel on average 826 ft.², and wood frogs typically travel more than 1,500 ft.³ from their breeding pools. In one study, Jefferson salamanders were found 2,050 ft.⁴ from the nearest breeding pool, suggesting that their maximum migration distance is significantly longer than their average distance.

While individual salamanders and wood frogs usually return to the same breeding pool year after year, the viability of individual pool populations depends on other vernal pools within potential migration distance. If a population at one pool is extirpated due to drought for example, it can be re-colonized by individuals who disperse from nearby pools. The cluster of several such connected populations is called a metapopulation.

Fairy shrimp are invertebrates that spend their entire life cycle in a vernal pool basin. Like the mole salamanders and wood frog they are obligate vernal pool species, meaning they can only use vernal pools rather than any other kind of wetland. Eggs laid in the leaf litter the

¹ Hunter, et al., eds. 1999

² Williams 1973

³ deMaynardier and Hunter 1999

⁴ Williams 1973

previous year hatch in early spring, and the adults can only be found through mid-May before they lay eggs and die.

Assessment: I found seven vernal pools at BLTQ (see map). VPs 1-4 are spread out in the northwest quarter of the property, and VPs 5-7 are in a cluster by rock pile 5. All of them appear to have been artificially excavated during the quarry operations. All except VP3 are located next to large piles of granite. VP2 has been identified by the state as a Potential Vernal Pool (# 1748) on its data layer based on aerial photo examination. The other pools are too small to have been identified by this method and are not included in the state's data layer.

On May 7 I searched each pool for fairy shrimp, wood frogs and the three species of mole salamanders. The results are shown in Table 2. Gelatinous egg masses with specific characteristics allow identification of different amphibian species. If marbled salamanders were present they would have been in the form of larvae about 1" long.

I found no fairy shrimp in any of the pools. They should be checked for again in future years because they can be present in some years but not others. There are two species of fairy shrimp in Massachusetts, one common and one rare. Both could potentially be found in this part of the state.

I found no marbled salamanders either, but these cannot always be found in the daytime so it's possible that I could have missed them. I did find spotted salamanders in every pool, and wood frogs and Jefferson salamanders in some pools. The finding of Jefferson salamanders is exciting because these are a rare species in Massachusetts, ranked as Special Concern (the lowest of three endangerment levels). Eggs of this species were abundant in pools 5 and 6, indicating a healthy population.

It's interesting to consider how these pools became colonized if they didn't exist before the quarry operations. VPs 5-7 are in a low area, so maybe there was a pre-existing vernal pool that was excavated more for the quarry. Otherwise there must be vernal pools on other nearby properties that have served as source populations. I did not look for vernal pools on adjacent properties, but the topographic map indicates areas where vernal pools could occur. One area is just south of Bonny Rigg Hill Road, right on the Otis/Becket town line. Another possible site is on the property to the east. Not only is there an isolated marsh indicated on the map, but also another indentation in a contour line between the marsh and the BLTQ property line that could

house another vernal pool. It would be worthwhile to investigate the location and species composition of nearby pools to locate travel corridors between pools by Jefferson salamanders.

Table 2. Summary of Vernal Pool Characteristics

VP number	Length (ft.)	Width (ft.)	Depth (in.)	Wood Frog	Spotted Salamander (# egg masses)	Jefferson Salamander (# egg masses)	Vernal Pool Protection Zone (ft.)	Amphibian Life Protection Zone (ft.)
1	50	40	>36	Yes	>200	0	100	750
2	30	20	24	No	3	0	100	750
3	30	20	24	No	48	0	100	750
4	10	5	8	No	2	0	100	750
5	40	30	24-36	Yes	>50	>50	300	1000-2000
6	30	25	>24	Yes	>24	>50	300	1000-2000
7	20	10	12	No	6	6	300	1000-2000

Management: Because Jefferson salamanders are a state-listed species, their protection should be a management priority on the BLTQ property. There are three zones to consider for protection: the Vernal Pool Depression, the Vernal Pool Protection Zone, (within 300 ft.), and the Amphibian Life Zone (300 to 1,000 or 2,000 ft.). The outer limit of the latter zone is not clear because the maximum (so far observed) migration distance for Jefferson salamanders is much farther than the average migration distance. By increasing the protection zone chances are increased of increasing a greater proportion of the population. But if the distribution of migration distances follows a bell shaped curve, then only a few individuals will go as far as 2,000 ft.

The Vernal Pool Depression should be protected from filling, dredging, or contamination and machinery should be kept out of the basins in all seasons. Introduction of fish or non-native plants should be avoided. Woody debris should be neither added to nor removed from the depressions. Dogs should be kept out of vernal pools so they don't destroy the delicate egg masses, tadpoles or salamander larvae.

In the Vernal Pool Protection Zone, the goal is to protect the hydrology of the pool and the area used by first year metamorphs (salamanders that have just emerged from the pool and become terrestrial). To maintain shady, moist conditions that protect young salamanders and allow the pool to hold water longer, no tree removal should be done within 300 ft. of any vernal pool.

Extensive clearcuts destroy upland habitat for mole salamanders by drying out the microhabitat on the ground. Small group cuts probably are not harmful because drying wouldn't be so extensive and during migration amphibians can go around these areas. Also ground vegetation would be expected to flourish beginning the next season after cutting. To find out the threshold between an acceptable small group cut and a harmful larger clearcut I consulted Patricia Huckery, the environmental reviewer at the Massachusetts Natural Heritage Program. She recommended that in the Amphibian Life Zone mini-clearcuts up to 1/2 acre would be ok as long as a 75% canopy was maintained overall. This will maintain the cool, moist conditions needed by amphibians. If larger clearcuts happen they should be at least 1,000 feet away from the vernal pools containing Jefferson salamanders. Pools lacking this species can have a smaller protection zone because other species either don't migrate as far as Jefferson salamanders or are not rare. If any cuts as large as 3 acres are made, they should ideally be more than 2,000 feet away from these vernal pools, but this greatly restricts the possibilities for where these cuts could be done at BLTQ.

In the Vernal Pool Protection Zone and the Amphibian Life Zone machinery should not be used during migration times. Spring migration of Jefferson salamanders to the pools is the earliest of all the vernal pool salamanders, during nocturnal rains when there may still be ice on the pools, and the ground is still partially frozen. This period can be anywhere from early March to mid-April. Newly transformed adults leave the pools between June and September. Their exodus period overlaps with when marbled salamanders, if present, would migrate to dry pool basins. Overall, it would be ideal if the use of any heavy machinery were restricted to October through February.

If the distribution of Jefferson salamanders in vernal pools off the property is known, then greater emphasis should be on protecting the uplands between these pools and those at BLTQ. Any ruts left behind by logging operations should be smoothed out so as not to create puddles that could attract breeding salamanders to breed unsuccessfully.

Cavity and Dead Trees

Description: Live cavity trees and dead trees constitute a critical, multi-purpose resource for a broad spectrum of wildlife. As a tree progresses through the stages from live and defective through rotted on the ground, it hosts sequential groups of wildlife that utilize it for different purposes.

A tree may initially be damaged by any one of a variety of factors, such as disease, insects, wind, ice, logging operations, or fire. Once the tree is damaged, fungal decay may begin, whether in the trunk or the limbs. The spread of decay inside the tree is limited by a process called compartmentalization, where the tree produces special tissue to wall off the diseased wood from the healthy wood. In this way, live cavity trees can survive for long periods of time. The decayed wood is attractive to woodpeckers for nesting, roosting, and feeding on insects that have invaded. Woodpeckers are known as primary excavators because they create cavities that are subsequently used by a variety of other species. The six woodpeckers of western Massachusetts all prefer live, decayed trees, but some will use dead trees as well. The excavation of a cavity is part of the mating ritual for woodpeckers, so they must excavate a new cavity each year. Additional cavities are also produced for roost and rest sites. Sometimes cavities occur naturally in trees, beginning when a top or large limb is broken off by wind or ice. Large broken-topped trees provide den or nest sites for raccoons, porcupines, barred owls, and turkey vultures.

Once a cavity has been created naturally or by primary excavators, another group of birds and mammals may move in. Some of these, such as the wood duck, eastern screech owl, northern saw-whet owl, great crested flycatcher, tree swallow, flying squirrel, little brown myotis (bat), and big brown bat, require cavities. Others may use cavities when available, but do not depend on them. A few of the animals in this latter group are the barred owl, house wren, gray squirrel, fisher, black bear, and ermine. Even for these opportunistic species, the availability of cavity trees or logs can greatly increase winter survival.

Cavity trees along streams are especially valuable for several reasons. Cavity trees often lean out over the water, allowing a sheltered entrance on the underside of the trunk or under the tipped-up roots. These protected cavities are preferred by species that use streams as travel

corridors, such as mink and raccoon. When a streamside tree falls, it creates cover and/or basking sites for a number of amphibian and reptile species.

The tree species makes a big difference in how quickly cavities form and how long a cavity tree will last. Red maple and blighted beech form cavities easily, but the tree rots away relatively quickly, so these trees are useful for rapid turnover of new cavities. Other species, such as pine, hemlock, red oak, sugar maple and ash are longer lived, but are more resistant to cavities unless made by woodpeckers. Once cavities do form in these latter species, they can last a very long time. These trees have a potential lifespan of 100 to 600 years! The presence of cavities does not necessarily diminish a tree's lifespan because trees seal off rot or other defects to protect the healthy wood in the rest of the tree.

Big cavity trees are always more valuable than small ones. Many wildlife species are limited to cavities in trees over a certain diameter. For instance, pileated woodpeckers require a tree at least 20" dbh and black bears need at least 31". Also, small animals can use large trees, but not vice-versa. In addition, larger cavity trees make larger logs when they fall, providing benefit to a greater number of log-using wildlife, and longer-lasting, moister, protected environments for amphibians and small mammals. The minimum diameter for dead trees to be useful to wildlife is five inches dbh. These small cavities or stubs are used by tufted titmice and black-capped chickadees.

Dead trees, even without cavities, serve a number of wildlife functions. Those projecting above the canopy, such as white pines, are used as perches by American kestrels, Cooper's hawks, sharp-shinned hawks, and broad-winged hawks. In the absence of such perches, these birds will be scarce. The bare branches of dead trees serve as critical hunting perches for the eastern phoebe, kingbird, great crested flycatcher, and least flycatcher. Sloughing bark of a dead tree provides nest and foraging sites for the brown creeper, and roosts for several species of bat. A tree at this stage of decay also hosts a wide variety of invertebrates that provide food for many birds. As decay continues, the stub becomes shorter, and the wood punkier. Black-capped chickadees excavate their own nest cavities by pulling out bits of soft wood from these rotted stubs.

Assessment: Cavity users confirmed at BLTQ were black bear, porcupine, raccoon, fisher, gray squirrel, red squirrel, pileated woodpecker, yellow-bellied sapsucker, hairy woodpecker, northern flicker, black-capped chickadee and winter wren. Not all of these were

actually using cavities on the property, though. Black bear, for instance, lack any cavity trees big enough for them to use here, and porcupines have ample denning opportunities in the rock piles. The presence of bigger cavity trees here would enrich the habitat value for these species that already use the property for other purposes, and may attract additional species.

Table 3 below shows the optimum number of live cavity plus dead trees per acre for a forest interior such as BLTQ. These numbers are based on which different wildlife species use a northern forest, the maximum number of breeding pairs per acre, and how many cavities or dead trees each pair requires. The forest inventory data from Bay State Forestry did not tally live cavity or dead trees, so the number of such trees per acre could not be calculated.

Table 3. Optimum Densities of Cavity Plus Dead Trees Per Acre*

	Optimum for forest interior
<10" dbh (live cavity + dead trees)	4
10-19" dbh (live cavity + dead trees)	8
>19" dbh (live cavity trees only)	1

* Optima based on Titus, 1983.

However, my rough estimate from walking the property is that there are very few cavity trees because the general size class is so small that cavities have not had the opportunity to form. Some of the massive hardwoods near and upstream of the Cushman Brook bridge do have cavities as do some of the diseased beech, which do not exceed about 14" dbh. Eventually, as trees are allowed to reach larger sizes, there should be good cavity opportunities in other species including hemlock, red oak, sugar maple and ash.

As for dead trees, these are currently ample in the <10" size class because of all the blighted beech. These small dead trees are most numerous in the Northern Hardwoods stands 1 and 4 and the Hemlock-Hardwood stand 5. A few dead trees in the 10-19" category are present in all three of the Northern Hardwood stands, but there are certainly less than 8/acre. No dead trees >19" were observed.

Management: A shortage of large cavity and dead trees is typical of a managed forest but can and should be corrected by leaving all present large (and medium) cavity trees. Trees with major defects like broken tops, large holes or cracks in the trunk, large broken limbs or butt rot should also be retained as these are the cavity trees of the future. A certain number of currently defect-free trees of poorer form class should also be retained through every cutting cycle because they may eventually develop defects and cavities. A tree must survive repeated cutting cycles to finally graduate to a large cavity tree. The reserved cavity/defect trees should include some of a variety of species, to address both short- and long-term needs.

Along all stream corridors and around vernal pools existing cavity trees and other woody vegetation need to be left undisturbed.

Dead and Down Woody Debris, Including Slash Piles

Description: Once a dead tree falls to the ground, it can last another 25 years or more. Logs of fallen American chestnut trees, which all died by the 1950s, can still be found in New England forests today. Oaks are the most rot-resistant of present-day forest tree species, so they provide a long-term habitat value once on the ground.

Even though woody debris on the ground may look ugly to humans, it is ecologically important in a number of ways. Large undecayed logs are used as drumming sites by ruffed grouse. Hollow logs may be used as dens by numerous mammals, including Virginia opossum, eastern chipmunk, porcupine, gray fox, black bear, fisher, ermine, long-tailed weasel, mink, and striped skunk. Logs in streams create important structure by forming pools used by fish, wood turtles, and stream insects. Branches in vernal pools are important for egg attachment by breeding amphibians. Inside of or close to rotten logs are ideal foraging and shelter sites for numerous invertebrates, many salamanders, and small mammals such as shrews and mice. These creatures are in turn hunted by such mammals as the fisher, striped skunk, and long-tailed weasel, by snakes such as the black racer and eastern milk snake, and by birds such as the pileated woodpecker, worm-eating warbler, Canada warbler, and ovenbird.

Large logs and other woody debris also contribute to moisture and nutrient availability in forest ecosystems. Decaying logs (as well as leaf litter) provide a moist microhabitat for amphibians and invertebrates, and are associated with nitrogen-fixing bacteria that ultimately

contribute to soil fertility. Rotting wood also returns calcium and magnesium to the soil. While these two nutrients are also replenished very slowly from the breakdown of rocks in the soil and from precipitation, they are also leached away by water in the soils. The critical unknown factor is the effect of centuries of logging on this balance. It stands to reason that long term removal of wood may eventually affect growth rates of trees and other vegetation.

Slash, the trees tops left over after logging, also contributes an important element of cover for wildlife. Loose rows or piles of slash can create denning or hiding places for animals such as the red-spotted newt, redback salamander, wood frog, northern brown snake, northern ringneck snake, eastern garter snake, house wren, Virginia opossum, eastern cottontail rabbit, southern red-backed vole, ermine, and black bear.

Assessment: Throughout the property there is only a small amount of large woody debris on the ground because of repeated timber harvests that remove trees before they have a chance to fall to the ground. One area with slightly more woody material was near Cushman Brook between the Old Motion Loop and the bridge. This area is the same one that contains nearly all largest trees on the property. Slash or brush piles were also absent except for one pile near the trail intersection directly south of the quarry and some in the cleared vista area. The lack of woody debris is sure to be a limiting factor for small mammals such as mice and voles, as well as amphibians and invertebrates. The importance of woody debris on the ground is especially important on this property because of the presence of the rare Jefferson salamander, which needs debris for cover.

Management: If logging continues at BLTQ woody debris will always be a limiting factor, but slash and low value logs should be left on the ground whenever possible, and debris from natural disturbances such as wind or ice storms should be left. Following a cut, deciduous slash should be gathered into piles to provide cover for small mammals.

High Exposed Perches

Description: High exposed perches are dead or live trees that project above the surrounding vegetation. In a hardwood forest, these are usually white pine or hemlock because they grow to a higher average height than the hardwood canopy. Such perches are used by red-tailed hawk, kestrel, and flycatchers to hunt in open forests. Within 1/2 mile of lakes or large

marshes, they are also used for nesting by great blue heron, red-tailed hawk, osprey, and bald eagle. Turkey vultures and ravens may use exposed high perches to search for carrion.

Another type of high exposed perch is a single tree or small group of trees surrounded by herbaceous or shrub vegetation. These usually occur in non-forested areas, but can also occur in the midst of a mini clearcut of an acre or more in a forested matrix.

Assessment: Very few white pines are included in the forest at BLTQ and this limits the number of above-canopy perches. The only perches I found were in stand 4, near the north boundary. Here there is a large dead hemlock and a cluster of 2-3 dead white pines that appear to have been killed by disease. The large hemlock along Cushman Brook and shown on the BLT trail map also probably serves as a high exposed perch. Most of the hemlocks that occur individually in the hardwood stands are stunted from porcupine feeding, and will never project above the canopy. The hemlocks in the hemlock-hardwood stand are not useful for this purpose because they are of a more or less uniform height.

Management: In a continuous canopy forest, little can be done to create high perches except to encourage and retain white pine wherever possible. This should definitely be an element of management at BLTQ. In addition, if larger mini-clearcuts are created, a single seed tree such as an oak could be selected to retain within the cleared area.

Coniferous and Deciduous Inclusions

Description: This habitat feature occurs where coniferous and deciduous trees are growing together. It can either be single trees on one type in a matrix of the opposite type, or a single mixed stand, such as a hemlock-hardwood stand. Coniferous and deciduous trees each offer special qualities that may be lacking in the other, so when they occur together more habitat needs can be met in a small area. Coniferous trees are good for providing shelter from winter weather, and provide specific feeding and nesting opportunities that some species require. Deciduous trees can provide unique and valuable food sources such as hard mast (fatty nuts) and birch seeds.

Assessment: A few inclusions of pine and hemlock occur in the northern hardwood stands at BLTQ and the hemlock hardwood stands provide a good juxtaposition of both types. Unfortunately, in hemlock-hardwood stand 5 there is hardly any beech or oak. Most of the

hardwood there is yellow birch and red maple. In hemlock-hardwood stand 3, there is beech, but most of it is blighted. I saw virtually no oak in this stand either. Encouragement of mast trees in these stands would enhance their habitat value.

Management: For the northern hardwood stands, the recommendation to encourage and retain white pines and hemlocks applies. For the mixed stands, any individual oaks growing there should be sought out and released by cutting competing trees around them. Also in the hemlock-hardwood stands, group cuts big enough to provide sunny conditions for oak regeneration should be considered.

Mast and Fruit

Description: Mast is the term used for nuts and fruits used as food by wildlife. In New England, the most important hard mast by far consists of acorns and beechnuts. Hickory nuts, butternuts, black walnuts, and hazelnuts are also eaten by animals that can break through their thick shells. All of these are extremely important as fat and protein rich foods that can be used by wildlife in the fall to build up a winter body fat reserve.

Soft mast, which is any fleshy fruit, is rich in carbohydrates and vitamins. Soft mast includes wild cherries, apples, grapes, blueberries, black and raspberries, and many other berries that grow on shrubs, vines, or groundcover. These are valuable to many species of birds and to mammals such as bear, fox, raccoon, deer, and many more.

The best mast production occurs on canopy trees that have large crowns and on sub-canopy plants that grow in openings where there is plenty of sunlight. Hard mast production goes through multi-year cycles, where one species has abundant production one year and moderate or poor production other years. Because the cycles of different species (beech, red oak, white oak, chestnut oak), are staggered the mix of mast species helps even out the overall hard mast supply from year to year.

Assessment: Overall mast production at BLTQ is low. The three sources I observed were beech, red oak, and black cherry. Beech is abundant in stands 1, 3 and 4, and is also present in stand 6. Unfortunately, much of the beech is infected with the beech blight, caused by the fungus *Nectria coccinea*. The fungus is spread from tree to tree by a tiny scale insect, which

can be observed in winter as minute white cottony dots on infected trees. Some individual beech trees apparently are resistant to the fungus, but I found few of these at BLTQ.

The lack of healthy beech was probably exacerbated by the removal of all high quality trees during the last timber operation, leaving only suppressed, disease-susceptible individuals. Now the remaining genetic stock of beech and other trees here is low. In addition, most of the beeches are too small to produce many nuts: most of them are in the pole size class (5-13" dbh) with a smaller portion going up to a maximum of perhaps 15" dbh.

Even though the general condition of the beech is poor, there was evidence that bears had been feeding on beechnuts. On a few trees I saw bear claw marks, which show where a bear has climbed up the tree to feed. On two trees along in the south of stand 4 were also two relatively large beech trees with bear "nests" in them. These are not really nests but resting platforms that bears construct by breaking and folding over branches near the top of the tree. As far as I know, only beech trees are used for this purpose.

Red oak is the only other hard mast producer on the property, but it makes up a fairly minor proportion of the trees. It is present in stands 1, 4 and 5, in the same size category as the beech, and this small size means low acorn production. I did not find any red oak in stand 6, although it is there according to the Forest Management Plan.

The biggest soft mast producer on the property is black cherry. This is an early successional tree that grows well in lots of sun. There was quite a lot of black cherry in stand 1, north, west and just south of the main quarry. This suggests that this area grew back to forest more recently than the rest of the property. The cherry here is of good quality, but is generally on the small side so mast production is limited. The management plan says that black cherry is also present in stand 6, but I did not see any there.

No other sources of soft mast such as blueberry or grapes were seen on the property. These and other soft mast producers need a more open canopy that allows growth of shrub and ground layers.

Management: Efforts to grow more and bigger red oak, black cherry, and healthy beech should all be pursued. Each red oak and black cherry tree can be released to grow bigger by cutting some the surrounding trees that compete with it. Increased sun will allow the crowns to expand, and will ultimately boost mast production. This method can also be used with the relatively larger and healthier beech trees, especially those already used by bears because these

are proven to produce nuts that the bears like. (Individual trees of a given species seem to be favored over others of the same species by animals including bears and porcupine. Perhaps some produce tastier or more nutritious nuts than others.)

Because so much of the forest is occupied by blighted, suppressed beech, this is another reason to try creating canopy openings. By cutting all the trees in one small area, including the poor beech, regeneration can start from scratch either by seed or by stump sprouts (for beech and oak). This might give the genetically superior, resistant beech a chance to get re-established from the sprouting roots of the larger, healthy individuals that were cut in the last timber operation.

These openings would also allow for regeneration of oak and cherry if any seed of these are on the ground. Acorns don't last more than one winter on the ground before sprouting, but cherry seeds can be in the ground for a dozen or so years and still be viable. These two species, especially oak, need a lot of light to grow competitively. That means that for oak regeneration to have the best chance of success, mini-clearcuts should be made after a good oak seed year, and they should be big enough to be free of shade from surrounding trees. Openings made by cutting a group of as few as 5 trees could be used but bigger openings will be better for regenerating oak.

In addition to oak and cherry regeneration, it's possible that mast production could also be boosted in the clearings because mast producing shrubs and groundcover could become established.

Ground, Shrub, and Midstory Vegetation Layers

Description: The ecological complexity of a forest is increased, and more habitat features are available, when vegetation is allowed to develop at different height levels. Many species of wildlife specialize in the use of a particular level, and will not be present if this level is absent. For other species, a certain vegetation level may increase survival and reproduction by making more food and cover available. Vegetation at all levels is a source of insects that provide food for warblers and other birds.

Ground level vegetation is defined as 0-2 ft. high and can consist of forbs (broadleaf non-woody plants), grasses, and woody seedlings. In the forests of western Massachusetts, some of the most common plants in this layer include a variety of ferns, wild sarsaparilla, whorled aster,

wintergreen, partridgeberry, trillium, Canada mayflower, lowbush blueberry and club mosses. A dense ground layer within the forest provides necessary cover for ground-nesting birds like the wild turkey, ruffed grouse, veery, hermit thrush, ovenbird, Wilson's warbler, Canada warbler and rufous-sided towhee. It also serves as cover for snakes and for small mammals like mice, jumping mice, voles, and shrews. Amphibians benefit by the shaded, moist environment provided by dense ground vegetation. Cottontail rabbits, hares, mice and deer also feed on the bark of woody seedlings.

Shrub level vegetation is the layer between 2 and 10 ft. high. Tree seedlings can help comprise this layer as well as a variety of shrubs. Some common shrubs that occur in forests in western Massachusetts are mountain laurel, witch hazel, hobblebush, highbush blueberry, shadbush, spicebush, maple-leaved viburnum, hazelnut, and striped maple. Raspberry and blackberry also grow at this level. A great variety of birds nest in the shrub layer. Just a few of these that occur in the forests of Becket are the black-throated blue warbler, wood thrush, black-and-white warbler, and blue-headed vireo. As mentioned in the previous section, the shrub layer can also be an important source of fruit for wildlife. Also, the buds and twigs of several shrubs are important browse for deer and moose.

The midstory layer is between 10 and 30 ft. high. Trees at this level are usually about 4-6" dbh. The midstory can be made up of canopy tree species that have yet to reach their full height, or can include tree species whose maximum height is less than 30 ft. This latter group includes striped maple, hophornbeam, American hornbeam, mountain ash, gray birch, pin cherry and sassafras. The main habitat value of midstory is for birds that prefer to nest at this level. These include the rose-breasted grosbeak, American robin, blue jay, northern parula, and magnolia warbler. Red maple and striped maple of this size are very attractive to moose, which use their incisors to strip off and feed on the bark. These incisor scrapes, usually 4-7 ft. above ground level, are a good sign to look for to indicate moose activity.

While all these vegetation layers are really important for increasing biodiversity, there are some species of wildlife that prefer a forest with an open understory (little vegetation in the ground, shrub or midstory). The northern goshawk, red-shouldered hawk, broad-winged hawk, great horned owl and saw-whet owl all need open forest to hunt in. Birds that catch flying insects also prefer open forest. These include the least flycatcher, eastern wood pewee, eastern phoebe, black-throated blue warbler and Canada warbler.

Assessment: AT BLTQ the ground and shrub layers are very sparse due to the closed canopy and shaded conditions. Stand 6 was a notable exception, with a fairly dense ground and shrub layer consisting of hobblebush and ferns. Lots of browsed hobblebush twigs and several piles of scat indicated that moose have been feeding here. Another place with a noticeable ground layer was in the north of stand 4, where quite a bit of American yew (another moose food) was growing. The boulder pile along the Circle of Stone Trail at the edge of the hemlock hardwood stand was a unique area with a heavy ground cover of moss, polypody fern, clintonia, and skunk currant. In stand 1, the cleared area downhill of the vista supported a dense ground layer. Plants here included grasses, fringed bindweed, wood fern, currants, blackberry, wild sarsaparilla and sprouts of red maple and beech. Also in stand 1, in the wet area west of the Cushman Brook Bridge, there was a robust ground layer of hobblebush, striped maple, wood fern, and trillium.

I only observed two actual species of shrub on the property. The first was mountain laurel, which was present in some openings east of the marsh. The second was hobblebush, which was limited to the locations described above and also to small patches in stands 4 and 5. What little other sparse vegetation there was growing at the shrub level was sapling trees: beech, hemlock and striped maple. The striped maple west of the quarry will soon reach a size where it will be attractive to moose.

The bulk of the forest cover blends the levels of midstory and canopy. This is because the trees are relatively young and small. Even though they are not topped by a higher layer, these trees may still be used by midstory-nesting birds as well as upper canopy nesters.

Management: Biodiversity would be greatly enhanced by either canopy gaps in a range of sizes, or by thinning larger areas of the canopy sufficiently (15-30% canopy cover) to allow sun to penetrate to the lower levels. This would allow ground cover and shrub layers to develop, and years later, a new midstory.

These lower vegetation layers are another feature that is good to vary on both large and small scales. Ground, shrub and midstory were not examined at the landscape scale in this study; however most forest in western Massachusetts is either unmanaged or harvested by selective thinning. In either case, a continuous canopy of >70% cover is maintained and growth of lower vegetation layers is very restricted. It is likely that much of the forest in the surrounding area has an open understory like BLTQ. Even if there are significant areas on surrounding properties

with canopy <70% cover, it would still make sense to include some canopy gaps at BLTQ to benefit animals that need both open and vegetated understories in different seasons or for different purposes. Examples are the red-shouldered hawk, saw-whet owl and ermine.

In order to protect Jefferson salamander upland habitat, canopy gaps larger than 1/2 acre should not be made closer than 1,000 ft. from VPs 5-7. No gaps at all should be made within 300 ft. of any of these pools. For VPs 1-4, the no-cut zone is only 100 ft.

Upturned Roots

Description: Upturned roots are formed when shallow-rooted trees, usually hemlock, fall over in wind storms. They often occur in wet areas where soils are thin and hemlocks are able to grow. Because the roots are so wide spreading, the exposed root mat, once horizontal, but now vertical, can reach up to about 6 ft. high. The nooks and crannies among the roots form mini-cavities that are desired nest sites for the winter wren, eastern phoebe, and Louisiana waterthrush. Bobcats often include them in their hunting circuit because they may harbor small mammals. Bobcats also use upturned roots as a protected place to rest, and bears may also use them for rest or winter sleep. Sometimes an upturned root creates a hollow that can fill with water and form a miniature vernal pool.

Assessment: Upturned roots were found in only two sites at BLTQ. One recently upturned, large hemlock lay on the ground in stand 3 west of the Old Motion Loop. The foliage and branches were still intact, and the root area as well as the rest of the area around the tree showed coyote and fisher tracks. Several other upturned hemlocks were in stand 5 in some wet areas along the marsh. These are likely to be used by some of the species listed above.

Management: No management is needed because this resource will exist as long as larger hemlocks are growing in wet areas.

Rock Dens, Crevices, and Cliffs

Description: Subterranean crevices and caves among rocks can provide snug dens, nests, or roosts for numerous animals, and basking or hunting sites for others. Rock dens and crevices can occur either in flat to moderately sloped rocky areas or on steep rocky talus slopes. Stone walls can also meet certain habitat needs for small mammals. Animals that use this feature

include the black racer, milk snake, turkey vulture, eastern phoebe, deer mouse, white-footed mouse, southern red-backed vole, long-tailed shrew, masked shrew, eastern chipmunk, porcupine, coyote, gray fox, black bear, fisher, long-tailed weasel, ermine, bobcat, and possibly several species of bat.

Rock cliffs can be nest sites for common ravens and eastern phoebes, and possible summer day roosts for bats including the little brown myotis and eastern small-footed myotis.

Assessment: The towering rock piles left behind from the granite quarry operations are the most dramatic feature of the BLTQ property. Granite piles reaching 60 ft. high are located surrounding the main quarry and nearby on the west side of the quarry access road. Additional smaller piles only 10-20 feet high are located at four old excavation sites: west of the main quarry; south of the quarry where the Founder's Loop Trail meets the quarry access road; and at two sites south of the Old Motion Loop. Some naturally occurring boulder piles occur in stand 4 along the Circle of Stone Trail and along the north boundary. At these last two sites the boulders are covered with dense vegetation but the other, recently formed rock piles are almost entirely bare of vegetation. These 8 rockpiles are shown on the map, labeled RP1, RP2, etc. In addition, a large portion of the forest here is situated on very rocky, bouldery, soil. In some places, it is hardly possible to walk without stepping on rock.

Many interesting wildlife sightings were made in the rockpiles. The most commonly observed rock pile users were porcupines. Porcupines usually use rock dens, hollow trees, or hollow logs for winter dens and go out at night to feed in hemlocks. Several porcupine dens were found in the main rockpile (RP1) with trails leading out to a grove of hemlocks west of the quarry. Other porcupine dens were found in RP4 from which they would venture south on the quarry road to some big hemlocks at the junction with the Old Motion Loop. Fisher tracks were also seen investigating the dens in RP4. The other rockpile with porcupine activity was RP7 along the Circle of Stone Trail. Here the porcupines don't have to travel far because hemlocks are close at hand. Weasel tracks were also found at this rockpile in the winter.

In June RP7 was the site of a dramatic encounter. As I approached I heard some very agitated birds. I then noticed a junco and a black-and white-warbler making a loud frenzied commotion, and flying in and out of a rock crevice. When I went to see what was happening, I found a milk snake hidden among the polypody ferns on the edge of the crevice. Protruding from its mouth was a pair of bird legs! Juncos and black-and-white warblers are both ground

nesters and must have both had nests among the dense vegetation on the boulders. Unfortunate for them but fortunate for the snake.

I searched the rockpiles for turkey vulture nests but found none. However, Neil Toomey reported to me that he had seen a turkey vulture at RP4, and all the rockpiles except RP8 have openings big enough for turkey vulture nests. These birds return year after year to the same nesting site. They often nest in dens that were used by porcupines over the winter.

Rock cliffs have been created by excavation along the north side of the quarry pond. The combination of the cliff and the surrounding rockpiles totally surrounds the pond. Another exciting wildlife observation was the discovery of a raven nest on the cliff. A pair of ravens flying over the property and calling was first observed on March 9. On May 7 I located the coarse stick raven nest on the cliff just below the upper white vein on the north quarry wall. In the nest were 3 young ravens, each about the size of an adult crow. By May 25, the ravens had fledged and the family was seen on the main rockpile. They were still in the area on June 13. Raven nests are often used perennially so they are likely to return again next year.

A pair of eastern phoebes was also nesting on the rock cliffs at the quarry. Such nest sites are typical for them in the absence of sites under the eaves of a roof. They also return to the same or nearby nest site year after year.

In winter, I noticed several separate raccoon tracks leading into the inner part of the main rock pile from the northwest corner. It is likely that a raccoon had made a winter den in the protected isolation of the rocks. I also found what could have been bobcat tracks leading into a remote section RP1 from the north. Unfortunately, I could not confirm the identity of the tracks because the snow was too granular. This remoteness and abundance of rocky caves definitely makes the immediate quarry area good habitat for bobcat. Young are born in late April to mid May, so up through mid June is probably the most sensitive time of year for them.

Management: No management of the rockpiles is needed except to make sure any nesting birds or denning bobcats are left thoroughly undisturbed. It would be a good idea to scope out the rock piles and cliff each spring for nesting ravens or turkey vultures, and if any are found, access to that area should be restricted, particularly for dogs. I also suggest the areas north and west of the quarry be left trail less in case bobcats are denning there. Bobcats are especially sensitive to disturbance of their den site.

Seeps

Description: Seeps are areas where the water table reaches the ground surface. The ground remains saturated for most of the year, even in all but the coldest winters. In the growing season a dense ground vegetation layer may occur, and the moist, protected environment can be a refugia for dusky, spring and two-lined salamanders, green frogs, red-backed voles, and star-nosed moles. The salamanders are most likely to use seeps located in the flat terraces along streams.

In winter the constant supply of water from underground often keeps seeps open from snow. Wild turkeys can forage for seeds on the bare ground, and many animals have a source of unfrozen water.

Assessment: The only seep I found was a small one at the head of Cushman Brook, west of the bridge. Seeps are not a critical habitat feature, so the lack of seeps would not have a big impact on wildlife use here.

Management: Clearing a few trees away on the south side of the seep might prolong its snow-free season by letting more winter sun in. This could provide a source of seeds and water to wildlife in winter. On the other hand, this is the same area I suggested could be left uncultivated to develop into an old growth zone.

Stable Banks

Description: Stable banks are fairly steep soil slopes, usually occurring in banks along lakes, rivers, streams and wetlands. They can also occur artificially in sand or gravel pits, but these may not be as stable. The value of these slopes is that they can be excavated for burrows by red fox, gray fox, coyote, and belted kingfisher.

Assessment: I did not notice any stable banks on the BLTQ property. The gravel pit on abutting property next to the parking lot is an example of this feature, and could serve the mammals above if they aren't disturbed by the human activity (ATVs and nearby parking).

Management: No management is needed. This feature cannot be created artificially.

PART 5. ASSESSMENT AND MANAGEMENT OF EACH STAND

In this section I will address the habitat value of the individual stands and make management suggestions, including comments about the management proposed in the Forest Management Plan.

Stand 1. Northern Hardwoods

Description and Habitat Potential: The dominant species in this stand are beech and red maple. Also present are red oak, sugar maple, black cherry, and scattered hemlock. The size class is mostly pole (5-13" dbh) with some slightly larger trees at the southern end of the stand. Much of the beech is infected with blight but there is good future habitat potential in the oaks and cherries. The canopy is uniformly closed, with only a few white pines projecting above the deciduous layer in one location. Understory layers are sparse. Three vernal pools are in this stand, but no rare species were found in them. The old ruin of a building behind the quarry is good potential habitat for milk and garter snakes because there's plenty of debris to hide under.

Beech nuts are relished by black bear, white-tailed deer, gray and red fox, raccoon, porcupine, flying, red, and gray squirrels, eastern chipmunk, white-footed mouse, wood duck, wild turkey, ruffed grouse, rose-breasted grosbeak, blue jay, white-breasted nuthatch, and tufted titmouse. Unfortunately, much of the beech here is infected with the beech blight, caused by the fungus *Nectria coccinea*. The role of beech in the forest is destined to decline, but a few scattered beech trees that are resistant to the fungus will provide the genetic potential for future generations of healthy beech. Meanwhile, the dying beeches provide abundant cavity trees in the smaller size categories.

Cherries are an outstanding part of the fall diet of many animals. In sites with a lot of cherry, black bear scat filled with cherry pits is often abundant. Other mammals that gorge on cherry fruits are the raccoon, striped skunk, red and gray foxes, red and gray squirrels, eastern chipmunk, and Virginia opossum. At least thirty species of birds in this region also feed on wild cherries. These include wild turkey, American robin, eastern kingbird, rufous-sided towhee, red-eyed vireo, and scarlet tanager. Most cherry trees contain one or more nests of tent caterpillars,

which feed on the leaves of the tree. These caterpillars are in turn relished by the black-billed and yellow-billed cuckoos, northern orioles, and other birds.

Over 35 species of birds of the northern hardwood forest feed on insects and other invertebrates instead of or in addition to plant matter. These include many species of woodpeckers, flycatchers, vireos, warblers and others.⁵ These different species all have slightly different niches, to most efficiently partition the food resource of this habitat. Some, such as nuthatches and the brown creeper, glean insects off tree trunks. Some, such as the flycatchers, swoop out from a perch to catch flying insects. Some birds pick insects off of foliage, and others look for bugs on the ground. Even the different vertical layers of the forest are used by particular species. The red-eyed vireo, for example, only searches for insects in the uppermost layers of the canopy, while the black-and-white warbler rarely looks for food above 35 feet.

Hardwood stands such as this provide nesting sites for a large group of birds, whose composition changes dramatically as the stand progresses from a fresh clearcut to a mature forest. Species of birds that prefer to nest in hardwood stands in this size class (with trees in the pole to sawtimber size) are the sharp-shinned hawk, northern goshawk, broad-winged hawk, barred owl, northern saw-whet owl, ruby-throated hummingbird, downy, hairy, and pileated woodpeckers, least flycatcher, black-capped chickadee, white-breasted nuthatch, hermit and wood thrushes, red-eyed vireo, black-and-white warbler, American redstart, ovenbird, and scarlet tanager. Mammals, reptiles, and amphibians tend to be more general in their choice of forest type, but several species do prefer the northern hardwood forest for denning. They generally require hollow trees or logs, brush piles, upturned roots, or other structural features for cover. These include the southern flying squirrel and gray fox. Others, such as the black bear and fisher are more likely to den in older forests with bigger cavity trees and logs.

Wildlife Observed: Lots of wildlife activity was confirmed in this stand, especially west of the quarry. In this area, there were many porcupine trails leading from the main quarry rockpile to a winter feeding area in a grove of hemlocks near the western boundary. There was also an abundance of tracks left by coyotes, perhaps lured by the porcupine activity. One

⁵ Birds in this feeding category are the downy, hairy, and pileated woodpeckers, least and great crested flycatchers, eastern phoebe, black-capped chickadee, tufted titmouse, red-and white-breasted nuthatches, winter and house wrens, blue-gray gnatcatcher, veery, hermit and wood thrushes, American robin, solitary, warbling, yellow-throated, and red-eyed vireos, American redstart, ovenbird, common yellowthroat, scarlet tanager, rose-breasted grosbeak, white-throated sparrow, dark-eyed junco, northern oriole, and the following warblers: black-throated blue, yellow-rumped, black-throated green, black-and-white, worm-eating, and Canada.

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isolated rock near the hemlock grove appeared to be a coyote marking site, as many tracks converged here, and there was much urine marking. The vista overlook also was a popular site for coyote. The cleared area at the overlook may be a good location for them to hunt mice and voles. In the summer, several species of dragonflies were observed at the clearing. Though dragonflies breed in water and have an aquatic larval stage, clearings like this are important feeding areas for adults, even if not adjacent to water.

Mink tracks were observed passing overland through this stand, probably heading from Cushman Brook toward another wetland. Just north of the quarry were possible bobcat tracks, indistinct due to crusty snow conditions. They were leading into an isolated back section of the big rockpile. No moose sign was seen in the stand despite the presence of one of their favorite foods, striped maple (moosewood). Probably these saplings are still too small for moose, who seem to prefer them when they're around 4-6" dbh.

Management Recommendations: To improve the habitat of this stand, the following types of trees should **not** be cut: black cherry, some of the better quality beech, cavity trees, hemlock and all white pines. Thinning of competing trees around the black cherries, mostly growing in the northern end of the stand, would be beneficial to improve mast production. The beech is also needed to increase mast production, especially with the lack of oak in this stand. The hemlock provides essential winter food for porcupines and indirectly for fisher who prey on porcupines. Hemlocks also provide protected sites for deer beds, even though deer activity was very low on this property. Pines are so few on this property that all should be kept for their unique food and cover value and as future high perches and cavity trees.

Trees to be removed in this stand are some of the poorer quality red maple and beech, but care should be taken to maintain the recommended buffer zones around the vernal pools. Even outside the buffer zones, cutting all the poor quality trees throughout the stand is not recommended because there would be too few trees remaining. The resulting hot, dry ground conditions over a large area would be detrimental to amphibians, invertebrates, and fungi that all contribute to a healthy forest. To recover from the effect of past high-grading, the removal of poor quality trees will have to be done in stages over several cutting cycles. A good way to do this would be to do patch cuts (cutting of several trees in a cluster to create canopy gaps) or mini clearcuts as long as they are no bigger than 3 acres. However, with the vernal pool restrictions it might be difficult to find a suitable site for a cut as large as 3 acres.

Another potentially sensitive area is rockpile 4, a potential turkey vulture nesting site. This should be checked every spring for turkey vultures and if any are nesting there, the area should be off limits to any human or dog intrusion.

Stand 2. White Birch

Description and Habitat Potential: This stand consists of the sparse sapling to small poles growing along the bottom edge of the main quarry rockpile (RP1). Species are white birch, white ash, red oak, sugar maple, red maple, black cherry, striped maple, and mountain maple. The big rockpiles (RPs 1 and 2) actually consist of three distinct communities. The lower vegetated zone is a Northern Hardwood Talus Woodland and the upper unvegetated area is Open Talus. The Temperate Acidic Cliff community is present along the north side of the quarry pond.

In the Open Talus community the only vegetation that will become established in the foreseeable future will be on the flat top of rocks, or where the rocks are tightly packed enough to hold soil. In these places, moss and a few herbaceous plants can subsist. Otherwise green plants cannot grow here because any bits of organic matter that do accumulate fall into the deep crevices where light does not reach.

In the Northern Hardwood Talus Woodland a little more soil will accumulate because it is downslope, and small trees can then become established. Vines can also do well here because their leaves can reach out into the sun even though they are rooted in dark crevices. Mosses, lichens, and polypody fern can also become abundant.

The quarry pond itself offers limited habitat opportunities because it is too deep for there to be much aquatic vegetation that would form the base of a food chain to support aquatic fauna. The open space above the water could be used by other flying hunters such as phoebes, swallows, flycatchers and bats, but I did not see any feeding activity going on here.

Wildlife Observed: The abundance of large and small gaps between the boulders offers a unique cover opportunity for many animals. Porcupines were the most obvious denizens of these protected caves, but raccoon and possibly bobcat tracks also led into this rocky area. Other potential species that could use the talus habitat here include turkey vultures, black racer and black rat snakes. While timber rattlers and copperheads also utilize talus slopes, they are

unlikely to become established here because there are no other nearby sites from which they could colonize.

The cliffs were being used as nesting sites for both a family of ravens and of phoebes. The ravens are probably attracted to the remoteness and the structure of the cliff ledges while the phoebes use the cliffs for attachment of their mud nests and use the open space to catch flying insects.

Management Recommendations: The Forest Management Plan for this stand calls for creating small openings to maintain early successional habitat, but this is not necessary because the conditions prevent anything but early successional stages from ever being established anyway. My only management recommendation for this stand is to leave the ravens undisturbed during nesting season.

Stand 3. Hemlock Hardwood

Description and Habitat Potential: This small stand in the southwest corner of the property is a mix of hemlock and beech with a little red maple, yellow birch, and black birch. I did not see any oaks or white pines that were mentioned in the Forest Management Plan. Like most of the property, the tree size class is pole to small sawtimber but I did find one 30" dbh hemlock.

The hemlocks appeared to be healthy with no sign of the hemlock wooly adelgid. The beeches were generally in only fair condition with most of them infected with blight. One large hemlock that had fallen to the ground would make a superb bear den, but there was little woody debris otherwise, and no ground or shrub layer.

Wildlife is drawn to hemlock stands both for food and cover. Birds that might nest in this hemlock stand include the veery, black-throated blue warbler, black-throated green warbler, blackburnian warbler, and dark-eyed junco. In this area of western Massachusetts, the foliage, bark, twigs, and tiny but abundant hemlock seeds could be utilized by black-capped chickadees, red-breasted nuthatches, cedar waxwings, deer mice, red squirrels, porcupines, snowshoe hare, and white-tailed deer. Other birds, such as the black-throated green warbler, prefer to feed on insects associated with hemlocks. All these animals can, of course, become food for birds and mammals of prey such as the sharp-shinned hawk, northern goshawk, great horned owl, saw-

whet owl, fisher, red and gray fox, eastern coyote, and bobcat. Many of these same animals are also attracted to hemlock stands because the closed canopy helps to retain radiated heat from the earth in winter, and snow depth is often less than in hardwood stands.

Porcupines are especially dependent on hemlocks in the winter. They often occupy a winter den in a hemlock grove and venture out at night to feed on the twigs of a few favorite trees. In this stand den sites for porcupines were lacking and porcupines on the BLTQ property were feeding only on individual hemlocks in other stands closer to den sites.

Because this stand also contains a hardwood component, a wider mix of food resources is available to wildlife than in a pure hemlock stand. Unfortunately, most of the beech in this stand is diseased, so a major source of hard mast is being lost.

Wildlife Observed: Coyote and fisher tracks showed that these animals were investigating the big fallen hemlock. Bear and moose tracks were both found along Bonny Rigg Hill Road. Chickadees and black-throated blue warblers were the only birds I observed here, but the lack of birds and other wildlife observed here is more likely a function of the small size of the stand than of its habitat qualities.

Management Recommendations: The Forest Management Plan recommendation to encourage red oak and white pine in this stand should be followed if any of these species can be found, but I did not see any of them here. If cutting is to be done at all in this stand, it should emphasize thinning some of the smaller trees and leaving all the big hemlocks because there are so few on the property.

Before considering opening the canopy more than 70% or creating patch cuts, the potential vernal pool sites along the other side of Bonny Rigg Hill Road should be investigated in the spring for Jefferson salamanders. If they are found, then this stand is probably important upland habitat for this species, as it would be located in between two breeding sites (the other being VPs 5-7 in stand 4). That would mean that little if any cutting should take place in this stand.

Stand 4. Northern Hardwoods

Description and Habitat Potential: This large stand in the center of the property is similar to stand 1 except there is an even greater proportion of beech here and the average tree size is a

little smaller, almost all in the pole class. In addition to the beech, there is a lesser proportion of red maple, sugar maple, yellow birch, white ash, and sprinklings of red oak, black cherry and hemlock. The shrub layer is light to none, consisting of beech, hobblebush, striped maple and one patch of yew. A lot of the ground in this stand is so rocky that potential tree growth would be severely limited.

The most important habitat features in the stand are VPs 5-7 at the southern end. (See Vernal Pool section in Part 4.) Also, there is a small area at the western origin of Cushman Brook with some unique characteristics. This pocket in some ways resembles old growth forest, with a mix of tree sizes including very large; a fairly high amount of large dead woody debris on the ground, greater coverage of ground vegetation and moister soil, including a seep. A few gigantic trees, with one red oak measuring 50" dbh, were present near this area in the vicinity of the Old Motion Loop Trail, north of Cushman Brook.

A few other valuable habitat features exist in stand 4. Rockpile 6 has the kind of crevices that would make suitable turkey vulture nest sites, but no nests were found this year. Other rocky crevices throughout the stand could be used by small mammals, and several dead pines serve as high exposed perches in the north end of the stand. The ruins of a shack and a stone foundation from a long-gone building are located just west of the vernal pools. These could be good shelters for snakes like the milk snake.

There is a 1-acre wetland at the southeast corner of the property, but it is totally taken over by the invasive species, *Phragmites australis*, or common reed. The dominance of this species here limits the habitat value of this small wetland that probably used to be a cattail marsh.

Wildlife Observed: Bear claw marks and bear "nests" in beech trees were clues to this animal's presence here sometime in the past, but no recent bear sign was found. Fisher tracks were seen in several areas, and fresh moose tracks were found at the trail/stream crossings in the spring. Pileated woodpecker and 11 other species of common forest birds were observed. Eggs of wood frogs, and spotted and Jefferson salamanders were found in the vernal pools.

Management Recommendations: The Forest Management Plan calls for removal of "all damaged, diseased, and suppressed growing stock. The residual stand would be thin and open, but stocked with seed trees that would provide seed for tree regeneration and wildlife food as well as timber for future harvest". While this makes sense from a silvicultural perspective and

also from a landscape habitat perspective because it would allow development of an expanse of ground and shrub vegetation, I recommend against such a large amount of cutting. The presence of vernal pools and especially the presence of rare Jefferson salamanders in this stand are factors that were unknown when the Plan was written but play an important role now. As described in the vernal pool section in Part 4, it is important to maintain moist, cool ground conditions in the vicinity of the vernal pools, even up to 1,000 ft. or more from them because Jefferson salamanders are known to use upland habitat this far away. As described in that section, some openings would be acceptable within 1,000 ft. but this is very different than an overall thinning of the canopy to the degree proposed. Cutting should also be limited along the stream corridor according to the state's Best Management Practices⁶ guidelines.

In the parts of this stand away from the vernal pools, the main considerations are the impact cutting will have on aesthetics and recreation and how much is practical because of the rocky conditions. I think a mixture of patch cuts and canopy gaps of 1/2 to 1 or 2 acres, with crop tree release of desirable individual trees in between is sensible. However, there are so many low quality trees in the stand that to remove all of them would leave very little. Instead cutting should focus on removing the worst of the worst in carefully selected areas. Education materials should be provided to recreational users of the property. These can address the importance of using silviculture to enhance habitat and to ameliorate the effects of high-grading.

Throughout the stand, cavity trees, especially those >10" dbh, should be retained, and red oaks, cherries, and pines should be released by thinning around them.

If you have a willing group of volunteers and the money to pay an herbicide applicator, a worthy goal would be to remove the *Phragmites* from the little wetland near the southeast property corner. The habitat value of this wetland would be increased, and it would probably attract additional species. See details of this procedure under the management section for stand 7.

Stand 5. Hemlock Hardwood

Description and Habitat Potential: This large stand centers on Cushman Brook where the moist acidic soils favor hemlock. At the north end of the stand hemlock predominates and what

⁶ Kittredge and Parker, 1995

little hardwood grows there is mostly beech in poor health. Moving upstream, the hardwoods become more diverse, with red maple and yellow birch present. At the most upstream section of the stand it grades into the surrounding northern hardwoods, with some sugar maple, red oak, white ash, and white birch.

The size class overall is in the pole to small sawtimber category (5-21" dbh) but the actual size distribution is even narrower than this, with most trees between 8 and 14" dbh. The lack of both saplings and large trees, combined with the overall sparse ground and shrub layer are limiting habitat factors. Some upturned roots along the marsh edge could be used for nesting by winter wrens, phoebes, and Louisiana waterthrushes.

Patches of good shrub cover do exist in a few places. East of the marsh are some patches of dense laurel and hobblebush, and abundant hobblebush grows along the Circle of Stone Trail just west of Cushman Brook. At the west end of the stand there is a patch of hemlock and beech saplings. All of these shrub patches were the result of disturbances which opened the canopy and caused a flush of new vegetation to sprout. This is a sample of what could be expected if canopy gaps are created through forest management.

An interesting site in this stand is the mossy boulder field along the Circle of Stone Trail. Here there was a heavy ground cover (due to insufficient substrate for shade-producing trees to grow) of polypody fern, wood fern, moss, clintonia, and skunk currant (*Ribes glandulosum*). The hemlocks here are extremely stunted from decades of being fed on by porcupines that den in crevices among the boulders in winter. This is the site where I observed the previously described encounter between the milk snake, junco, and black-and-white warbler.

General habitat qualities of hemlock-hardwood stands were described for stand 3.

Cushman Brook itself is a major component of this stand that has important and unique habitat attributes. It is an upper perennial stream with a bottom of sand and flat stones 1-12" diameter. In the upper tributaries the substrate consists solely of mossy boulders. A mixture of flatwater and riffles, the stream is about 10 ft. wide and 6-12" deep. A moderate density of herbaceous vegetation is growing along the banks of the lower stretches, including moss, oak fern, sensitive fern and aster. The stream is shaded and cool and has good associated habitat structures of overhanging branches and woody debris dams.

Streams in general have many features attractive to wildlife. Obviously, they are important sources of drinking water needed by nearly all species, and they provide habitat for

aquatic invertebrates, fish, and amphibians. They are also used by upland species for travel corridors and opportunistic feeding. Rocks, logs and woody debris in streams are valuable because they create pools, attachment sites, and hiding places for many stream dwellers, ranging from salamanders to crayfish to larvae of insects like caddis flies, stone flies and black flies. Soft stream bottoms may be used for hibernation by turtles and snakes and foraging sites for dragonfly larvae, while vertical banks may be used by otters, mink, and muskrats for dens and by kingfishers and bank swallows for nests. Trees along streams tend to grow larger due to the availability of water, and their large size makes them attractive to a greater variety of wildlife. Streamside trees also tend to lean out over the water. Woodpeckers prefer to make cavities in the protected underside of trees like this. Overhanging trees and branches along the stream are also used as hunting perches for flycatchers.

Wildlife Observed: The hemlocks provide good cover for deer, and an interesting deer sign was digging for false truffles. False truffles (genus *Elaphomyces*) are spherical capsules about 1/2" diameter that contain a fungus relished by deer, porcupine, and perhaps other species. The fungus co-exists symbiotically with hemlock, with each species helping the other grow. The truffle attaches to a hemlock root and its mycelium collects water and minerals that benefit the hemlock. The truffle in turn benefits by receiving carbohydrates from the hemlock. Consumers of false truffles spread its spores through their droppings to other parts of the forest, maintaining this strand of an intricate web of ecological connections.

It is very likely that a pair of red-shouldered hawks is nesting in this stand within a few hundred feet of the marsh. Both members of the pair were seen on May 25 and June 13 hunting and calling over the marsh. This raptor nests in a large coniferous or deciduous tree with large support branches, and a pair, which mate for life, return to the same nest site year after year. They feed on amphibians, reptiles, crustaceans, insects, and mammals of wetlands. They require both forest for nesting and open wetland (preferred) or upland for hunting. Some human disturbance is tolerated as long as large trees and a closed canopy are maintained around the nest site.

Another wildlife sign observed in this stand was the circuitous hunting trail of an ermine. This stand was also the only one on the property where I found a Canada warbler. This bird likes dense shrubby patches and was nesting in a hobblebush/laurel patch east of the marsh.

I searched for salamanders in Cushman Brook, hoping to find the state-listed spring salamander, which lives in cold forested streams such as this. I didn't find this species, but did find several each of two other common stream-dwelling salamanders: the dusky salamander and the two-lined salamander. They hide under rocks that are partially submerged or along the stream bank. Their eggs, laid on the watery underside of rocks, hatch into aquatic larvae that to the untrained eye look like tiny minnows.

A very lucky observation was the opportunity to witness on May 25 the synchronized emergence from the stream of an uncommon species of dragon fly, the southern pygmy clubtail (*Lanthus vernalis*). Like all dragonflies, they have an aquatic larval stage until the larvae crawl out of the water and metamorphose into flying adults. This species is found in small shaded streams and was found by the dozens resting on streamside vegetation along the lower stretch of Cushman Brook. Evidence of recent emergence was the shed larval "skin" left behind on the same stem where each newly emerged adult was resting.

On this same day I witnessed crane flies emerging from the stream. The larva would crawl into the moss alongside the stream and insert itself vertically into the moss before crawling out the top as an adult. These insects are just two of a multitude of species that inhabit the stream and contribute to its complex and fascinating ecology.

Management Recommendations: The Forest Management Plan calls for the harvest of hemlock "where appropriate" to encourage a mixed overstory and understory. As in stand 3, the species mentioned for retention here (black cherry and sugar maple) are not numerous in this stand, especially the northern part. I do think cutting here would be beneficial to open up the canopy and allow additional layers to develop, but removal of all poor quality trees would result in too heavy a cut. Either or both selective cutting or group cuts could be used to thin the canopy and create gaps, but certain areas should be excluded.

As the plan mentions, the stream corridor should be excluded from nearly all cutting to maintain the shady, cool conditions required by the stream inhabitants. The same is also true for the edge of the marsh. Before cutting in any area within 200 ft. of the marsh, it should be searched for the red-shouldered hawk nest, and a 100 ft. buffer should be left around this site. Operations should not take place in this stand during hawk nesting season, from mid-March through the summer. Because raptors occupy the top of the food chain, there are relatively fewer of them than songbirds, so they merit more stringent protection of nest sites. Unsuccessful

breeding by one nesting pair of hawks would make a bigger impact on the ecosystem than unsuccessful breeding by one nesting pair of songbirds.

Stand 6. Northern Hardwoods

Description and Habitat Potential: This stand lies in the northeast corner of the property and is quite distinct from the other two northern hardwood stands at BLTQ. Instead of being dominated by beech, stand 6 is dominated by red maple, yellow birch, and sugar maple. Ash, beech, and hemlock are minor species. This might be what stands 1 and 4 looked like before they were high-graded. The size class is a little larger, too, with more trees in the small sawtimber size (14-21" dbh) than the pole size (5-13" dbh). Another significant difference is the presence of a moderate to dense hobblebush shrub layer.

Wildlife Observed: The main wildlife sign I saw here was heavy moose browsing on the hobblebush. As evidenced by recent scat, this had occurred during the spring of this year. Bear claw marks were also seen on one beech, and 7 bird species were counted during the breeding bird survey.

Management Recommendations: The goal for this stand stated in the Forest Management Plan is to create an overstory of black cherry, red oak, and sugar maple by removing red maple, beech, and birch. While encouraging mast trees is a worthy goal, few cherries and oaks presently exist here or in the surrounding stands, so regeneration of these species is chancy. Selective cutting and group cuts could be tried here by cutting red maple and leaving yellow birch and sugar maple, but I don't see cutting in this stand as a priority. A few decent beech trees should be left especially if they have bear claw marks indicating past feeding activity.

Stand 7. Marsh

Description and Habitat Potential: This is a 5-10 acre, semi-permanently flooded, beaver-enhanced wetland with patchy shrub, emergent, and moss/lichen vegetation layers. In the shrub layer were winterberry holly, mountain laurel (around the edges), maleberry, cinnamon fern, and meadowsweet. Emergent plants (herbaceous plants rooted in water but emerging into the air) were grasses, cattails, and *Phragmites*. Along the edges were many hummocks of

sphagnum moss and lichen where carnivorous sundew plants were also common. Scattered trees of hemlock, red maple, white pine and black spruce also dotted the marsh.

Large herbivores such as deer, moose, muskrat, and beaver can all find food here, and the dense ground and shrub cover makes a great place for hiding and foraging by small mammals and birds. Even in winter some of these animals are active beneath the snow, such as the masked shrew or southern red-backed vole. The small mammals here would attract predators like mink, weasels, coyotes, hawks and owls.

Several dead trees stand above the shrub layer and along the edges of the marsh. These can be used by brown creepers looking for insects beneath loose bark. These snags could also be used by flycatchers, phoebes and hawks as hunting perches, and by woodpeckers and other cavity nesters for nest trees. The lack of forest canopy here could provide a place where various bats might hunt for insects at night. The slow-moving water here is used for egg-laying by many different amphibians. These could include toads, spring peepers and green, pickerel, bull- and gray tree frogs. The quiet pools along the edge function as vernal pools, and spotted salamander eggs were found here. Usually restricted to breeding in vernal pools, this species is known to occasionally lay eggs in the quiet backwaters of a stream system. The success of this choice is not known. The sphagnum hummocks are would make suitable habitat for the rare four-toed salamander, but I did not find this species here.

Wildlife Observed: The marsh offers a unique habitat that greatly increases the diversity of the BLTQ property. Sign of otter, moose, raccoon and beaver were found here. Fourteen bird species were seen or heard during breeding season, and many of these were specialists of open and/or wet environments. These include rufous-sided hummingbird, cedar waxwing, northern waterthrush, common yellowthroat, swamp sparrow, grackle, chipping sparrow, and red-shouldered hawk. A quick look for dragonflies turned up 5 species on June 13. A thorough search for these amazing insects would be time-consuming, but would turn up many more species because of the patchy mix of habitats within the marsh, and because different species are evident at different seasons.

Management Recommendations: The most important management action here is to control the *Phragmites* that has invaded a 30' x 40' section of the marsh along its west side. A southern extension of this wetland (near the glacial erratic boulder) is completely taken over by phragmites already. Other colonies may be present in the northern and eastern sections of the

marsh I didn't investigate. This plant has the potential to become a monoculture throughout the entire marsh, destroying the valuable diversity of vegetation and habitats that exist here now.

Getting rid of *Phragmites* is a difficult but crucial task, at least in the main marsh where it now occupies only a small area. The only effective treatment involves the use of the herbicide Rodeo (glyphosate). A group of volunteers could be gathered to hand cut the stems just after it goes to seed in August or September, after the plant has expended the maximum energy. All cuttings should be carried out in plastic bags and burned so the seeds don't establish themselves somewhere else. Then just before frost, a licensed herbicide applicator should use a fine-nozzle squirt bottle to apply 10% by volume of Rodeo into the hollow stem where it will go down into the root to kill the plant. If applied carefully like this, the herbicide won't harm other plants because it will be broken down by bacteria before it can leave the *phragmites* stem. This is the control method for *Phragmites* used by the Nature Conservancy in Massachusetts.

Once the *Phragmites* has been dealt with, annual checks to look for fresh infestations of this and another nasty invasive, purple loosestrife, should be conducted. If some *Phragmites* still exists it should be re-treated. If loosestrife is found, individual plants should be pulled before they set seed. Larger populations are much harder to get rid of, and involve the use of Rodeo followed by constant monitoring. A good resource on how to identify and control many different invasive plants is Invasive Plants, published by the Brooklyn Botanic Garden (handbook # 149). They can be reached at 1000 Washington Ave., Brooklyn, NY 11225-1099 and at (718) 622-4433 ext. 274.

The only other management for the marsh is to not cut trees along its edge, retain any cavity trees within 100-200 ft., and ascertain the location of the red-shouldered hawk nest before cutting near the marsh.

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Appendix 1. List of Amphibian, Reptile, Bird, and Mammal Species by Community Type

C = Species characteristic of this community type. Only species that could occur with the specific conditions at BLTQ are listed. Many other species could also occur in the BLTQ community types, but these are the ones typical of that community type

O = Species I actually observed by sight, call or sign in this community type at BLTQ

R = State-listed rare species that could occur with the specific conditions at BLTQ. If these species were not observed, they would be worth keeping an eye out for.

Appendix 1. List of Amphibian, Reptile, Bird, and Mammal Species by Community Type
(See explanation below)

	Northern Hardwood- Hemlock Forest	Open Talus	Northern Hardwood Talus Woodland	Temperate Acidic Cliff	Woodland Vernal Pool	Deep Emergent Marsh	Upper Perennial Stream
AMPHIBIANS							
Marbled salamander					R		
Jefferson salamander					R,O		
Spotted salamander					C,O		
Red-spotted newt	C (juv.)					C (adult)	
Northern dusky salamander							C,O
Northern redback salamander	C						
Four-toed salamander						R(sphagnum)	
Northern spring salamander							R
Northern two-lined salamander							C,O
Eastern American toad	C					C	
Northern spring peeper						C	
Gray treefrog						C	
Bullfrog						C	
Green frog						C	
Wood frog					C,O		
REPTILES							
Snapping turtle						C	
Northern water snake						C	
Common garter snake	C		C				
Northern black racer		C	C				
Eastern milk snake	O						
BIRDS							
Great blue heron						C	
Green heron						C	
Turkey vulture			C	C			
Wood duck						C	
Broad-winged hawk	C						
Red-shouldered hawk	O					O	
Ruffed grouse	C						

	Northern Hardwood- Hemlock Forest	Open Talus	Northern Hardwood Talus Woodland	Temperate Acidic Cliff	Woodland Vernal Pool	Deep Emergent Marsh	Upper Perennial Stream
Wild Turkey	C						
Ruby-throated hummingbird						O	
Yellow-bellied sapsucker	C, O						
Downy woodpecker	C						
Hairy woodpecker	C,O						
Northern flicker	C,O						
Pileated woodpecker	C,O						
Eastern wood-pewee	C,O						
Eastern phoebe	C			C,O			
Great crested flycatcher	C						
Eastern kingbird						C,O	
Blue-headed vireo	C,O						
Red-eyed vireo	C,O						
Blue jay	C,O					O	
American crow	O						
Common raven				C,O			
Black-capped chickadee	C,O						
Tufted titmouse	C						
Red-breasted nuthatch	C						
White-breasted nuthatch	C						
Brown creeper						C(dead trees)	
Winter wren	C,O						
Veery	C						
Hermit thrush	C,O						
Wood thrush	C						
American robin	C,O						
Cedar waxwing						O	
Northern parula	C						
Yellow warbler						C (shrub)	
Black-throated blue warbler	C,O						
Black-throated green warbler	C,O						
Blackburnian warbler	C,O						
Black and white warbler	C,O						

	Northern Hardwood- Hemlock Forest	Open Talus	Northern Hardwood Talus Woodland	Temperate Acidic Cliff	Woodland Vernal Pool	Deep Emergent Marsh	Upper Perennial Stream
American redstart	C,O						
Ovenbird	C,O						
Northern waterthrush					C	C,O	
Louisiana waterthrush							C
Common yellowthroat						C,O	
Canada warbler	O						
Scarlet tanager	C,O					O	
Chipping sparrow						C,O	
Swamp sparrow							
Dark-eyed junco	O (vista)						
Red-winged blackbird						C	
Common grackle						C,O	
MAMMALS							
Masked shrew	C					C	
Water shrew						R	R
Smoky shrew	C						
Rock shrew		R	R				
Northern short-tailed shrew	C						
Eastern mole						C	
Star-nosed mole							
Eastern small-footed myotis (bat)		R	R				
Eastern chipmunk	C,O						
Gray squirrel	C,O						
Red squirrel	C,O						
Beaver						C,O	
Deer mouse	C						
White-footed mouse	C						
Southern red-backed vole	C	R				C	
Rock vole			R				
Woodland jumping mouse	C						
Porcupine	C,O		C,O				
Coyote	C,O		C,O				
Black bear	C,O						

	Northern Hardwood- Hemlock Forest	Open Talus	Northern Hardwood Talus Woodland	Temperate Acidic Cliff	Woodland Vernal Pool	Deep Emergent Marsh	Upper Perennial Stream
Raccoon			O			O	C
Fisher	C, O						
Ermine	O						
Mink	O					C	C, O
River otter						O	
Bobcat			C, O?				
White-tailed deer	C, O						
Moose	O					O	