5.5 Management and Protection of Biological Diversity

Biodiversity can be defined as the diversity of life in all its forms and at all levels of organization (Hunter, 1999). This definition looks beyond simple species diversity to include genetic and ecosystem diversity as well. Setting management goals for maintaining biodiversity is inherently difficult for a variety of reasons. In most cases natural resource managers are responsible for managing biodiversity without a complete understanding of all the elements of biodiversity that may exist within the lands that they manage. For example, approximately 1.7 million species have been described globally, although estimates of the total number of species range from 10-100 million (Hunter, 1999). The local knowledge of species, habitat, and community dynamics is improving, but is still far from complete.

Incorporating the promotion of biodiversity in management activities requires management decisions to be made with a watershed, landscape, or larger regional perspective. Throughout the agency's tenure, DWSP management activities have incorporated specific practices that maintain or enhance biodiversity at the forest stand level (i.e., saving wildlife trees, buffering wetlands, protecting rare communities, etc.). In recent years, DWSP has made more deliberate efforts to further incorporate the landscape perspective in its efforts to support biological diversity. The "green" certification process (see sections 1.5.2 and 5.5.2.1.2) resulted in specific conditions for management requiring this larger-scale perspective in management. For example, certification conditions included the requirement to develop ecoregional plans as background guidance for local site plans (see section 1.5.3) and the recommendation that the state identify large and small areas permanently reserved from management, in order to allow the development of late seral forest conditions in significant blocks across the state (see sections 1.5.4 and 5.5.2.1).

Hunter (1999) describes only 2 real goals when planning for biodiversity: 1) Maintain the biodiversity of ecosystems that are in a reasonably natural condition and 2) Restore the biodiversity of ecosystems that have been degraded. DWSP's goals for biodiversity focus on maintaining or enhancing natural ecosystems across the watersheds. DWSP recognizes that its greatest contribution to regional and local biodiversity is protecting significant areas of land from development and maintaining those lands in forest or other natural cover. DWSP's primary management activity on these lands is creating small openings in the forest to stimulate regeneration and diversify species and age composition. These activities maintain forest cover while mimicking small-scale disturbances that occur naturally.

5.5.1 Biodiversity Mandate: Programmatic and Regulatory Framework

In 1973, Congress passed the Endangered Species Act to provide federal protection for 292 declining species, and began to legally define the national commitment to maintaining biodiversity in the process. The ESA specifically protected 27 plant and animal species in Massachusetts, and provided both the impetus and funding to restore popular species such as the Peregrine Falcon and the Bald Eagle in the state. Subsequent to the passage of the ESA, Massachusetts has added additional statewide legal protection for biodiversity. Both Chapter 131 (the Wetlands Protection Act) and Chapter 132 (the Forest Cutting Practices Act) require regulatory bodies to consider impacts on habitat and species during proposed development or management activities. In 1990, Massachusetts passed its own Endangered Species Act, providing protection currently for 424 plant and animal species. This act provides regulatory protection for significant habitats of the listed species, as well as direct protection for the species.

In recent years, the protection of biodiversity has become a high priority for Massachusetts state agencies. Massachusetts is a diverse environment that currently supports at least 15,000 visible (i.e., macroscopic) native species of plants and animals (including about 12,000 insects). MassWildlife (previously the Division of Fisheries and Wildlife) currently maintains the Natural Heritage and Endangered Species Program, the goal of which is to protect the state's native biological diversity. MassWildlife also recently launched the "Biodiversity Initiative," in order to coordinate two new programs that were created by the

1996 Open Space Bond Bill (Chapter 15, Acts of 1996). These programs include the Ecological Restoration Program and the Upland Habitat Management Program. The Ecological Restoration Program's major goal is to "focus future restoration action on the fundamental problems threatening biodiversity, including the restoration of natural processes and native community composition." To achieve this goal, the Ecological Restoration Program intends to follow the following strategies:

- Conserve species before they become rare by protecting their habitat.
- Restore natural processes that sustain biodiversity at key sites.
- Limit invasion by exotic or invasive species.
- Replicate natural processes, where they cannot be maintained or restored, at appropriate times, places, and in justifiable quantities.
- Consider species reintroduction only when species' requirements and causes of extirpation are sufficiently understood, and carefully consider the costs and benefits.

The Natural Heritage Program, in conjunction with the Massachusetts Chapter of The Nature Conservancy published "Our Irreplaceable Heritage: Protecting Biodiversity in Massachusetts" in 1998. This document outlines a Biodiversity Protection Strategy that includes the following:

- Encourage all conservation agencies, land trusts, municipalities, and not-for-profit conservation organizations to increase the importance given to and financial support for the conservation of uncommon and under protected components of biodiversity.
- Educate landowners about maintaining and restoring certain natural processes and minimizing disturbance.
- Aid land managers in implementing land management techniques that mimic natural processes where they cannot be maintained or restored.
- Strive to achieve an equitable distribution of biologically viable conservation lands at all topographic elevations and across all ecoregions.
- Take action to conserve natural communities and species that have experienced tremendous loss or are under considerable threat.
- Focus attention on natural communities and common or rare species that are underprotected.

The April 2000 "The State of Our Environment" from the Executive Office of Environmental Affairs (EOEA, now the Executive Office of Energy and Environmental Affairs, EOEEA), acknowledges the link between human needs and healthy, thriving natural communities. EOEEA identifies loss of habitat through development and invasive species as the two most distinct threats to maintaining natural diversity in Massachusetts, and further commits to preserving biodiversity through the identification and protection of critical habitats and the creation of bioreserves that include central cores of public land.

As stated in Section 4.5, DWSP's principal goals for maintaining biodiversity on its Quabbin holdings are to retain most of these lands in a forested condition, to identify and provide habitat for the protection of uncommon and rare flora and fauna, and to eliminate and prevent the spread of non-native invasive

species. DWSP also seeks to provide the range of seral stages from early successional habitat through unmanaged mature forest across its total holdings.

5.5.2 Massachusetts Biodiversity Objectives and Accomplishments: 1995-2007

The maintenance of biological diversity across the Commonwealth of Massachusetts has been a priority among state agencies for many decades, although the term "biodiversity" has been popularized only since the mid-1980s. In 1988, E.O. Wilson edited and published Biodiversity, a National Academy Press publication, and the term has been in popular use since that time. Preserving our "natural heritage" carries similar objectives as the conservation of biological diversity and programs devoted to natural heritage have been developed in every state in the U.S., including the Natural Heritage and Endangered Species Program (NHESP) in Massachusetts, a component of the Division of Fisheries and Wildlife. The Massachusetts NHESP, in conjunction with the Executive Office of Environmental Affairs and the state land agencies, has been at the forefront in developing programs to support the conservation of biodiversity.

5.5.2.1 Statewide Biodiversity Initiatives

5.5.2.1.1 BioMap

The BioMap was an initiative of the EOEEA to utilize existing and new databases of rare plants, animals, and natural communities collected since 1980 to produce a guide for land conservation efforts in the state that would more efficiently support and protection existing and potential sources of biodiversity. The BioMap report, published in 2001, provides the methods used in the assessment of 7,000 site-specific records within 13 ecoregions in Massachusetts which generated priority areas for conservation efforts. Within each ecoregion, "core habitat" is identified as well as areas within that core that are currently protected versus unprotected. A full text of the BioMap as well as technical guides to the process are available through NHESP and/or online at http://www.mass.gov/dfwele/dfw/nhesp/nhbiomap.htm .

5.5.2.1.2 Green Certification

At the beginning of the previous management period for the Quabbin Reservoir watershed, the Division sought "green certification" from the international Forest Stewardship Council, through the FSC-approved SmartWood program of assessment. The 1997 certification of Quabbin Reservoir watershed forestry practices was the first third-party, "green" certification of public lands management in North America. As the Quabbin certification approached its five-year renewal date, the Executive Office of Environmental Affairs (EOEA, now EOEEA) decided to pursue a broader certification audit. On May 11, 2004, *all* state forest lands in Massachusetts became "green" certified.

Certification provides third-party review and auditing of forest management practices for the long-term sustainability of their relationship to the environment and to the regional human economy. The Massachusetts state lands certification was granted by Scientific Certification Systems, an independent, third-party certification body accredited by FSC. Certified lands in Massachusetts are managed by different agencies of the EOEEA, including the Division of State Parks and Recreation (285,000 acres), the Division of Fisheries and Wildlife (110,000 acres), and the Division of Water Supply Protection (104,000 acres). With this certification, Massachusetts becomes the first state in which multiple forest management agencies have joined forces to earn certification of all of the publicly managed state forestland. Certification is an endorsement, but conditions for improvements in management practices must be attained within a five-year period for this endorsement to remain current and valid. The full MA certification report, including the details of these conditions is available online, at www.mass.gov/envir/forest/default.htm.

5.5.2.1.3 EOEEA Reserve Initiative

As a result of the green certification process, EOEEA also initiated an effort to identify large areas across the state land holdings that would be permanently set aside from commercial timber harvesting in order to allow the development of habitat conditions that may not develop under active management. These large reserves were identified through a scientific process worked out in conjunction with science staff from The Nature Conservancy and intend to provide conservation of habitat conditions determined to be high priorities at the landscape scale of analysis. Nine reserves totaling in excess of 50,000 acres were proposed by EOEEA in 2005 and adopted in 2006. A full description of the process and these proposed reserves is available online at www.mass.gov/envir/forest/pdf/whatare_forestreserves.pdf.

5.5.2.2 Quabbin Biodiversity Initiatives

5.5.2.2.1 Identification of Rare, Uncommon, and Exemplary Communities

The Quabbin watershed harbors a wide array of unique natural communities. Some of the communities are rare on a regional or global level. In response to a recommendation by the FSC forest certification auditor that the biological diversity at Quabbin should be better characterized, the University of Massachusetts Department of Natural Resources Conservation, under the primary direction of Associate Professor Kevin McGarigal, from 1997 to 2000, assessed the watershed for rare, uncommon, and exemplary natural communities. In a September, 2000 report entitled, *Rare, Uncommon, and Exemplary Natural Communities of Quabbin Watershed"*, the purpose of this study is described: "to identify, classify, and describe the rare, unique, and exemplary natural communities in the Quabbin watershed area of Massachusetts and to provide recommendations for their management". The report identifies 22 rare communities in the Quabbin watershed and describes these in detail and is available through Natural Resources staff at Quabbin.

5.5.2.2.2 Protection of Rare Species

The Division provides extensive protection for known populations of rare, endangered, or uncommon species, primarily through protection of their habitats. Division staff record new occurrences as they are discovered, and track changes in existing populations. The Division works extensively with the DFW Natural Heritage and Endangered Species Program to protect these species, and through a joint collaboration between DCR and NHESP, recently helped to produce updated Forestry Conservation Management Practices for specific species that may be encountered during harvesting operations.

The following were among the protection efforts initiated by the Division during the previous management period:

1. Identification and mapping of populations of rare plant species, first through a two-year contract with the University of Massachusetts Biology Department, and later through annual visits by professional botanists to survey habitats predicted to contain rare species. From 1995 to the present, at least 15 new populations of rare or endangered species were identified through this survey work (see section 2.6.2.2), including a 2007 discovery of *Asclepias purpurascens L.*, the threatened Purple Milkweed.
2. On at least two of the sites on which populations of rare plant species were identified, manual removal of invasive plant species threatening these populations was performed by Natural Resources staff.
3. New Wildlife Conservation Management Practices (WCMPs) for the protection of habitats and rare species during harvesting operations were developed with NHESP for Blanding's turtle, eastern box turtle, wood turtle, spotted turtle, four-toed salamander, mole salamanders, and common loon. Discussions also focused on identifying critical habitat conditions surrounding vernal pools, and forestry practices to maintain these.

5.5.3 Areas with Special Management Restrictions and Small Reserves

The 1972 *Quabbin Reservoir Watershed Land Management Plan* delineated areas on which conventional forest management practices were either impractical or otherwise undesirable. That plan included 3,360 acres in "Aesthetic Areas" and 3,200 acres of "Protection Areas", which included islands, rock quarries, caves, rock outcrops, hill top views, cellar holes, mill sites, exceptional forests or individual trees, and areas that have been undisturbed for the past 100-150 years. The "Protection Areas" also included 1,350 acres in the Cadwell Creek watershed, a control area for a watershed study done by the University of Massachusetts. While the Division had not planned cutting in the "Protection Areas", commercial forest management in the "Aesthetic Areas" was allowed if special logging techniques were used. The plan also included 1,440 acres in "Wildlife Wetland Areas" (chiefly beaver flowages), where no cutting was planned.

In the 1986 *Quabbin Forest and Wildlife Management Plan*, 7,600 acres were designated in the "Protection Zone". This zone included steep, rocky, or extremely wet sites; exceptional, rare, or endangered plant communities, or wildlife habitat; and significant cultural resource sites. No forest management was permitted in this zone.

This Section updates the concept of areas where special management restrictions apply. As the Division continues to refine its analysis of the watershed protection provided by the lands under its control, some refinements in the restrictions have been made. For instance, efforts to maintain an understory (for the reasons cited throughout the plan) seem even more critical in riparian zones than in areas that are distant from tributaries or the shoreline. While riparian areas have traditionally been untreated, understory maintenance will be a priority for this decade, and will include such practices as planting, single tree selection harvesting, and non-harvest silviculture to stimulate understory growth.

Table 58 lists the areas with special management restrictions as they stand currently. The recent Forest Stewardship Council re-certification of Quabbin's forest management practices, provided by Scientific Certification Systems, acknowledged the long-standing identification and treatment of these areas by the Division as meeting the certification criteria for the designation of "ecosystem reserves". Specifically, the certification report states:

> [DCR] has submitted adequate information to determine that they have reserved a substantial portion of their ownership (>15%) as natural areas or unmanaged lands. Furthermore, the silvicultural strategy employed on [DCR] lands assures that old forest conditions will be encouraged within managed areas of the forest. This agency is protecting a substantial amount of their ownership, and they have done extensive inventories for rare species and communities on their ownership. (SCS 2004)

Included in the lands in **Table 58** are two major categories:

- Areas with uncommon, rare, or potentially rare resources.
- Areas where commercial forest management is impractical.

The first category includes areas such as uncommon forest communities, habitats containing rare, endangered, or threatened plant or animal species, and historic/prehistoric sites. Examples of these areas include pitch pine/scrub oak communities, diverse or unique regions designated as Natural Areas, and cellar holes and Native American encampments and work sites. The delineation of each area may also designate an appropriate buffer zone around the resource.

The second category includes commonly occurring but fragile areas such as bogs, forested wetlands, marshes, wet meadows, vernal pools, areas with fragile wetland soils, and slopes greater than 30%. There may be rare plants, animals, or communities within these sites as well, and overlap of the two categories

of restrictions is not uncommon. For example, steep talus slopes are generally impractical to operate with timber harvesting equipment and often harbor rare or uncommon plants as well.

Approximately 10,000 acres of DWSP lands at Quabbin were classified in the 1995-2004 Land Management Plan as "Areas with Special Management Restrictions". These areas include large blocks of land such as the 3,716 acres of reservoir islands and two blocks in excess of 1,000 acres each in Quabbin Park and adjacent to Pottapaug Pond. All identified wetlands and steep slopes are included, some of which are contiguous areas of several hundred acres (e.g., the steep Pelham shoreline, or the wetlands along the East Branch of Fever Brook). In addition, many small areas have been included, representing sensitive resources and buffers around historic and rare wildlife habitat areas. For example, Division and University of Massachusetts staffs have mapped, from aerial photos, more than 500 potentially viable vernal pools across the Quabbin watershed.

In addition to these previously designated lands, the Division has been gradually mapping areas that are impractical to manage for a combination of reasons. For example, some potentially manageable land is enclosed by wetlands or adjacent rare species habitat in such a way that the land will not be managed. These lands will be excluded from the total acreage considered to be under active forest management. Based on a similar approach on the Ware River watershed, it is expected that once the mapping process has been completed, the acreage that is identified as reserved from active management will total approximately 25-30% of the total DWSP holding at Quabbin. Therefore, approximately 15,000 to 18,000 acres on this watershed will grow and develop without timber harvesting. There may still be efforts to manage such influences as invasive species, herbivore populations, and fire on these properties, but active commercial silviculture is not planned for these areas.

Table 58: Areas with Special Management Restrictions within the Quabbin Reservoir Watershed

Area	Acres	Restrictions/Practices
Islands	3,674	No management
Steep slopes	1,712	No management
Wetlands	2,272	No management except limited beaver control (see beaver policy, Section 4.4.4.1)
Rare and endangered species habitats	NA	Subject to restrictions upon advice of Natural Heritage and Endangered Species Program
Quabbin Park (western portions) acres	1,058	Limited management including tree planting, non-commercial regeneration cuts, and roadside salvage cutting
Pottapaug Natural Area	1,183	Restricted by designation as a Natural Area, in 1991, no commercial management.
Areas where access is precluded by physical or regulatory barriers	Mapping in progress	No active commercial management; control of herbivores, invasive species, fire may occur
Areas of Historic, Cultural, or Natural Significance	NA	Varies from no management to selective restoration and maintenance

Areas that have been set aside for the reasons mentioned above also can function, on a long- or short-term basis, as areas from which background measurements can be taken for comparison to areas that are directly under management. The Division will retain this function, and will regularly reevaluate the sufficiency of current "restricted" areas for establishing background information.

GIS analysis has provided some preliminary information on this topic. For instance, of the 12 common forest types occurring on the Quabbin Continuous Forest Inventory plots, six are also represented on CFI plots that fall within the "restricted" areas (most of the "missing" types are generally uncommon, such as red spruce, larch, or pitch pine.) Each of the five Division soil types (see Section 2.2.6.) is well-represented within the "restricted" areas. The Pottapaug Natural Area (**Figure 23**) was added to this category to address the public interest in a block of accessible forest that was allowed to grow and change without silvicultural intervention. The area was chosen because it offered a wide variety of forest types and wildlife habitats but was hydrologically removed from the Shaft 12 intake and sheltered from typical, south-easterly hurricane winds. The details of long-term management of this area, including fire and invasive species response, are being developed (e.g., the decision to let a wildfire burn rests in the hands of the fire chief of the town, not with the Division).

Figure 23: Pottapaug Natural Area

5.5.4 Management for Special Conditions

5.5.4.1 Primary Forests

5.5.4.1.1 Definition and Significance

Primary Forest or "primitive woodlands" are areas that have always been in a forest condition or cover. These lands were not cleared for crops or pasture, and instead managed for forest products, such as timber for barns and houses and for firewood. The location of primary forest comes from crude maps provided by the Harvard Forest that were made for tax purposes by town governments in Massachusetts in 1830, at the height of agricultural clearing. The working assumption is that because these woodlands had not been cleared by the height of the land clearing period, they likely have been woodlands throughout history. The locations of Quabbin's Primary Forest were determined from these maps. These forests are usually located in the uplands, on steep and/or on rocky ledge soils or wetlands unsuitable for even pasture. Cultural features such as stone and wire fences are absent and often late successional species such as hemlock, beech and tupelo are present. Sometimes the maps were found to be incorrect, as to the extent of the primary forest, because field checks found stone fences and pasture type trees even on steep and rough land with stony soils and exposed ledge. In a few cases primary forest were located on mostly level uplands and suitable for quality pasture, but for some reason stayed in forest. Part of the significance of primary forest is that many organisms from the original forest may still be present and may be important in determining long-term sustainability of forest ecosystem integrity.

5.5.4.1.2 Management Practices in Primary Forests

Since most of the primary forest at Quabbin is either on steep slopes or wetlands or on sites of very low productivity, it has not been and likely will not be actively managed. Primary forest located on productive and accessible areas will be managed using multi-aged silvicultural methods. The proposed management would allow for older age classes to occupy more then 1/3 of the area. Cutting cycles would vary from 30-50 years and require 60-100 years to develop multiple age classes where only one now exists. At the stand level this management would be designed to promote and maintain structural elements, similar to those found in old growth stands. Structural targets are 12 or more trees/acre >20" DBH and dead snags and live cavity targets are 2 trees/acre > 12" DBH, 3 trees/acre >15" DBH, 1 tree/acre > 18" DBH and 1 tree/acre > 20" DBH. Primary forest occupies approximately 10-15% of the overall forest.

5.5.4.2 Late Seral Forest Conditions

5.5.4.2.1 Value of Late Seral Forest Conditions

The late seral stands discussed here are often the second forest stand to occupy the site since the land was abandoned for agricultural purposes such as pasture or tillage. These stands are often on productive soils and with species well suited to the site. Most of these stands regenerated between the Civil War and World War I. They are not of great age but are of large diameter, exceptionally tall, and of high quality. Their location varies from very accessible to remote and consequently spread across the landscape. Their importance is derived from both their scattered presence on the land and their potential to provide old growth attributes at an early age. They are often bordered by primary forest or stone walls and agricultural border trees of great size, that often have large cavities. Unlike primary forest, which tends to be on less productive sites, these late seral stands are on highly productive sites and consequently of high stocking (density). They came about during a time with few or no large herbivores or invasive species, diseases and insects. Air pollution was minimal during most of their development. The plant community and the processes that assist its growth and development were intact. These exceptional conditions for tree and stand development may be impossible to duplicate in the future, but the Division will try to take advantage of the exceptionally good conditions afforded by these stands.

5.5.4.2.2 Management Practices to Produce and Sustain Late Seral Forest Conditions

Management of these stands will promote regeneration of similar species, maintain vigor of the overstory and allow for structural conditions similar to old growth. The selection system would be used employing single tree and small group removals and conducted every 30-50 years. Structural targets would be 17 trees/acre > 20" DBH and dead snag and live cavity tree targets would be 3 trees/acre > 14" DBH, 2 trees/acre > 16" DBH, 1 tree/acre > 20" DBH, and 1 tree/acre > 24" DBH. Late seral stands would occupy up to 15% of the forest.

5.5.4.3 Early Successional Forest Habitat

5.5.4.3.1 Importance of Early Successional Forest Habitat

Broad changes in land use have dramatically impacted the number, type, and extent of open lands within the watershed. Early successional habitat was a major component in the landscape prior to European settlement. Evidence suggests that grasslands existed in the Northeast before Europeans arrived, and grassland birds have been a component of avian diversity for a long time (Dettmers and Rosenberg 2000). Beaver activity, wildfires, windstorms, and fires set by Native Americans generated early successional habitat. By the 1800s grasslands were even more abundant in the northeast as agricultural land dominated

the landscape. Since the mid-1800s, the amount of grasslands and open fields has decreased dramatically, causing a similar decrease in many species of plants and animals that depend on open habitat. As farms were abandoned, the open fields and meadows were left undisturbed. Without frequent disturbance such as mowing, burning, or grazing, grasslands gradually revert back to forest. Some grassland species, such as the loggerhead shrike and regal fritillary butterfly, have been extirpated from Massachusetts as their preferred habitat has declined below a minimum threshold.

Recent population trends for grassland dependent species show disturbing declines. Bobolinks and grasshopper sparrows have declined 38 and 69 percent, respectively in the last 25 years. Partners in Flight, a national conservation organization, has identified Neotropical migratory bird species of concern in Massachusetts. These species have a high perceived vulnerability (they may or may not be state or federally listed) and are critical to maintaining avifauna diversity in the state. Priority species include Henslow's sparrows, upland sandpipers, grasshopper sparrows, and bobolinks. These species are all associated with grassland habitat. As farmland continues to be abandoned or converted to house lots, the amount of viable open land continues to shrink. The remaining grasslands, particularly large (>100 acres) or clustered fields, are increasingly vital to a variety of wildlife. Eastern meadowlarks, savanna sparrows, eastern bluebirds, and bobolinks use hayfields, meadows, or pastures to forage and raise young. During the fall and winter, fields provide food for migrating sparrows, warblers, larks, and snow buntings. Raptors such as northern harriers, short-eared owls, and American kestrels hunt in fields for small mammals (meadow voles, meadow jumping mice) and insects. White-tailed deer often graze in fields, and foxes will hunt fields for small mammals or rabbits. Finally, butterflies like the monarch, tiger swallowtail, and various fritillaries feed on nectar of grassland wildflowers.

Early successional forested habitat is also in decline in Massachusetts. Evidence suggests that early successional forested habitat was present in sufficient amounts and distributed well enough across the landscape to support long-term populations of early successional birds in the Northeast prior to either European or Native American intervention (Dettmers and Rosenberg 2000). Fire, major weather events, or beaver activity maintained or generated these habitats across the landscape. European and Native American populations increased the amount of early successional habitat in the region. By the mid 1800s, forest cover in New England had dropped from >90% to <50% (Dettmers and Rosenberg 2000). As farms were abandoned during the late 1800s large amounts of early successional habitat became available. Over time these large areas of early successional habitat grew beyond the early seral stages used by early successional species. A survey conducted in 1998 in Massachusetts concluded that only 4 percent of all available timberland was in a seedling-sapling (early-successional) stage (Trani et al., 2001).

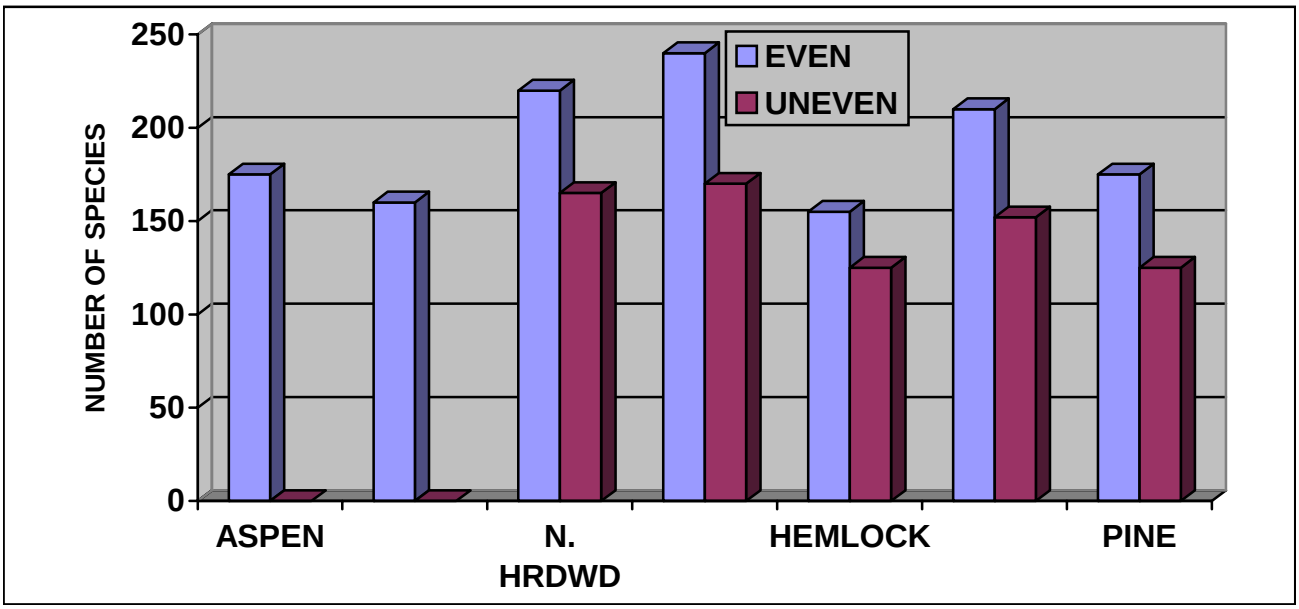
Species dependent on these early successional habitats have been declining since the 1950s as the amount of available habitat continues to shrink (Scanlon 2000). The Partners in Flight "species of concern" list highlights species associated with early successional forested habitat (i.e., blue-winged warbler, Eastern towhee, and prairie warbler). In addition, New England cottontails, bobcat, woodcock, and northern bobwhite have all experienced declines and are dependent on early successional habitat (Hunter et al., 2001, Dessecker and McAuley 2001, Litvaitis 2001). Providing habitat for early successional species involves considerations in both space and time. Early successional habitats are temporary and only support wildlife for 8-15 years. To remain viable, these habitats need to be set back on a regular basis or new areas of early successional habitat need to be created nearby to replace them.

5.5.4.3.2 Management Practices to Maintain Early Successional Forest Habitat

Even-aged forest management is the primary technique used to produce early successional forest stands. This type of silviculture provides the opportunity to regenerate shade-intolerant species such as aspen and birch. The resulting habitat provides distinct foraging and shelter features that are not usually available when uneven-aged management is used (DeGraaf et al., 1992). In addition, even-aged management

appears to have little effect on mature forest species (Thompson and DeGraaf 2001). Even-aged management provides habitat for up to 26% more species than uneven-aged management in similar cover types (DeGraaf et al., 1992) (**Figure24**). Payne and Bryant (1994) state that even-aged management tends to support more wildlife species than uneven-aged management does in northern hardwoods, hemlock, oak-pine, and pine forests of the northeast. Because the current level of tree harvesting within the state is relatively light, widely dispersed, and generally does not provide substantial early-seral habitat, the Division will try to incorporate management techniques geared towards creating a limited amount of this type of habitat, to the extent that this is compatible with water supply protection. In the end, utilizing a range or combination of silvicultural treatments, rather than strict adherence to one, should eventually result in increased use by a wider variety of wildlife species (DeGraaf et al., 1992).

Figure 24: Potential Number of Wildlife Species by Silvicultural System and Cover-type Groups



Wildlife species defined as total number of amphibians, reptiles, birds and mammals using each cover type taken from DeGraaf et al., 1992.
Even-aged: forests containing regeneration, sapling-pole, saw timber, and large saw timber stands of 5 acres or larger.
Uneven-aged: essentially continuous forest canopies and intermixed size and age classes produced by single-tree selection.

Uneven-aged management techniques will be the primary silvicultural approach across the watershed.. For this 10-year management period, the Division's goal for the creation and maintenance of early successional forested and non-forested habitat will be approximately 1% of the manageable land.

Although "clear-cuts" are often associated with even-aged management, there are a variety of even-aged techniques that can be used to accomplish particular management goals. Typically 10-20% of the overstory will be retained in clusters of 5-10 trees scattered across the stand, where creation of these habitats is the objective. An average of 2-3 clusters per acre will be retained. These occasional clumps of trees are an attempt to mimic natural disturbances. Major catastrophic events typically don't completely remove the overstory in a given area, but instead create a patchy effect on the landscape as some trees survive the event. In addition, preserving clumps of trees allows the Division to selectively save valuable mast, den, and nest trees.

In order to create conditions favorable for early successional species, forest openings need to be large enough and placed appropriately to provide enough habitat to sustain viable animal populations over time. The small group openings or single-tree selection that is conducted on a majority of Division land does not provide habitat for species dependent on early successional forest. To the extent that maintaining this habitat is an objective of the Division, larger openings would need to be created on selected areas of the

watershed. Ideally, natural land forms would select the boundaries of these openings and actual acreage would simply work itself out. From a biodiversity perspective bigger tends to be better because larger habitats can more viably sustain animal populations over time. Forest openings of various sizes would be carefully placed within the watershed to ensure adequate water quality protection. Topography, distance to tributaries, soils, stand vigor, and distance to human interface would be considered when planning early successional habitat management. Introducing a limited amount of this type of management provides an opportunity for further study to determine the short and long-term effects of even-aged management on nutrient cycles and water quality parameters.

The Division recognizes the regional importance of these open lands to the diversity of wildlife within the state. Unfortunately, land managers can't rely on nature or natural disturbances to provide this type of habitat. The large amount of land that has been lost to development, coupled with the loss of species and abundance of exotic, invasive species have all combined to alter natural processes. The maintenance of these types of habitats requires active management. Although the Division will continue to manage a majority of its property as a multi-aged, multi-species forest, on particular areas where open habitat exists, or could exist, the Division will manage to maintain or enhance early successional communities.

5.5.4.4 Early Successional Non-Forest Habitat Management Practices

5.5.4.4.1 Field Prioritization

The Division owns a variety of open lands. In most cases, these are lands the Division has traditionally managed in an open condition. Analysis of the distribution, size, and juxtaposition of open lands within the watershed highlights the need for prioritization. Fields will be prioritized based on their size, distance to flowing water, relative isolation, and juxtaposition with other open fields. In general, very small (<2 acres), isolated fields will be abandoned and allowed to naturally regenerate to forest cover. In addition, those fields (or portions of fields) that border reservoir tributaries will also be abandoned and trees allowed to grow. This will provide an adequate forest buffer around flowing streams. Larger fields (>5 acres) that are isolated will be maintained in open condition through various management practices. Large (>20 acres) fields situated near (< 1 mile) or next to other fields will be given top management priority, because these areas offer the most potential for wildlife diversity. Large clusters of open habitat may actually act as one unit, providing habitat for species (northern harrier, upland sandpiper) that require large tracts of open land. These areas will be maintained or enhanced using a variety of management techniques in order to optimize the available habitat.

Following prioritization, those fields not abandoned will receive management to either maintain them in open habitat or to enhance the existing conditions. Management activities will be done by Division personnel, or through a service contract. In all cases, wildlife considerations will be incorporated into the proposed management activities.

The quality of Division grasslands is variable. Encroaching exotic invasive plants are invading some fields. These plants typically crowd out native species and degrade the quality of the existing habitat. Most invasive plants are extremely vigorous and hardy and can be difficult to control. Removal and control of these species is critical to the maintenance of this grassland habitat. Multiflora rose, autumn olive, honeysuckle, and buckthorns have all been found in Division grasslands. Control of invasive plants is addressed in Section 5.5.5.

5.5.4.4.2 Periodic Maintenance Practices for Non-forested Upland Habitat

The Division owns and maintains approximately 60 acres of manicured lawn, located primarily at the administration complex and adjacent to the radio observatory on Prescott Peninsula. These lawns are mowed regularly during the growing season. The Division also owns approximately 165 acres of fields

throughout the watershed. These fields are comprised of a variety of grasses and forbs, and on these fields, wildlife habitat management is an important secondary objective. These fields still require active management in order to maintain them in a grassland condition. However, there are more opportunities to apply various management techniques to enhance the existing habitat.

The following management guidelines for mowing on lands not used for hay production will be followed:

- Limit mowing to every one to three years; this regimen will inhibit woody vegetation while allowing late-blooming wildflowers to develop.
- Mowing should occur after August 1.
- Mower height should be a minimum of 8-10 inches off the ground to provide habitat for small mammals.
- Manage adjacent fields as one unit; multiple contiguous fields should be managed through rotational mowing to provide a diversity of grassland types.

The Division owns several large contiguous grasslands that are potential candidates for other management activities. In addition, some smaller grasslands may also be suited to disturbances other than mowing. Burning grasslands can reduce buildup of dead vegetation, prevent the spread of woody vegetation, release nutrients into the soil, and rejuvenate plant growth. However, burning an area can eliminate some butterflies and moths and the newly burned area may be avoided by some bird species. When feasible and practical, fire management can be a benefit to grassland bird populations and other wildlife usually within a year or two of the burn. If and when the Division conducts fire management, the following guidelines will be followed:

- Burns should be conducted in early spring (mid-March to the end of April) after snowmelt but before bird nesting. Appropriate weather conditions should be considered.
- Grasslands should be burned once every 3-4 years, and if possible, an unburned, adjacent field should be available for nesting birds during the burn year.
- On larger grasslands, only a portion of the area should be burned, if possible, in any given year. Staggering burns allows for the development and availability of a variety of habitat conditions. Not more than 30% of habitat should be burned during any year.

5.5.5 Invasive Plants Management

5.5.5.1 Definitions

"Invasive" plants fall into at least two categories – native or non-native species. Most of the difficulties associated with invasive plants involve plants that are non-native. This is true in part because these non-native "aliens" have been transported out of the ecosystem in which they evolved, and may have escaped specific population-controlling insects and diseases in the process. It is important to point out that not all non-native plants are invasive. Most have been intentionally introduced into agricultural or horticultural environments, and many are unable to reproduce outside of these intensively managed environments. There are, unfortunately, hundreds of others that were introduced either deliberately or accidentally to natural settings and have managed to aggressively force out native plants, raising serious biodiversity issues, and potential threats to water quality protection.

It has taken time for these issues to become apparent. Some of the invasive plant problems on DWSP properties are the result of deliberate plantings of species that effectively addressed other concerns (for instance, planting autumn olive to improve wildlife habitat), but then became invasive. Other invasive species are escapees from landscaping that predates DWSP's acquisition of reservoir properties, including Japanese barberry, common barberry, Japanese knotweed, the buckthorns, Asiatic privets, honeysuckles, and purple loosestrife. In all cases, a plant's "invasiveness" is composed of several defining qualities:

- The plant grows and matures rapidly in abundantly available habitats.
- The plant is capable of producing vast quantities of seed that is easily dispersed by animals, and often can also reproduce vegetatively.
- There are no diseases or pests effectively controlling its reproduction and spread (which generally means there are no close relatives in the habitats it invades).
- The plant does not require intensive management to thrive.

5.5.5.1.1 Federal and Massachusetts Definitions

In February of 1999, President Clinton signed Executive Order 13112, to "prevent the introduction of invasive species and provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause"(see: www.invasivespecies.gov/council/nmp.shtml). EO 13112 created a federal Invasive Species Council to "recommend plans and actions at local, tribal, State, regional, and ecosystem-based levels" to address prevention and control of invasives. The first edition of a National Invasive Species Management Plan from this Council was produced in January of 2001, serving as a blueprint for invasive species actions. This plan provides both additional mandate and an overview of the costs and agency responsibilities to begin to gain control over invasives. More recently, the Massachusetts Invasive Plants Working Group produced a methodically developed list of invasive and potentially invasive plants in the Commonwealth, through cooperation among biologists, government staff, non-profits, nurseries, and landscape organizations (see: massnrc.org/MIPAG/index.htm). Strategic recommendations for managing invasive plants in Massachusetts have also been developed by the same group, and are posted on the New England Wild Flower Society's website, at: www.newfs.org/conserve/invasive.htm#strat1. Following the creation of the list of invasive and potentially invasive plants in Massachusetts, the Massachusetts Department of Agricultural Resources, Division of Regulatory and Consumer Services filed legislation to phase these species out of commercial production and use. This legislation passed and became effective on January 1, 2006, effectively phasing out the sale and importation of 140 plant species (see: www.mass.gov/agr/farmproducts/Prohibited_Plant_Index2.htm).

5.5.5.2 Problems Associated with Invasive Plants

The EOEA report "The State of Our Environment" (April, 2000) states that "the two biggest threats to biodiversity in Massachusetts are the destruction and fragmentation of wildlife habitats and the introduction of invasive non-native species." The Nature Conservancy has reported that 42% of the declines of threatened or endangered species in the US are partly or wholly due to the effects of invasive species. Some of these threats are subtle. For instance, when the declining West Virginia White butterfly lays its eggs on the invasive garlic mustard instead of on the usual native mustards, its eggs fail to develop. Other threats are more obvious; for instance, purple loosestrife currently covers an estimated 500,000 acres in northern US and southern Canada, displacing native food sources and threatening to prevent successful nesting in 90% of the wetlands used by breeding waterfowl along the Atlantic and Mississippi flyways. Impacts from invasives on the soil and its faunal community have also been

documented. There is evidence that a Chinese tallow tree is altering nutrient cycling where it invades, causing a decline in the native soil invertebrates as a consequence.

Beyond issues of biodiversity conservation, resilient plant communities are important to watershed management for controlling the erosion of soil and nutrients throughout the range of natural disturbances (e.g., droughts, insect outbreaks, fire, wind, heavy snow and ice). Resilience is dependent upon species and size diversity in the plant community, because disturbances are frequently species and/or size specific. When plants become aggressively invasive, replacing the diverse native flora with monocultures, they increase the susceptibility of the plant community to disturbances. The prevention of forest regeneration by certain aggressive invasives has become a problem on some areas of the watersheds. Around the Quabbin Reservoir, Japanese barberry that was planted on historic home sites has taken advantage of high deer populations (which do not feed on barberry) to colonize and monopolize the understories of significant forest areas. At the Wachusett Reservoir, autumn olive has aggressively occupied open fields, delaying or precluding their return to forest cover. Invasives are often more effective than natives in colonizing disturbed areas, and may overrun young trees that do become established. **Table 59** lists the invasive plants that are present surrounding the Quabbin Reservoir.

Invasion by Japanese barberry on rich, mesic (moist) site

Table 59: Invasive Plants Present on the Quabbin Reservoir Watershed

Common name	Latin name	Habitat
Black locust	*Robinia pseudoacacia*	Edge of forest/field
Norway maple	*Acer plantanoides*	Forest
Oriental bittersweet	*Celastrus orbiculata*	Forest
Japanese barberry	*Berberis thunbergii*	Forest
Common barberry	*Berberis vulgaris*	Forest
Glossy buckthorn	*Frangula alnus*	Forest
Common buckthorn	*Rhamnus cathartica*	Forest
Honeysuckles	*Lonicera sp.*	Open areas
Autumn olive	*Elaeagnus umbellata*	Open areas
Russian olive	*Elaeagnus augustifolia*	Open areas
Multiflora rose	*Rosa multiflora*	Open areas and edges
Goutweed	*Aegopodium podagraria*	Floodplains, riparian areas
Japanese knotweed	*Polygonum cuspidatum*	Riverbanks, wet edges
Purple loosestrife	*Lythrum salicaria*	Wetlands
Garlic mustard	*Alliaria petiolata*	Floodplains, disturbed woodlands, roadsides
Phragmites (common reed)	*Phragmites australis*	Wetlands
Winged euonymus	*Euonymus alata*	Open woods, fields, edge

5.5.5.3 Control and Management Options

All of the features that make a plant invasive also frustrate efforts to control and reverse its expansion. Seed production is generally prolific, and many invasives also reproduce vegetatively. General control requires the removal or killing of mature plants, but also requires that these removals be timed in such a way that they do not result in further reproduction and spread of the plant. Controls are either mechanical

or chemical. Mechanical controls include hand-pulling, girdling or mowing, mulching, tilling, and the use of heat. Chemical control is often more efficient and effective, but carries stronger risks of collateral damage to non-target species, as well as risks of water and soil contamination. Controls need to be designed around the morphology, phenology, and reproductive strategies of specific plants. For example, while prescribed fire will reduce invasions of conifers in native grasslands, it tends to stimulate growth and reproduction of many other invaders.

Recommended controls from various sources in the literature for the treatment of the primary invasive plants found on the Quabbin Reservoir watershed are listed in **Table 60.** The controls listed are not necessarily the methods proposed by the Division to address specific plant invasions. During FY2008, a Division-wide invasive plants plan will be developed that will include mapping and inventory methods, a strategy for detecting and eliminating new invasions, and the prioritization of treatments and controls for existing populations. In addition, the Division will hire two seasonal staff in the summer of 2007 to assist with invasive plant control.

Table 60: Major Invasive Plants on Quabbin Watershed and Conventional Control Measures

Invasive Species	Control[1]
Norway maple	Cut mature trees as close to base as possible. Pull seedlings/saplings including as much of the root as possible.
Japanese barberry	Pull young plants when ground is moist, and remove all root fragments. Repeated mowing can eliminate small populations. Mist apply 2% glyphosphate mixed with water and surfactant early in the season to cover plant, or apply 25% triclopyr directly to the outer 20% of cut stumps.
Japanese knotweed	Hand pull or grub plants, removing all fragments to prevent resprouting. Cut stems 2" above ground and immediately apply 25% solution of glyphosphate or triclopyr to cut stems. Follow with foliar spray of 2% glyphosphate or triclopyr with 0.5% non-ionic surfactant applied when outside temperatures are 65 degrees F or warmer, to control juvenile regeneration.
Oriental bittersweet	Regular mowing of edges and open areas will exclude bittersweet. Triclopyr herbicides are effective as foliar or basal applications.
Buckthorns	Seedlings are easily pulled. Larger stems can be pulled or cut, and may be killed by repeated fire. Freshly cut stumps should be treated with a 50% solution of glyphosphate to prevent resprouting. As buckthorns enter dormancy later than most species, treatments should be applied mid to late autumn to reduce risk to non-target species.
Honeysuckles	Hand-pulling is effective for isolated shrubs less than 3 years old. Most effective control of larger populations occurs through cutting and basal application of 20% glyphosphate. Seeds are not long-lived, so returning to remove seedlings by hand every two years or so should eliminate the population in time. Repeated burning is only effective for a short time, as the shrubs continue to resprout indefinitely following fire.
Olives	Repeated cutting of mature stems and sprouts and pulling of new seedlings may be effective. Best control is achieved by cutting followed by either burial or herbicide treatment of cut stump.
Multiflora rose	Regular mowing, where feasible, will remove this plant. Larger shrubs should be pulled or dug out. Where mowing is not practical, cutting followed by stump treatment with glyphosphate to prevent resprouting, is effective.

[1] Control measures are from current literature but are <u>NOT</u> DWSP policy at this time.

5.5.5.3.1 MA Invasive Plants Advisory Group: Strategic Recommendations for MA

In February of 2005, the Massachusetts Invasive Plants Advisory Group, an ad hoc committee of private and public organizations brought together in 1999 to address invasive plant issues in Massachusetts, produced its *Strategic Recommendations for Managing Invasive Plants in Massachusetts*. These recommendations were intended to provide guidance to landowners, public and private, seeking to

address the issue of invasive plants in an effective and efficient manner. The document includes the following nine principle recommendations:

1. Massachusetts should develop and implement a strategic management plan based on the recommendations of the MIPAG and integrated with the existing Massachusetts Aquatic Invasive Species Management Plan to address introduced invasive plant species.

2. A strategic management plan for managing invasive plants in Massachusetts should include a scientifically objective assessment process; a system for early detection and rapid response; criteria for setting research, management and education priorities; and develop broad public and private partnerships integrating efforts from the local to national scales.

3. Massachusetts should adopt the MIPAG criteria for invasive plant assessment and recognize the list of plant species determined by this process to be Invasive, Likely Invasive or Potentially Invasive within the Commonwealth. It should maintain an ongoing, transparent assessment process using the MIPAG criteria and with the participation of both public and private interest groups. This assessment should inform invasive species management strategies. Prevention strategies should predominantly focus on species assessed as Potentially Invasive and controlling the spread of Invasive species into priority conservation areas. Candidate species for eradication strategies should be selected from among those assessed as Likely Invasive.

4. Massachusetts should establish and support a centralized means within state government for inter-agency coordination on invasive species management, in partnership with public and private sector interests. This mechanism should facilitate the production of a strategic management plan for invasive plant species in the Commonwealth based on MIPAG's recommendations. It should help coordinate invasive species management efforts within the Commonwealth and integrate efforts with regional and national partners.

5. Massachusetts should establish and support an effective early detection and rapid response system for invasive species that is well integrated with regional and national efforts.

6. Massachusetts should assign to a responsible entity the task of assessing invasive species research needs and priorities for Massachusetts. It should integrate the work of public and private research partners, actively develop sources of funding for this research, and maintain a centralized database of this research in easily accessible form and linked to regional or national databases of this type. Funding sources for needed research should be developed and promoted.

7. A strategic management plan for invasive species in Massachusetts should set priorities for prevention, control, eradication and restoration efforts. Prevention should emphasize an early detection and rapid response system for new invasions and education about best management and prevention practices directed at the primary vectors for spreading invasive plant material. Except where eradication is feasible, control efforts should always manage toward a desired status or outcome for conservation resources compromised by invasive plant species, rather than the invasive species itself. Priority areas for management should be determined by identifying at all scales the natural and cultural resources at risk from invasive species and conducting baseline assessments of invasive species at those sites.

8. Massachusetts should adopt a policy of targeted outreach and education to raise awareness of the extent of the invasive plant problem and of the importance of each of our roles in preventing and controlling invasive species. Public education should focus on those vectors of spread most likely to introduce invasive plants into priority areas. The Commonwealth should endorse and adopt the voluntary protocols established under the Saint Louis Declaration for all government agencies, and promote their adoption by nursery professionals, landscape architects, the

gardening public, and botanic gardens and arboreta in Massachusetts. Specifically, the Commonwealth should prohibit state agencies from purchasing or intentionally introducing species determined to be Invasive, Likely Invasive, or Potentially Invasive through the scientifically objective assessment process of the MIPAG. Commercial industries should adopt a carefully constructed phase-out of these species in the trade while accommodating the economics of current inventories and existing contracts. Education and outreach described herein should be sufficiently funded and implemented assertively in order to steadily reduce the consumer demand for these species.

9. Public and private partnerships should be endorsed and strengthened as part of a strategic management plan for invasive plants in Massachusetts. The transparent, collaborative work of the MIPAG should be encouraged and supported as the means of assessing invasive species for the Commonwealth. Regional and national Partnerships and sources of funding for invasive plant management should be promoted and integrated into invasives management efforts in Massachusetts.

5.6 Protection of Cultural Resources

Forest management activities may be detrimental to archaeological resources without appropriate controls. Modern harvesting methods employ a wide range of heavy machinery, some of which, because of weight distribution and/or tire characteristics, can do irreparable damage to prehistoric or historic sites. Skidding logs can further disturb the soil. Operations may entail clearing areas for landings, turn-a-rounds, and access roads. Archaeological sites that lie closest to the surface can be obliterated by such activities. It is these same type of sites – those that are the youngest in time (i.e., the Early, Middle and Late Woodland) – that were most susceptible to destruction by the plow of the local farmer, and thus represent a relatively scarce piece of the archaeological record.

Accordingly, the DCR Archaeologist is one of several specialists who review proposed silvicultural operations during the annual internal review process. The Archaeologist specifically evaluates and assesses the impacts that harvesting could potentially have on archaeological resources that exist at any given site.

5.6.1 Silviculture and Cultural Resource Management: Prehistoric Sites

Management Objective: DWSP will minimize ground disturbance during a harvest in order to protect archaeological resources.

Recommended Practices for Highly Sensitive Areas:

- The harvest should occur during the winter with frozen soil conditions.
- Skidding should not be permitted.
- A small, tracked, excavator platform feller buncher, with its long reach and weight distributing tracks, is best suited for these sensitive areas.
- Wheeled feller bunchers, with limited reach and high ground pressures, should not be employed.

Recommended Practices for Moderately Sensitive Areas:

- One or more of the Highly Sensitive Area restrictions will be recommended.

In advance of any silviculture operation (also known as harvesting lots) on a site, Quabbin foresters submit a detailed Lot Proposal and 1:12,000-scale map for simultaneous in-house and public review.* The proposal describes the purpose for prescribed silvicultural treatment for an individual lot. It includes detailed site-specific information: overstory and understory vegetation, local forest composition and condition, topography and soils, wetlands and wildlife, etc., as well as Environmental Quality and Engineering considerations and harvesting limitations such as the type of machinery required to protect the soils and residual vegetation. All cultural resources known to the foresters are identified: foundations, cellar holes, walls, wells, dams, and prehistoric sites.

Lot Proposals and the associated maps provide the basis for Impact Assessment for the DCR Archaeologist. Site visits are sometimes required in order to assess microenvironment and features not reflected on the 1:25,000-scale USGS basemaps. The primary analytical tool is a predictive model of prehistoric site potential, based on Site Location Criteria.

Archaeologists have analyzed the environmental characteristics of thousands of sites throughout New England, and have identified a number of topographical variables that are consistently associated with

* The Lot Proposals for each fiscal year are available to the public at the Quabbin Visitor Center in Belchertown and at the Swift River Valley Historical Society in New Salem.

prehistoric sites. These Site Location Criteria are the basis of the predictive model used by the DCR Archaeologist to assess the likelihood of prehistoric significance at any given location.

The most important criteria for determining the archaeological sensitivity of a lot are: slope < 5 - 7 degrees; the presence of well-drained soils; and the prehistoric availability of fresh water within 1,000 feet. Other variables that may also be factors include: aspect, available lithic sources (stone for toolmaking), and elevation above sea level. When one or more of these variables are met, a site is considered to have been an attractive location for Native American habitation or subsistence activities. Such sites are classified as *highly sensitive* or *moderately sensitive* for prehistoric archaeological resources.

5.6.2 Silviculture and Cultural Resource Management: Historic Sites

Management Objective: DWSP will undertake vegetation management on historic sites which are particularly vulnerable and significant, as determined on a case-by-case basis. Careful removal of brush, saplings and trees is typically labor-intensive and must be repeated as resprouting and new growth occurs.

Recommended Practices:

- Remove most small to medium sized brush, saplings and trees from on and within historical features ,such as cellar holes and their foundation walls, channelized stream beds, mill dams, and historic buildings.
- Remove vegetation by cutting as close to the ground as feasible. Vegetation should not be pulled, or otherwise dislodged in a manner that would affect root systems.
- A small, tracked, excavator platform feller buncher may be appropriate for tree removal in some cases where the terrain is sufficiently level and stable. This machine has a long reach which limits the need to bring equipment too close to the structure; it picks the tree up, so there is no concern about the direction of the fall; and the tracks tend to distribute the weight, thereby limiting soil compaction.

Some cultural resources on the Quabbin watershed are protected at least in part by overall management and access strategies (see Landscape and Landscape Features, section 2.7.3 above). Others are more vulnerable and may require direct management efforts.

Vegetation, if left to grow unchecked in and around stone foundations, dams, raceways, etc., may compromise and ultimately destroy these archaeological features. The control of vegetation growth in and around archaeological sites and historic structures may therefore be a high priority at some sites.

Dana Common: Past and Present

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