UPPER WHITE RIVER WATERSHED ASSESSMENT PART I

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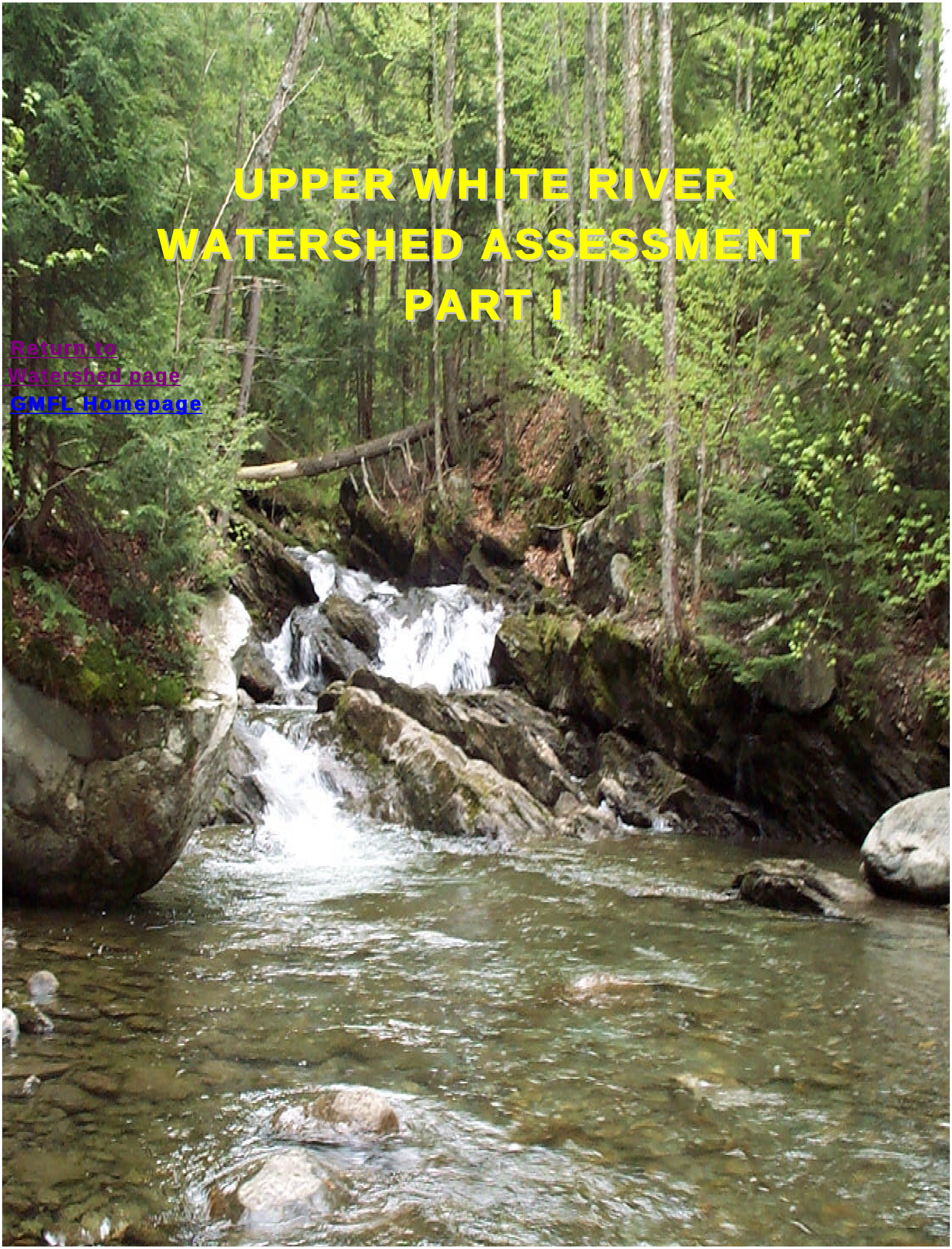

UPPER WHITE RIVER

WATERSHED ASSESSMENT

"That land is a community is the basic concept of ecology, but that land is to be loved and respected is an extension of ethics…. We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect."
Aldo Leopold

December 2000

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With important assistance from: The White River Partnership

Upper White River Watershed Assessment

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UPPER WHITE RIVER WATERSHED ASSESSMENT

INTRODUCTION

The term "watershed" originally described the common ridge from which water flowed, or was shed, in two directions. This early understanding of the term led to the popular usage of it to mean a significant dividing point in history or a mode of thought; for example, a "watershed event" or "watershed idea".

In the 19th century, conservationist and Vermonter George Perkins Marsh (author of the landmark volume Man and Nature) retained an appreciation of childhood lessons about the dynamics of erosion and watersheds. He became a life-long activist for responsible land management in drainages, with particular attention to promoting clean water and reducing erosion of productive lands.

Marsh's advocacy of watershed protection is described in a new book by David Lowenthal (George Perkins Marsh: Prophet of Conservation, 2000). In a recent (April 2000) lecture as part of the University of Vermont's George D. Aiken Lecture series, Lowenthal cast Marsh's message as a metaphor: a "watershed" understanding of the dynamic connection between nature and human nature -- a precursor to our current concepts of ecology and ecosystem management.

Today, the term watershed has evolved to refer to the drainage basin into which water is shed. The Forest Service's recent emphasis on watersheds as our unit of analysis, or area of study, harkens back to the genesis of the National Forest, which was established to protect watersheds through responsible, regulated forestry and land management practices. The Weeks Act, establishing the National Forest System, owes a debt to Marsh and his allies in advocating responsible land management. This is particularly relevant on the Green Mountain National Forest, where we are stewards of the headwaters of 15 drainages.

The condition and health of the Upper White River Watershed for the several thousand years following the melt and retreat of the glacial ice may have been affected by the presence of people. We would like to know more about this long epoch of Native American occupation, but assume that their low population numbers ensured a relatively "light" hand on the landscape in our study area until the development of agriculture 1000 or more years ago. Natural processes of vegetative succession and climate change more likely drove dramatic, long-term changes in the watershed during this period.

Over the last several *hundred* years, however, particularly since the arrival of European immigrants, that pattern has been largely reversed. Thus, the land-use and settlement patterns since the late 1700's have had a profound and dramatic affect on the landscape and ecosystem health. Land clearing, logging, altered stream channels, intensive agricultural practices, home building, and the establishment of road systems created the "classic" Vermont landscape of open hillsides, rural homesteads and stream-side roads and mills – sometimes at the expense of animal habitat, water quality, soils and aesthetics.

Today, the Upper White River Watershed is a mosaic of landscape types reflecting a healthier mix and intensity of land-uses than existed 100 years ago. Our assessment looks at a range of issues reflecting this current condition, and recommends several actions to address areas of concern.

In the spirit of Marsh and his successors, we are aware that our "prime directive" is to ensure that we work toward maintaining clean water. In that same vein, we are also committed to managing for the health of the larger ecosystem and the sustainability of the watershed's natural and cultural resources valued by the public.

<u>Watershed Analysis Process</u>

A watershed analysis is an ecosystem analysis at the watershed scale. The purpose of this analysis was to identify a prioritized list of recommendations, which when implemented, would begin to address the most important ecosystem issues in the restoration of the Upper White River Watershed. The focus of this analysis was mainly for the National Forest land portions of the watershed although much of the information applies to the watershed as a whole.

The process used is the 6-step process is described in the Federal Guide for Watershed Analysis (Ecosystem Analysis at a Watershed Scale, Federal Guide for Watershed Analysis, Revised August 1995, version 2.2, Portland Oregon). In this process, specific ecological issues were identified for the analysis area. Then current and reference conditions of the resources related to the issues were identified and the reasons for change from reference condition were explained. Last, actions were recommended to address each issue. We hope these actions will provide a meaningful contribution to the White River Partnership's effort in restoration and maintenance of our watershed.

This analysis is a "living and working" document. Appendices and other additions and revisions will continue to be produced over time as new data is obtained or new issues and priorities are recognized.

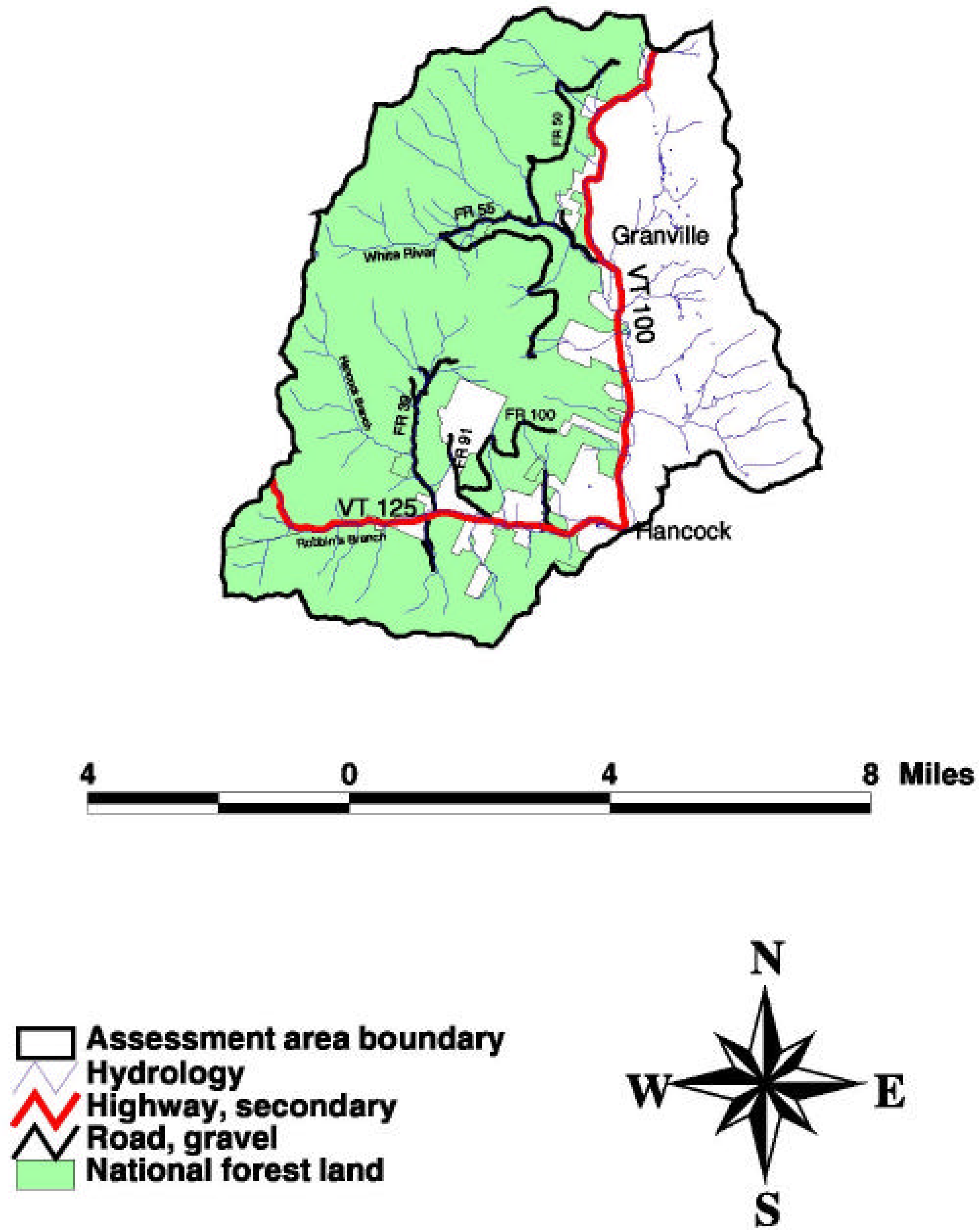
<u>Location</u>

The location of the Upper White River Watershed is shown on figure 1., page 8. The watershed is 36,217 acres in size. It is located in the White River Basin, on the eastern flank of the Green Mountains, in the Towns of Granville, Ripton, Hancock, Rochester, and Braintree. Most of the upper watershed, and all of the National Forest land is located in Addison County; a small part of the watershed is in Windsor and Orange Counties.

Elevations range from approximately 900 feet along the White River to 3,745 feet at the top of Mount Wilson. The major tributaries to the White River in the watershed are Texas Brook, Deer Hollow Brook, Boyden Brook, Hancock Branch, and Robbins Brook. The highest elevations in the watershed are comprised of spruce-fir forests, while northern hardwood forests of beech, birch and maple dominate the middle and lower elevations.

Most lands west of the main stem of the White River are National Forest. Most lands east of the main stem are wooded, and are owned by private individuals. Some livestock grazing also occurs on private lands along floodplains and terraces of the White River.

Location of Upper White River Watershed



STEP 1: CHARACTERIZATION OF THE WATERSHED

The purpose of this step is:

- To identify the dominant physical, biological, and human processes and features of the Upper White River Watershed that affect ecosystem function or condition.
- To identify, map and describe the most important land allocations, uses, plan objectives and regulatory constraints that influence resource management in the watershed.

LAND OWNERSHIP, USES AND MANAGEMENT AREAS

The Upper White River Watershed has a mix of land ownerships and uses. Privately owned lands dominate the watershed east of Route 100, and along the main stem of the White River, Hancock Branch and Robbins Brooks. Private lands at the upper to middle elevations are primarily forested, and some timber harvest is done there. Lower elevations along the main stem of the White River, Hancock Branch and Robbins Branch Brooks are used for home sites, grazing, cropland, and woodlots - some of which are used for maple sugaring. The area east of Route 100 has an extensive gravel road system accessing private homes on mountain slopes. The upper watershed contains two small towns - Granville and Hancock.

Several facilities or businesses on private lands are noteworthy: Camp Killoleet and Mountain Trail Campground near Hancock; Granville Manufacturers and Vermont Wood Specialties in Granville; Chesapeake Hardwood products Inc. in Hancock and SL Scholz Corporation Woodcarving in Hancock. Middlebury College Snow Bowl Downhill Ski Area is located in Hancock on College lands along Route 125 near the headwaters of Robbins Brook. Hiking is also popular at the ski area, and on the Long Trail. A small lake nearby named Lake Pleiad is a popular recreation spot.

The State of Vermont manages Granville Gulf and Moss Glen Falls, also popular recreational spots. Both are located in the northern part of the watershed along Route 100. These are the only state lands in the watershed.

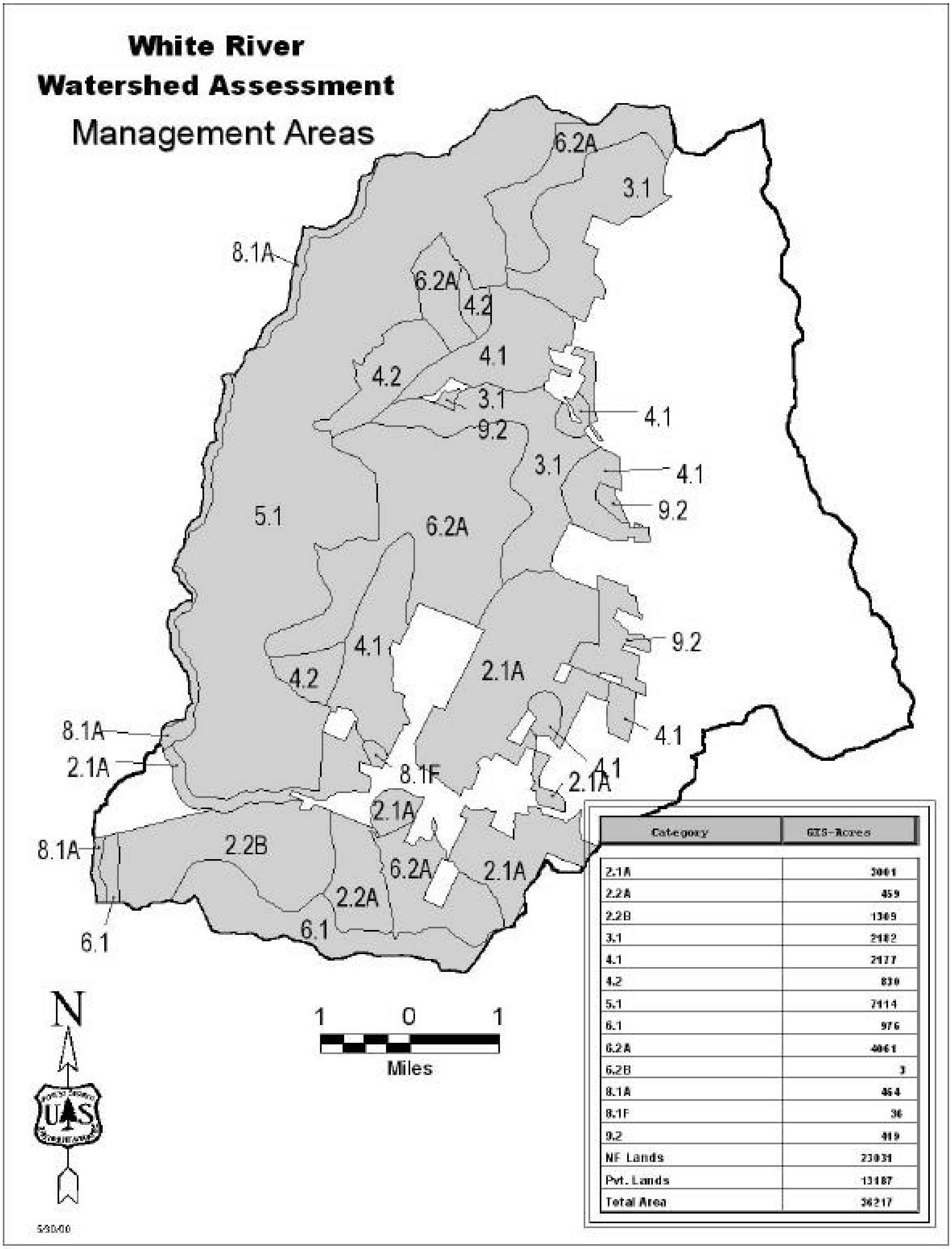
<u>National Forest Management Areas</u>

The Green Mountain National Forest (GMNF) occupies most lands in the watershed (23,030 acres) west of Route 100. On these lands, the forest is "zoned" into Management Areas (MA) see figure 2, page 11. Each Management Area has a unique emphasis or prescription that drives what kind of activities can take place or do not. The upper elevations Management Areas (MA) are managed to provide wilderness and primitive recreational experiences. North of Route 125 is the 21,480 acre Breadloaf Wilderness (MA 5.1), of which about 8,000 acres lie within the watershed. Timber and wildlife management does not occur in wilderness.

The middle elevations (MA 6.2) are managed for semi primitive recreational experiences, wildlife habitat and timber. Timber harvest in any MA is limited to the suitable lands. GMNF lands on the lower elevations in the watershed are managed to provide: deer wintering areas (MA 4.1 and 4.2), continuous forest cover for visual attractiveness (MA 2.1, 2.2A and B), and for roaded natural recreational activities and production of high quality sawtimber (MA 3.1).

Areas of special interest on the GMNF are: Route 125, a State Scenic Highway; Texas Falls Special Area (MA 8.1F) listed on the State Register of Fragile Areas; the popular Texas Falls picnic area and campground; and the Long Trail (MA 8.1A) which weaves along the western boundary of the watershed at the crest of the Green Mountains. There are also numerous snowmobile trails on both GMNF and private lands, mainly in the southern part of the watershed.

Newly acquired land awaiting Forest Plan revision for Management Area designation, is identified as MA 9.2.



Category	GIS-Acres
2.1A	3001
2.2A	459
2.2B	1309
3.1	2182
4.1	2177
4.2	830
5.1	7114
6.1	976
6.2A	4061
6.2B	3
8.1A	464
8.1F	36
9.2	419
NF Lands	23031
Pvt. Lands	13187
Total Area	36217

HERITAGE RESOURCES

Prehistoric Conditions

The potential for impacts on the environment from socio-economic activities increased through prehistory due to changing technologies, settlement patterns, and increased population densities across the region. Specific knowledge about the archaeological resources in the analysis area is poor, because of a lack of surveys and field research. There are two general reasons for this lack of investigation. First, the level of recent economic development in the White River valley has been low. Since the advent of historic preservation legislation 30 years ago there have been no major highways, industrial parks, or government-sponsored developments to provide an opportunity for archaeological studies. Second, it has only recently been acknowledged that the uplands and mountains were a critical, and qualitatively different, part of the larger Native American land-use strategy.

Current predictive models and ideas suggest that there could be numerous sites in the analysis area. The analysis area's location near the headwaters of the White River and just below Granville Gulf suggest that it would have been a strategically important territory within an Indian political/land-tenure system, based largely on hydrological-derived boundaries. The White River also constitutes a significant travelway connecting the interior to the Connecticut River and points south. The types of prehistoric sites anticipated are: small hunter-gatherer camps in the uplands in association with terraces or well-drained locations along secondary streams & wetlands; larger village sites once located in valleys (their preservation would be relatively rare); and occasional traditional use or sacred sites at highest elevations, such as mountain tops, and at natural vistas and natural landmarks – for example, Texas Falls. Few, if any, quarry sites are anticipated. Burials grounds or cemeteries may occur, but are hard to predict.

Sites located out of the floodplains or valley bottoms probably are in fairly good condition. Sites in the bottomlands could be in poor condition considering past development, agriculture, and most importantly erosion caused by major floods like those of 1830 and 1927.

Major current threats to the health of these sites (both discovered and undiscovered) are: human error in implementing project mitigation measures; unregulated development on private lands; natural processes such as erosion and tree throws; vandalism; and competing claims of cultural origin.

The Abenaki have no Treaty rights in or near the Upper White River Watershed, but they have legal standing under the federal Native American Graves Protection and Repatriation Act (NAGPRA). They do have oral histories about the area indicating regular use and occupation of the watershed. They have not been consulted about this particular project, but this will be arranged through our Abenaki Research Project partners.

Historic Period Conditions

Virtually every acre of the watershed has been affected by historic developments. Forest specie age and diversity, wildlife populations, stream profiles, soils, viewsheds, fragmentation and openings ratios, and the demographic profile of the area (for example the ratio of Indians to Europeans) all changed between the late 18th and early 20th centuries. Some of these changes were dramatic.

There are literally hundreds of sites and features left on the landscape from the historic period. They are the correlates to the standing architecture and functional outbuildings of the historic economy. We would therefore expect to find the remains of houses, barns, outbuildings, mills, blacksmith shops, schools, mining structures, etc. We would also find the footprints of transportation systems, and vegetative "artifacts" in the form of complete and partial cultural landscapes (apple orchards, pine plantations, sugar bushes, openings, and more). Their distribution is heavily biased toward the five main transportation arteries mentioned above.

By and large, historic sites on NFS lands are in good condition, with some damage from historic and recent management practices and natural processes. Evidence of intentional looting or vandalism is low. Like the prehistoric sites, the massive floods may have compromised the archaeological remains of historic sites in the valley bottom in 1830 and 1927. However, the effects of erosion varied from one location to the next, so sites need to be evaluated on their own merits.

The major threats to historic sites are human error in implementing project mitigation measures, unregulated development on private lands, natural processes such as erosion or tree throws, and vandalism.

SOCIAL SETTING-ECONOMY

Both the Towns of Hancock and Granville were established in 1781. Farming and wood products dominated their economies during the last century, and continue to do so to some degree. The populations of both towns peaked in the mid-1800s, and as common in Vermont, steadily declined for the next century due to both westward expansion and limited local employment opportunities.

Today, both towns remain relatively isolated. Due to their location, neither provides local employment for the majority of their residents. Most people will continue to work outside their towns as part of a broader regional economy. The limited local employment opportunities include logging, manufacturing of wood products, recreation-based tourism, and a variety of small businesses.

Community values reflect its traditional rural Vermont character. Long time residents play a dominant role in local government. The recent influx of new residents has caused a slight increase in population, but has not brought the "cultural clash" as in other parts of Vermont. New residents are attracted to the area because of its rural and traditional character, and dispersed recreational opportunities such as provided on the GMNF.

Both town plans show a strong desire to retain their rural character, including recreational and scenic values, while promoting measured economic growth. This desire is also shared at the state level. Approximately 10,800 acres of forest and farmland in Granville are enrolled in the Current Use program. This is an indication that local residents understand the importance of managing their natural resources to keep the forests “working”. The Vermont Land Trust is actively involved in obtaining conservation easements to maintain farm lands, protect the water quality of the White River, and provide recreational access to this water way.

The GMNF comprises a large portion of the towns of Hancock (85%) and Granville (43%). Therefore, "Local economies are strongly dependent on the use of these lands for timber production and on the annual Forestry Receipts" (Hancock Town Plan, September 1992). At the same time, "future land use needs to allow easy access to the natural environment and protect it from destruction (Granville Town Plan, January 1995).

Given the strong rural identity and traditional values of both towns, their commitment to environmental quality, and their close physical and economic ties to the GMNF, it is important that not only do their governmental bodies and citizens participate in decisions impacting neighboring GMNF land, but also that GMNF land use plans are compatible with these two towns.

VISUAL RESOURCES

Large contiguous blocks of NF ownership characterize land in the Upper White River Watershed. The private and State lands that do exist in the area are located mostly along the two State road corridors, Route 125 and Route 100, see figure 3., page 16. These private lands include pastures, home sites and other openings that contribute to the ability to view scenery by the public traveling on those highways. Located within this area along Route 100 is the Granville Gulf State Reservation, which includes scenic Moss Glen Falls. Hancock Overlook, one of the White River Travelway sites, is also located here and offers views into the area. Texas Falls Recreation Area, located off of Route 125 is also located within this area.

In 1973 the State of Vermont officially recognized the Robert Frost Memorial Highway on Route 125 from East Middlebury to Hancock. In 1980 this same stretch was designated as one of three State Scenic Highways in the State of Vermont. In 1996 a corridor management plan was developed for this Scenic Highway. Route 100 does not have this State Scenic designation, but it is one of three primary roadways in the State of Vermont (the other two being I-89 and I-91).

The Hancock and White River Opportunity Analysis Plans, completed by the GMNF in 1987 and 1989 discuss the visual conditions, existing and desired future roads trails and travelways for this area.

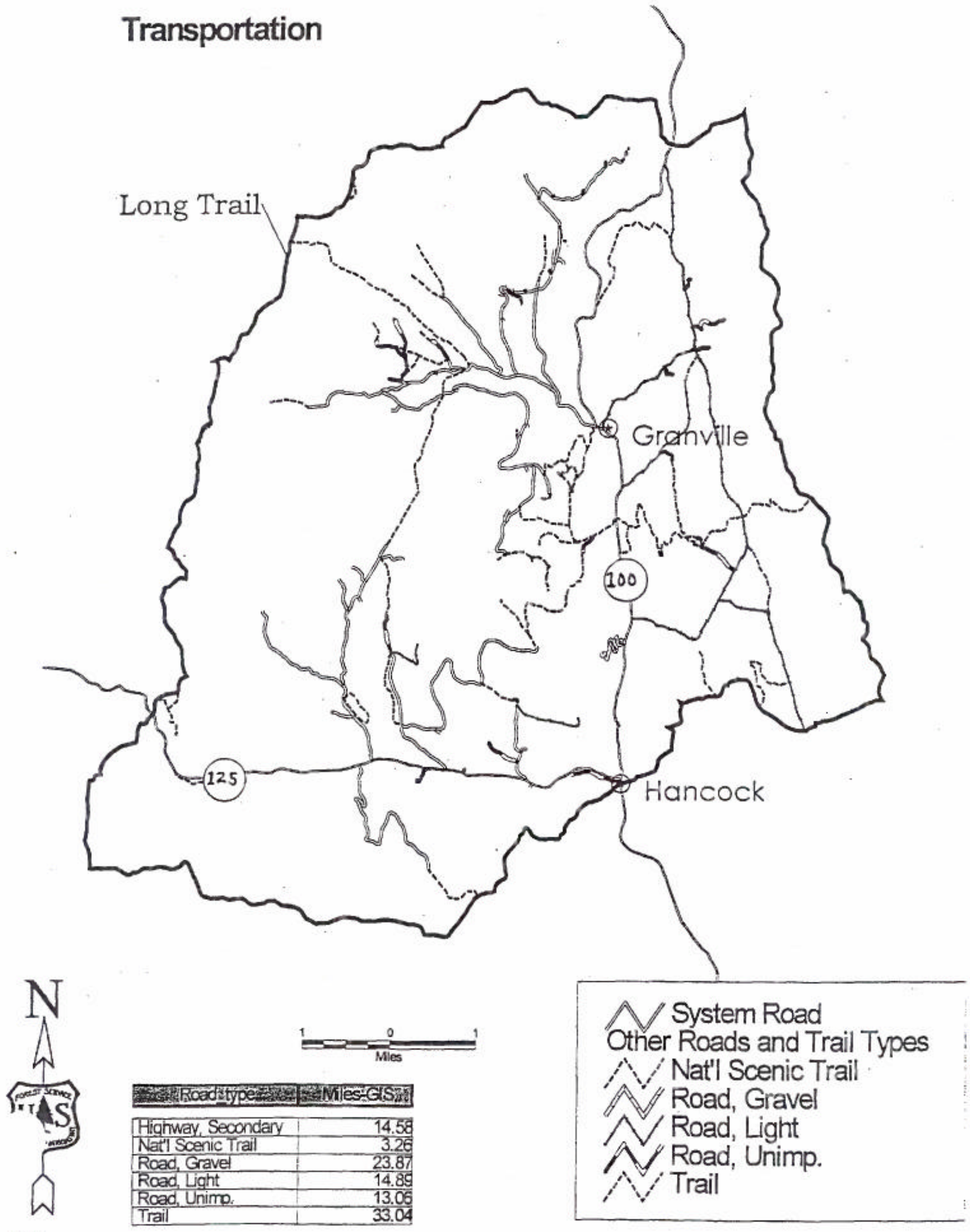
The White River Watershed is bounded on the west at the height of land by the north/south running Long Trail. Several vistas from the Long Trail have been documented and offer panoramic views into this watershed. The majority of foreground views from the trail (less than 1/2 mile) fall within the Breadloaf Wilderness. Middle ground views (1/2 to 4 miles) account for the majority of views onto GMNF lands within the watershed. Some background views (greater than 4 miles) fall onto GMNF lands with the majority of background views falling outside the GMNF, onto the Northfield Mountain Range that bounds this watershed to the east. Various vistas exist along the road system from temporary openings created by timber harvests and maintained upland openings created for wildlife.

In general, the Green Mountain National Forest is seen as a valued scenic backdrop from roads and private lands in the villages of Hancock and Granville. The Breadloaf Wilderness at the highest elevations offers a forested canopy that will not be noticeably disturbed by humans.

The trees that make up the spectacular fall color and create contrast between evergreens and deciduous trees offer an important component in this area since many of the roads, trails and recreation sites are valued for scenery. The streams and rivers running parallel to many of the roads in this watershed are also a visual and sensory feature of this watershed.

White River
Watershed Assessment
Transportation

FIG. 3



Road type	Miles-GIS
Highway, Secondary	14.58
Nat'l Scenic Trail	3.26
Road, Gravel	23.87
Road, Light	14.89
Road, Unimp.	13.06
Trail	33.04

5/30/00

RECREATION

Comparatively, the Upper White River watershed area generates more recreation and tourism than most areas on the Green Mountain National Forest.

The primary uses are:

- Sightseeing and picnicking
- Primitive camping
- Trail uses
- Wilderness
- Fishing and hunting

A natural appearing landscape with distinctive features such as Texas Falls and Moss Glen Falls, rugged terrain typified by Granville Gulf and the Hancock Branch valley blended with the pastoral/farm foreground setting draws visitors to the area. Even with the limited amount of development along major state highways, those coming from more urban and suburban settings view the area as wild. The steep valleys make the summer green and fall colors more apparent making this a prime foliage viewing area. Most sightseeing is done on roads and some vistas on high mountain roads exist. Facilities or features such as the Hancock Branch Overlook, Texas Falls Nature Trail, Silent Cliff, and Skyline Lodge are attractors too.

Streams in this area are aesthetically pleasing and attractive for fishing. They draw visitors because of their general sparkling clarity, privacy, and close proximity to roads.

The Rob Ford meadows, upper Texas Meadows, and the National Forest roadsides along the White River tributaries make this watershed one of the more important for primitive camping on the National Forest in Vermont. Many of these sites are located less than 50 feet from streams. Overall, most primitive campsites are reasonably well vegetated and maintained. An active Low Impact Camping information effort has reduced the impacts created by this use. Picnicking occurs primarily at the Texas Falls recreation area.

There are about 36 miles of trails within the Upper White River watershed. Most of these trails lie on National Forest land. Most hiking and walking is done on the Long Trail, the Hancock Branch trail, and the Texas Falls Nature trail. Most of the winter sports trails in this watershed follow roads. Road snowplowing during logging operations has been the main impact on these uses. The area is attractive and draws people from Addison and Rutland counties during the winter because it receives more snow than adjacent lower lying areas.

About 8,000 acres of The Breadloaf Wilderness occurs in this watershed and draws another segment of visitors to experience an area with less apparent influence from humans.

Hunting remains an important activity although less so than in lower elevation habitats associated with farms, large swamps, and oak stands. Still many hunters seek the unique conditions of early successional habitats created by evenage timber harvesting systems. These areas provide prime habitat for a variety of small and large game species. The watershed is popular for moose, small game, woodcock, turkey and grouse hunting. Fall and early winter deer hunters like the area because there is room to roam and some of the biggest deer are found in the high mountains. Vermont's' black bear population has increased significantly recently and this area has some excellent bear habitat. Because of its relative remoteness, this area draws hunters in fall. Granville and Hancock usually show some of the highest bear harvests in Addison County and the state.

Fishing in local streams is considered good, with native and stocked brook, rainbow and brown trout available.

AIR

Air quality in the watershed meets Vermont air quality standards. However, there are two regional air quality concerns, which apply to the watershed. First, visibility is significantly reduced due to particulates in the air, consisting primarily of sulfur, nitrogen, carbon and metals. Most of the haziness observed in the sky on any given day is due to particulate matter. Scenic views are degraded on most days due to particulate matter.

Second, acid deposition and elevated levels of ozone in summer are affecting the soil, water and vegetation in the watershed, especially at the higher elevations.
The highest elevations in the Green Mountains have the highest rates of acid deposition and ozone production in the state. Soil and water acidity have likely increased over the past 50 years, and it is reasonable to expect that this has decreased the availability of some plant nutrients such as calcium and magnesium. This, along with increased ozone levels, may result in stresses to vegetation over the long term. Acid deposition has also caused degradation of water quality and aquatic communities. These effects on water quality and the aquatic community have been documented at Skylight Pond. Research is on going to better understand these concerns in New England.

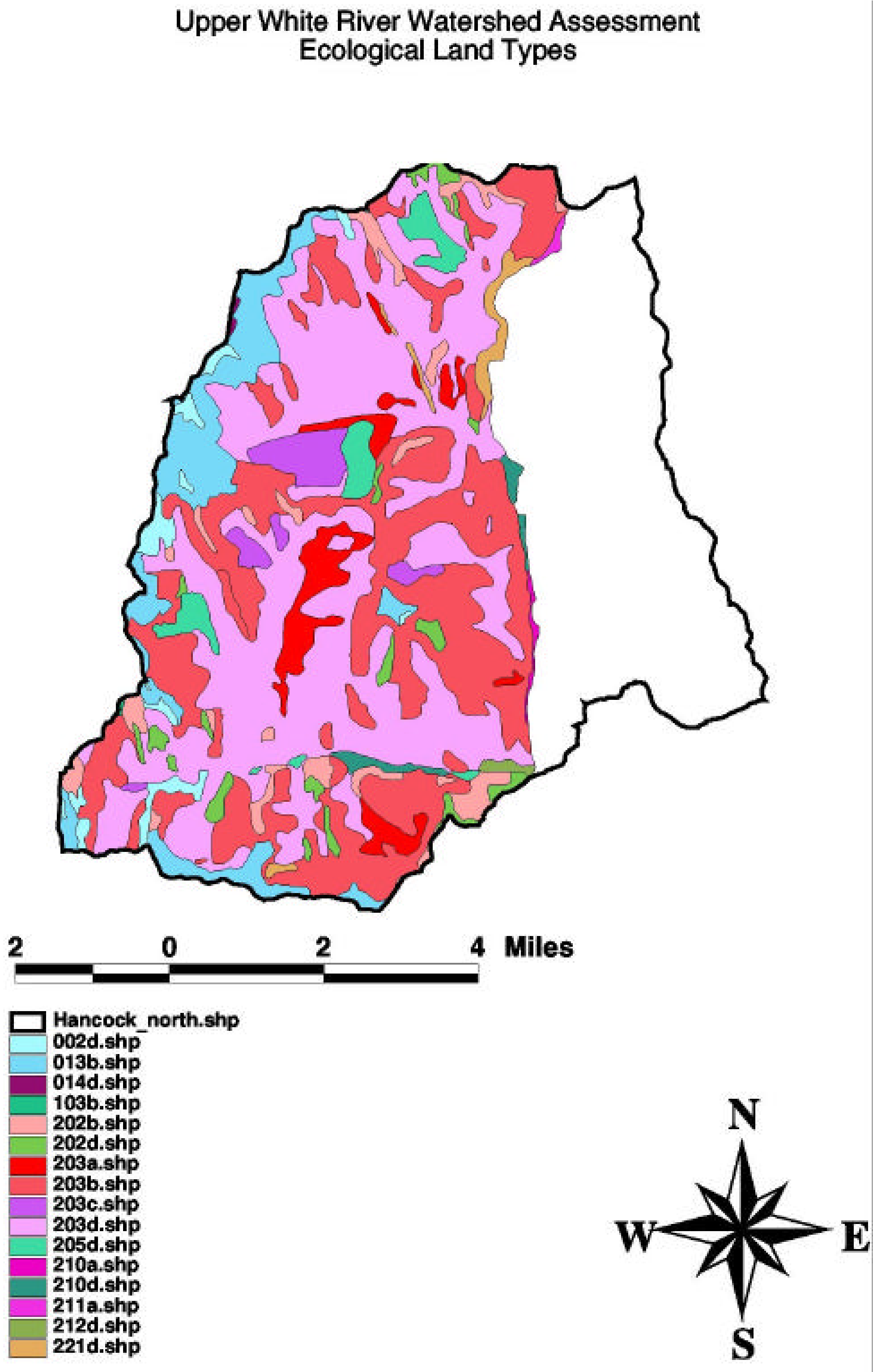
SOIL

Soils on mountain side slopes and ridge tops in the Watershed are generally well to moderately well drained, loamy in texture, and derived from glacial till. Soils above approximately 2300 feet are steep, shallow (less that 2 feet deep to bedrock), lower in productivity, and highly erosive. These soil conditions typify Ecological Landtypes (ELTs) starting with "0" and ELT 202b. Soils on midslopes and lower sideslopes are usually deep (greater than 40 inches deep to bedrock) and are often underlain by a hardpan at a depth of 20 to 30 inches. They are more productive, and lack the thick organic layer of the high elevation soils and are less erosive. ELTs 203d and 205d dominate. Poorly drained soils (small wetlands) are often found on flat or concave landscape positions on mid to lower sideslopes.

Soils in valley bottomlands (primarily along the main stem of the White River) are sandy and gravelly, the result of glacial outwash deposition. ELTs 210d and 212d dominate. Most soils are well to moderately well drained but some areas of wetter soils occur in the lower landscape positions. In general, soils in the bottomlands are less erosive because they are on relatively flat landscape positions. However, sandy and gravelly soils along unstable stream banks can contribute significant amounts of sediment when disturbed due to natural or anthropogenic causes.

Soil productivity (and thus site productivity) throughout the watershed is greatly influenced by the amount of calcium in the bedrock. The most productive sites are on calcium rich bedrock in areas with optimum moisture conditions.

Several natural or anthropogenic processes affecting soils in the watershed are worth noting. Soil acidification is occurring due to acid deposition, which may decrease soil productivity over the long term. Soil erosion is on going. The rate of natural erosion is very slow, and landslides are rare. However, the rate of erosion has been accelerated in some locations due to development (including road building and maintenance), agricultural and grazing land uses, floods, and to a lesser extent, timber harvest. Soil erosion results in losses in soil productivity, and water quality and aquatic habitat degradation.


Upper White River Watershed Assessment
Ecological Land Types
2 0 2 4 Miles
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013b.shp
014d.shp
103b.shp
202b.shp
202d.shp
203a.shp
203b.shp
203c.shp
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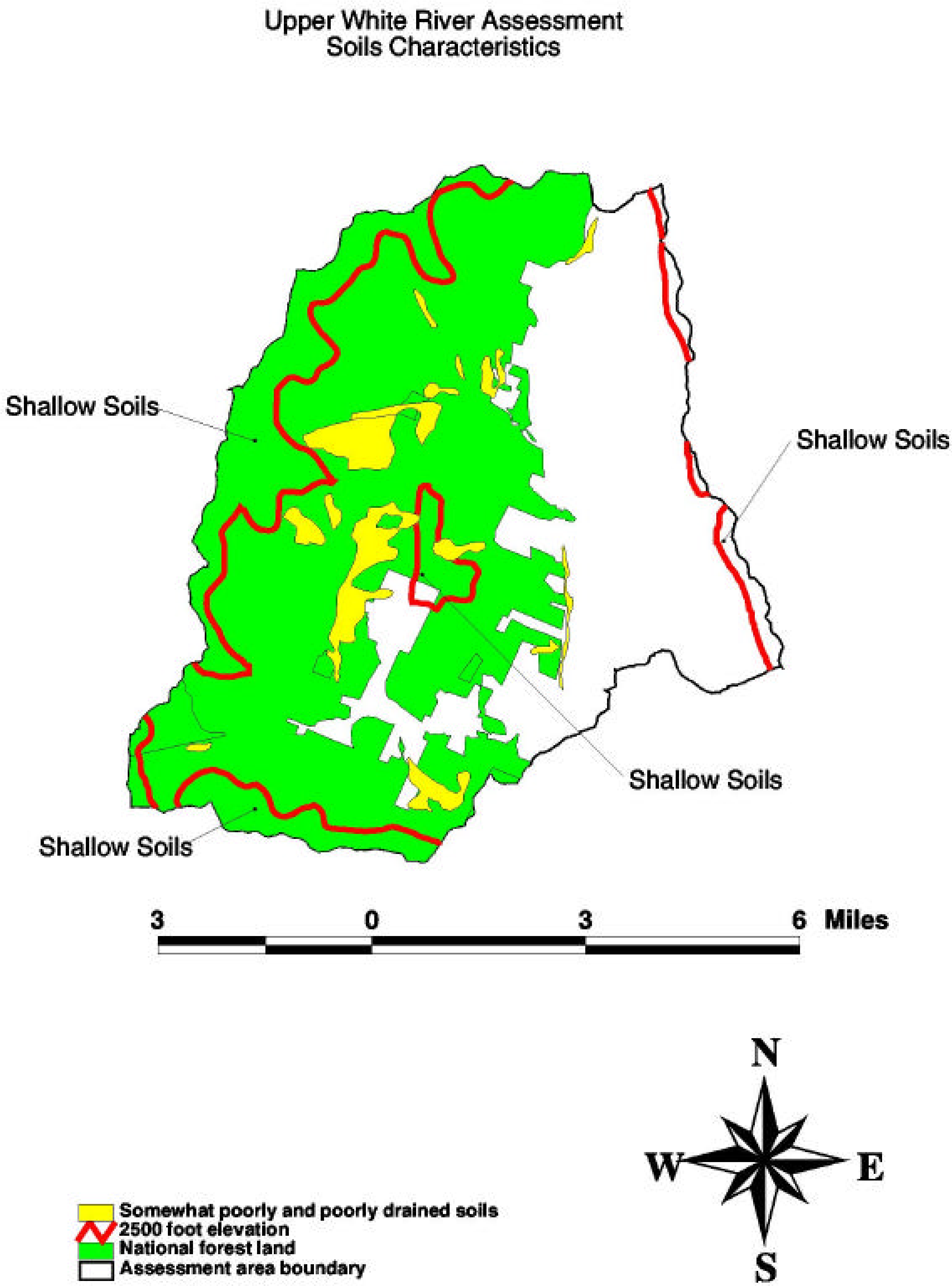
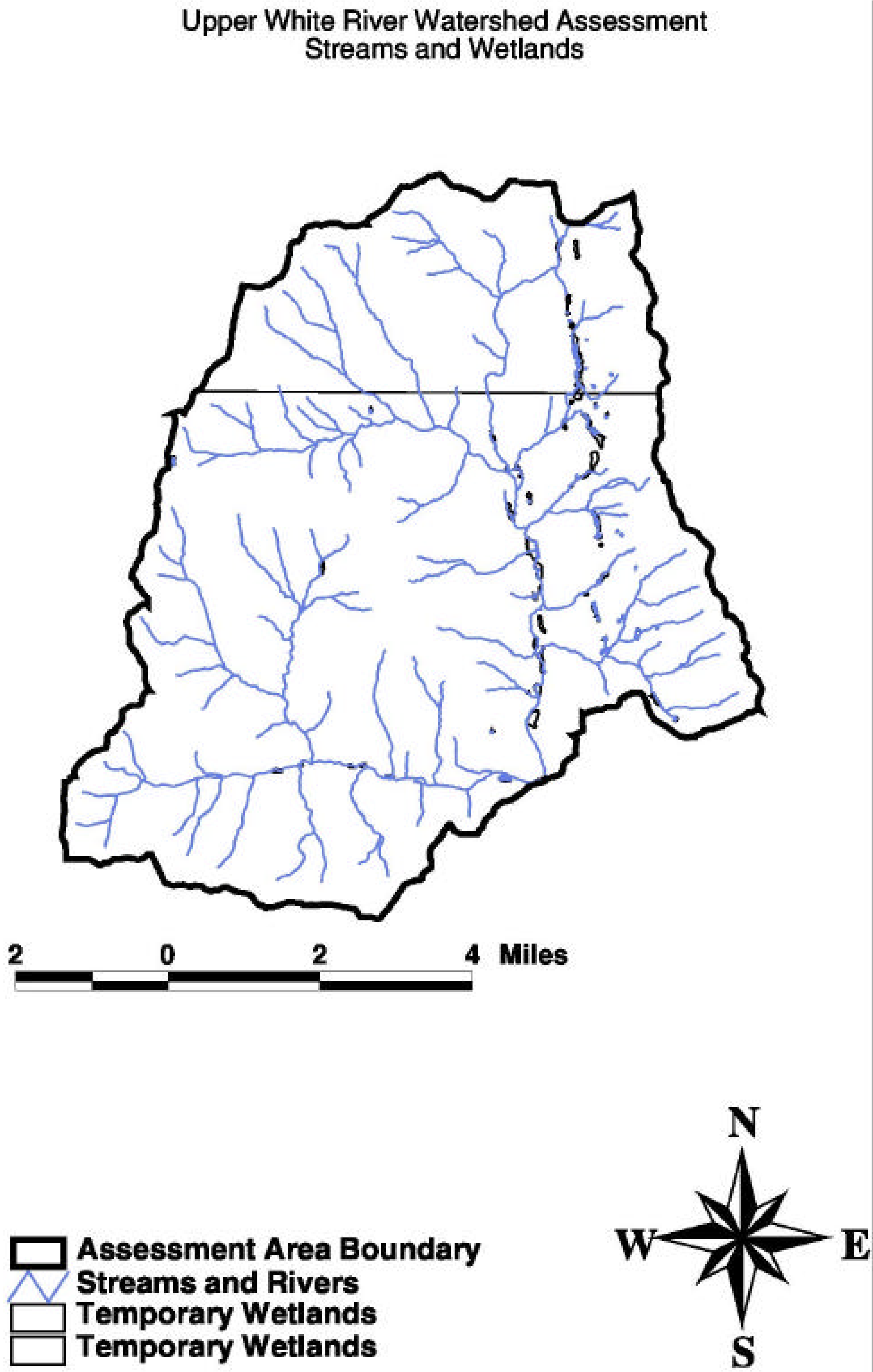

Upper White River Assessment
Soils Characteristics
Shallow Soils
Shallow Soils
Shallow Soils
Shallow Soils
3
0
3
6 Miles
N
W
E
S
Somewhat poorly and poorly drained soils
2500 foot elevation
National forest land
Assessment area boundary

WATER

Water resources consist of cool, headwater mountain streams (Rosgen type A and B channels), wide valley bottom streams (Rosgen type C and E channels), and occasional wetlands, see Figure 6. Water quality in the mountain streams is high and most streams have forested riparian areas, providing much of the habitat and energy needed to fuel riparian area processes. Water quality and riparian areas in the valley bottomlands are more affected by people and their land management activities. Much of the bottomlands are used for crops, pastures, or home sites. This has resulted in lower water quality, a lack of large woody debris, and heavy sediment loads and degraded aquatic habitats. Some wetlands have been lost to development, or their functions have been impaired due to adjacent land uses. According to the 1997 White River Basin Assessment Report done by Vermont ANR, the major sources of water quality problems to the White River system are stream bank destabilization, removal of riparian vegetation, agriculture (including grazing), road maintenance and runoff, and development. Other disturbances that have affected waters resources in the near and distant past are fires, floods, logging, gravel mining, and acid deposition. In fact, Skylight Pond, a small, high elevation pond, is on the Vermont impaired waters list because of low pH levels caused by acid deposition.

Despite water resource problems in the valleys, water quality and aquatic habitats are adequate to support fishing, canoeing, swimming, and other recreational uses. Water resources throughout the watershed are highly valued by residents and visitors, and are a critical component of the watershed landscape.


Upper White River Watershed Assessment
Streams and Wetlands
2
0
2
4 Miles
N
W
E
S
Assessment Area Boundary
Streams and Rivers
Temporary Wetlands
Temporary Wetlands

VEGETATION

Landscape – scale Vegetation Patterns

The Upper White River Watershed is comprised of four broad landscape units or Landtype Associations (LTAs),: alpine/krummholtz, upper slopes/subalpine spruce-fir, mountain sideslopes/northern hardwoods, and lower slopes & hills/northern hardwoods (see Figure 7). The following Table 1. shows the distribution of area for the GMNF proclamation boundary of the Forest among these four landscapes:

Table 1.

LTA	Area	%
Alpine/krummholtz	25 acres	<1%
Upper slopes	6958 acres	26%
Mountain sideslopes	14,114 acres	53%
Lower slopes & hills	6711 acres	20%

In this area, the alpine/krummholtz LTA has no true alpine vegetation, but consists of stunted balsam fir and some red spruce that occasionally reaches krummholtz stature. This LTA occurs only along the main ridgeline of the Green Mountains from near Breadloaf Mountain north to Mt. Roosevelt - the highest elevation zone in the watershed. Disturbance in this zone is predominantly caused by wind and ice damage due to extreme conditions and exposure; the ground vegetation in this area can also be particularly vulnerable to damage from hiker traffic due to very shallow soils, limited growing season, and low nutrient levels available.

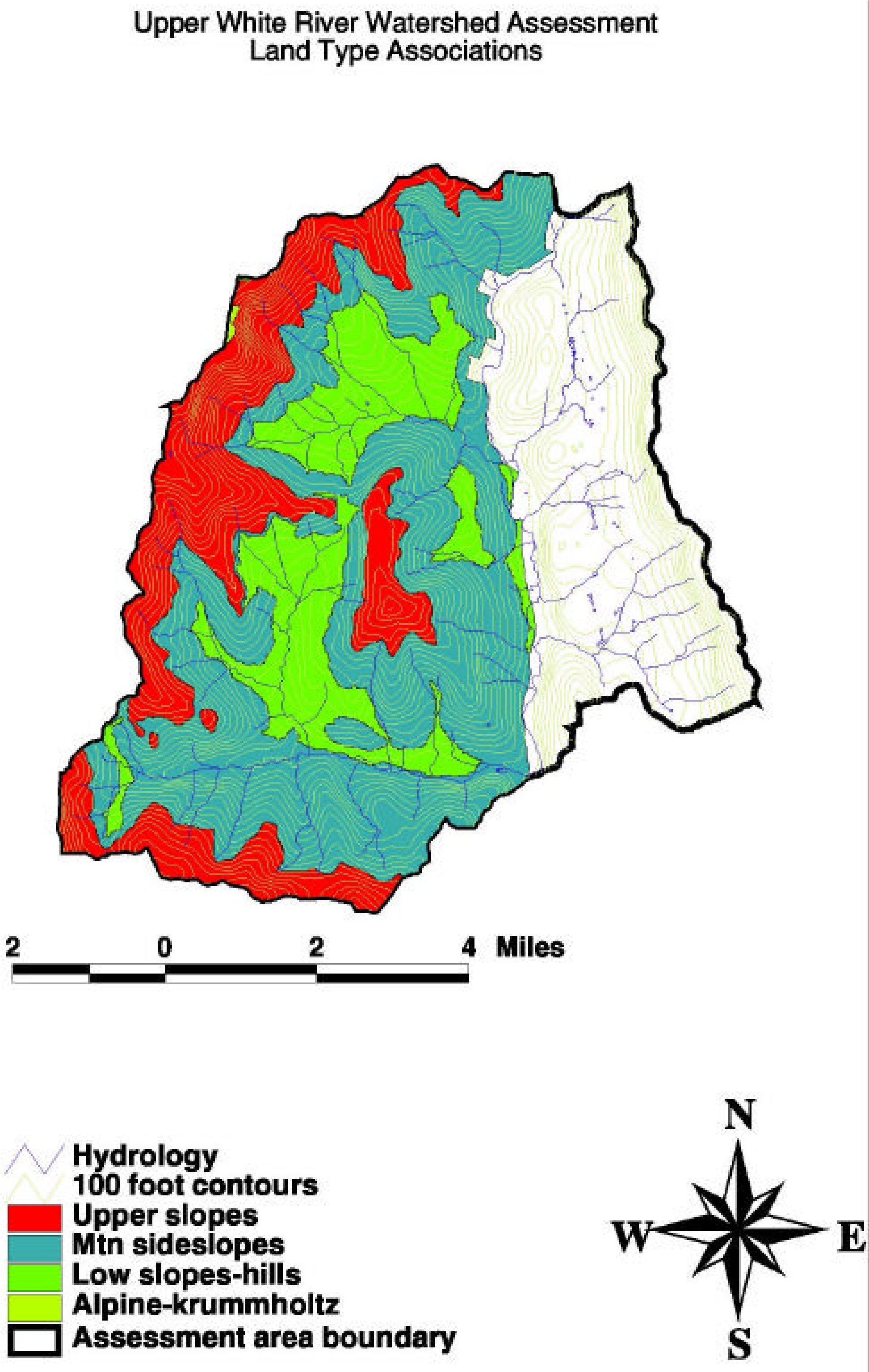
The upper mountain slopes LTA tends to be dominated by red spruce and balsam fir. This LTA falls along steep, convex to linear slopes, and transitions at the lower elevation boundary into northern hardwoods. Interestingly, an analysis of the vegetation groups based on forest types from field surveys (for example, Silvexam records) shows conifer types at much higher elevations, with hardwoods and a few pioneer (aspen, paper birch) stands extending far into the spruce-fir LTA zone. Undoubtedly the pioneer types in this zone are likely to be seral to more mixed hardwood/conifer types, or to conifers. It is also likely, as has been shown at Mt. Horrid to the south, that much spruce timber existed in the spruce-fir LTA, and was selectively harvested at the turn of the 19th to 20th century. To an extent, this allowed the northern hardwoods a competitive edge for a while. It's likely that most of the hardwoods in this zone are mixed with a component of spruce and fir. Aside from timber harvesting, the dominant natural disturbance regimes here are wind and ice damage - these elevations and slope shapes are more exposed to SE wind damage and winter injury, as well as inputs from acidic deposition. Most of the stands identified as having moderate to severe ice damage from the ice storm of 1998 occurred in this zone, although ice damage also occurred on the upper elevations of the mountain sideslope LTA. In fact, the greatest ice damage in 1998 occurred in the hardwood-dominated portion of this LTA, suggesting that ice storms may exert selection pressure against retention of hardwood overstories in this zone, and selection for relatively quick re-establishment and/or maintenance of spruce-fir dominated communities. Furthermore, at the turn of the century, there were nearby occurrences of wildfires (e.g. Mount Horrid 1908), but none appear to have been recorded from this area.

Northern hardwoods dominate the mountain sideslope LTA. These areas tend to be less mixed types (mixed with conifers) and more pure to northern hardwoods. Slopes tend to be moderate to steep, and linear. Also of interest is the fact that a great deal of survey work locating the "enriched" version of northern hardwoods has occurred in this area, and most if not all occurrences are in this zone. An analysis of limy types of bedrock from the state bedrock map and co-occurrence of rich northern hardwood stands show a correlation about half the time, again, all in this zone. There are a substantial number of enriched northern hardwood stands of various intensities in this area, amounting to something on the order of 10% of the proclamation boundary in the watershed. In addition, there are significant bands of limy rock that run through this watershed, both at low and high elevations, parts of which have not been surveyed for rich northern hardwoods or rare plants, but pose the likelihood of their occurrence. Natural disturbance in this zone tends to be dominated by wind events that usually create single-tree to small group-sized gaps, as well as the occasional large wind event (e.g. downburst, hurricane). Timber harvesting and dispersed recreation are prevalent uses in this zone that can also create disturbance.

The lower slopes and hills LTA contains the part of the landscape that is more moderate to easy in terrain, tends to include concave as well as linear slopes, moderately sloped bench areas, and areas that tend to be "lumpy" - patches of meso-scale hills and hollows. Most of this LTA in the subwatershed is associated with the lower and toe slopes of the main ridge and spur ridges. This LTA is associated with the basins around Patterson Brook, Clark Brook and upper White River, as well as upper Hancock Branch and Texas Brook. Smaller areas between Albee and Gulf Brooks, and near the White River main stem, are more hilly. These areas are presumed (in the classification) to still be dominated by northern hardwoods. However, a comparison with the forest type maps suggests that this LTA has a significant softwood component, primarily red spruce. It also appears to have been the focus for the variety of plantations (e.g. red pine, norway spruce, white spruce, white pine) that occur in the area. In addition, it is also interesting to note that the majority of upland openings in this area occur in this LTA as well. It may be that these protected basins receive cold air drainage and occur at a high enough base elevation to provide habitat for red spruce and hardwoods. Natural disturbance here tends to be associated with wind as described for the mountain sideslopes LTA; there may be a greater prevalence of windthrow creating larger canopy gaps due to hardpan soils and more shallow-rooted conifers in this zone. Fire history here is unknown. Settlement focused in these areas due to the terrain.

Most of the zone around the White River main stem is classified valley bottom LTA.   The vegetation of this LTA is hard to estimate, as so little of it remains in forest. Based upon the Vermont ANR’s White River Basin Report, it is reasonable to assume that floodplain forests would under natural circumstances dominate the riparian zone, which is often extensive. In addition, areas of glaciofluvial deposits and alluvium associated with previous river levels would likely be dominated by white pine, red oak, red maple, and beech – species that tend to tolerate more xeric conditions. The predominant natural disturbance regime was flooding, although human settlement probably exerted (and continues to exert) as large an impact on the valley bottom ecosystems. The likely presence of human use in the valley over centuries probably perpetuated early seral communities in this LTA, including herb and shrub-dominated openings of various types.

The LTA system used here has been applied only to the GMNF Proclamation Boundary. Consequently, we cannot yet develop a map or acreages for the watershed beyond this proclamation boundary. However, given the terrain, it is likely that the east side of the watershed includes all LTAs noted for the west side with the exception of the alpine/krummholtz LTA. Most likely any occurrence of the spruce-fir LTA is of small size and restricted to the tops of the smaller mountains on the east side.


Upper White River Watershed Assessment
Land Type Associations
2
0
2
4 Miles
Hydrology
100 foot contours
Upper slopes
Mtn sideslopes
Low slopes-hills
Alpine-krummholtz
Assessment area boundary
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WILDLIFE
The Upper White River Watershed supports a variety of wildlife species. The vegetative characteristics of the area are described in the vegetation section. The wildlife analysis is associated with the habitats that exist within the watershed. The forest types, habitats and how wildlife use them is described in New England Wildlife: Habitat, Natural History and Distribution, (Degraff and Rudis, 1986) USDA Forest Service, Northeast Forest Experiment Station, General technical report NE-108, 1986.

The White River valley bottom is where most of the human development has occurred. The presence of agriculture, manufacturing, and industry along the valley bottom has produced a mix of wooded and open habitats where deer, turkey and moose are seen regularly. The mountainside slopes are dominated by northern hardwoods with small patches of softwood plantations, mixed woods, maintained and overgrown openings. Along the mountain ridgelines and the upper slopes there are aspen, birch, and spruce/fir habitats with occasional openings caused by natural disturbance.

The Threatened and Endangered species identified by USDI Fish and Wildlife are peregrine falcon, Indiana bat, bald eagle, gray wolf, and Eastern cougar. Peregrine falcons may feed within the Upper White river Watershed, but this area is a considerable distance from any known nesting sites. The nearest nesting site is approximately 10 miles from the western edge of the watershed. The Indiana bat may utilize areas within the watershed for summer roosting and feeding. However, there are no known mines or caves within the watershed so it is unlikely that Indiana bats winter within the watershed. The Bald eagle, gray wolf, and Eastern cougar do not occur in the watershed.

Three species identified in the Regional Forester's list for sensitive species that could occur on the Green Mountain National Forest have the potential or have been documented as occurring within the watershed. The species that could inhabit the upper White River Watershed are Northern goshawk, Bicknell's thrush, and Eastern small-footed bat. Of the thirteen Management Indicator Species identified in the GMNF Forest Plan, peregrine falcon and American bittern are least likely to inhabit the watershed primarily due to lack of suitable nesting habitat. Brook trout, ruffed grouse, American woodcock, barred owl, blackpoll warbler, yellow-bellied sapsucker, tree swallow, snowshoe hare, gray squirrel, beaver, and white-tailed deer are likely to inhabit the watershed

RARE PLANT, ANIMAL SPECIES AND HABITATS

Plant and Animal Species
Known rare plant and animal occurrences in the watershed have been identified over the past ten years through field surveys conducted by GMNF and partners (primarily Vermont Nongame & Natural Heritage Program - VNNHP). See Appendix B for more information on the sources of rare plan information.

In terms of rare species, this watershed contains two documented occurrences of rare species from the VNNHP database: pygmy shrew *(Sorex hoyi)* in the Patterson Brook basin, and michaux’s sedge (*Carex michauxiana*), known from Skylight Pond. In addition to these records, a record of a state historic blue-eyed grass species (*Sisyrinchium atlanticum*) was located in 1999 in the Texas Falls area. Given its rediscovery, it will be listed as a state rare species at this point. An old historic record of auricled twayblade *(Listera auriculata),* a globally rare and state listed plant, suggests it could occur somewhere in the mountains in Hancock. Further location information does not exist (the record is based on a very old herbarium specimen). The plant could be present, however, appropriate habitat is limited. The southern most occurrences of the species in the U.S. are found in Warren. Butternut *(Juglans cinerea)* is a R9 Sensitive species but not tracked by VNNHP, it is known to occur in the Gillespie mountain area.

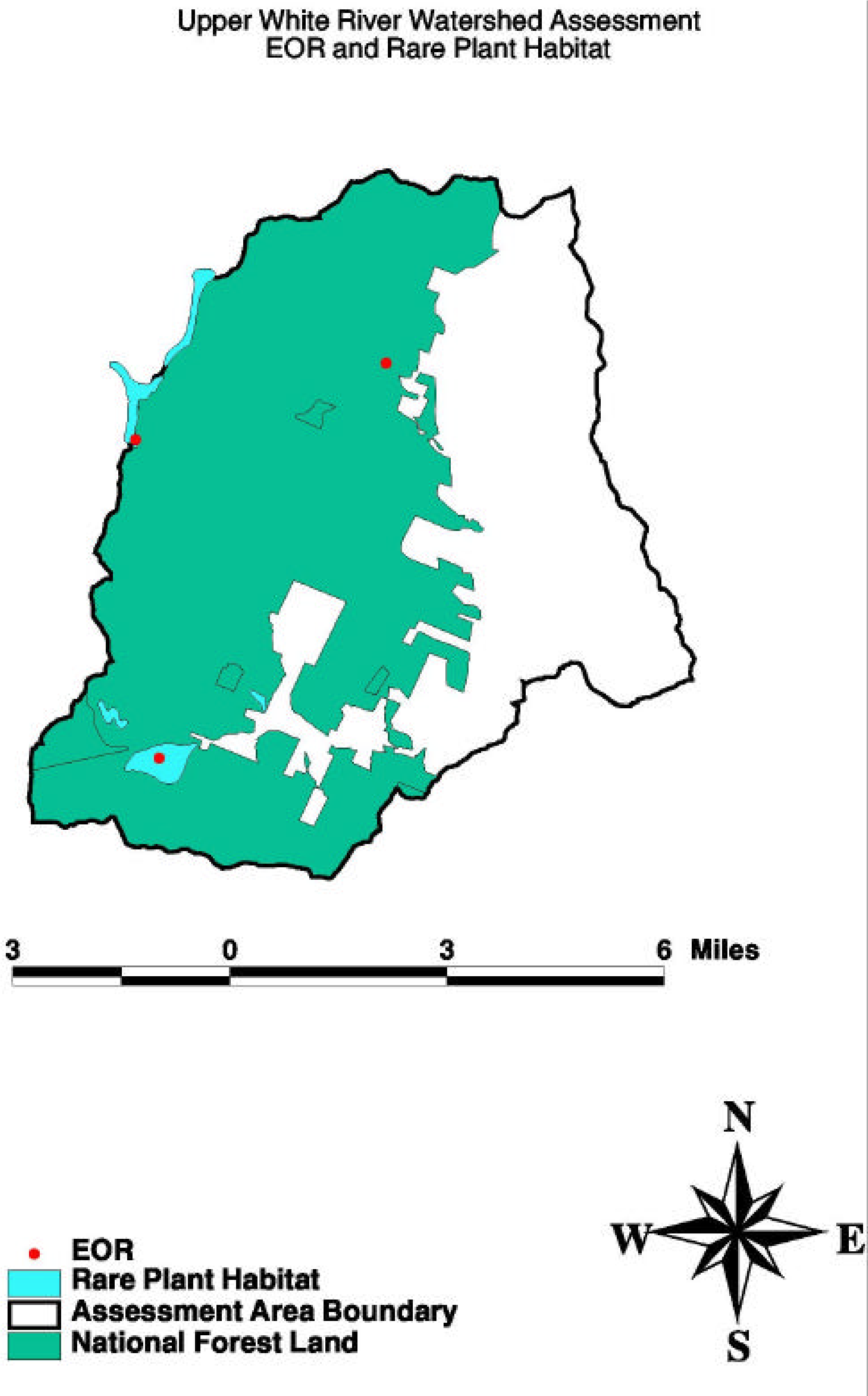
The Region 9 Sensitive species designation indicates that these species are at risk either in terms of viability on National Forest System lands or are trending toward Federal Listing. The FS is required to conduct biological evaluations of projects for these species to determine if the project puts them at further risk. These species receive priority for dedicated inventories and management to protect or enhance populations and habitats.

Only a small proportion of these lands in the watershed have been inventoried for rare species. However, of those species noted above, two (michaux's sedge and auricled twayblade) have very restricted habitat in the watershed and are unlikely to occur beyond their known or suspected locations. Another two species (butternut and the blue-eyed grass) could be much more widespread and have plenty of unsurveyed potential habitat. The pygmy shrew occurrence consists of one individual found during a small mammal trapping research project not designed specifically for locating this species. Its distribution and habitat within the watershed are uncertain at this time.

Additional rare plant and animal habitat exists in the watershed for other species. Two areas (Mt. Roosevelt to Mt. Wilson, and Breadloaf Mtn.) are identified as Bicknell's thrush habitat *(Catharus bicknellii),* although the thrush has not been found there. The R9 Sensitive list includes several odonates (dragonflies and damselflies). There have not been any surveys for these species in wetlands or riparian areas in the watershed. In addition, the local but frequent occurrence of enriched northern hardwood communities found in the area provide potential habitat for several additional rare plants, indicating that additional habitat probably exists in the area.

<u>Habitats</u>

VNNHP and the Forest Plan have also identified areas considered important for their biological or ecological significance, or for their significant value to humans. These areas are included in one or both of previously noted GIS coverages: the "han_rare" coverage as polygons and the "han_eor" coverage as points (see figure 8). These areas are: Texas Falls (significant for recreational and geologic qualities – Forest Plan), Hat Crown/Silent Cliffs (significant for relatively intact examples of acidic outcrop and cliff natural communities), and Monastery Mountain (north face – significant for including a patch of old growth northern hardwoods and hemlock within a younger late successional forest. Currently, only the Texas Falls area is protected through Management Area designation and standards and guidelines designed to protect its unique features. The remaining areas do not have any site-specific standard and guideline protection.


Upper White River Watershed Assessment
EOR and Rare Plant Habitat
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EOR
Rare Plant Habitat
Assessment Area Boundary
National Forest Land

STEP 2: IDENTIFICATION AND DESCRIPTION OF ISSUES

Issue Identification

The purpose of this step is to identify the most important issues that need to be addressed in this analysis. These issues focus on key elements of the ecosystem that are most relevant to the management questions, public values, and resource needs in the watershed. The most important issues will be the main focus of, and drive the remainder of this analysis.

To arrive at the most important issues, we considered the list of issues by the White River Partnership. This list of issues was compiled based on concerns raised by citizens at a public forum held in Bethel in late 1995. Although the public forum was several years ago, the Partnership felt the issues were still valid. The major issues they raised were: protection and preservation of water quality; water temperature increases and lack of stream shading; streambank erosion problems and stabilization needs; the decline of native fish stocks; public awareness of watershed problems and progress; public access to the river; removal of gravel to stabilize streambanks; and the creation of recreation and trail opportunities in the watershed. See Appendix B for more information about this public meeting.

Internal Forest Service issues in the analysis area were also listed (see Appendix C). Forest Service staff identified many of the same issues as the White River partnership, and added issues such as: sedimentation from gravel roads; the need for a transportation plan in the watershed; Texas Falls Recreation Area improvements; the effects of primitive campsites on water quality; the need for current vegetation inventory information; occurrence of noxious weeds; protection of rare plant and wildlife species and their habitats; loss of upland opening and early successional habitats; and identification of and protection of prehistoric archaeological sites.

The analysis team considered the pubic and Forest Service issues, and prioritized the issues to arrive at the seven most important issues, that will be the focus of the rest of the analysis. This is not to say that the issues not selected are not important; only that we will not to address all issues at this time.

Other issues will be addressed in later analyses. <u>Our seven most important issues are:</u>

1) Aquatic and riparian area degradation

2) Perpetuation of a working landscape

3) Need of better transportation plan

4) Recreation site development and maintenance

5) Protection of rare plants, wildlife, and habitats

6) Prehistoric site protection

7) Natural resource information sharing

Issue Descriptions (Including Key Indicators and Questions)

Next each issue is fully described. Then key indicators are listed which characterize the condition of ecosystem components pertinent to each issue followed by key questions for each issue. Answering these questions will be essential to addressing each issue. This information follows:

ISSUE 1) AQUATIC AND RIPARIAN AREA DEGRADATION

Issue Description

Aquatic and riparian areas have been degraded due to several factors: sediment and nutrient pollution; increases in stream temperatures due to lack of shading; loss of structural features such as stable stream banks, and large woody debris (LWD); lack of adequate riparian buffer strips; stream channelization; the effects of road construction and maintenance; and declining stream fisheries.

Based on public comment and data from natural resource agencies, sediment is determined an issue because of its impact on designated uses of the White River.
In fact, excessive sediment has been identified as the most significant cause of impairment of rivers and streams statewide (VTANR, 1997).   Sediment is of so much concern due to its potential effect on the biological and physical integrity of the river.

Stream bank instability, lack of riparian buffer strips, road development and maintenance also contribute to sediment production and therefore, potentially affect river biota and channel morphology. Additionally, channel morphological features dictate sediment transport and deposition. Removal of riparian vegetation, increased run-off from roads, and in-channel erosion from destabilizing banks and channelization can change channel morphology such as slope and channel width, resulting in increased in stream sedimentation.

An additional threat to the White River and its tributaries is the increase in nutrients.
The primary source of nutrients in the White River is believed to be from agricultural land runoff especially where there are no buffer strips. Water quality and beneficial public uses including recreational uses, can be adversely affected by excessive nutrient levels.

The White River watershed is an important watershed for anadromous Atlantic salmon restoration in the Connecticut River Basin. The watershed is also home to a native resident fish community and includes such species as brook trout, Slimy sculpin and Black nose dace.   In addition, the watershed supports naturalized populations of Rainbow and Brown trout. State and Federal fisheries biologists have observed declines in the trout fishery over the past decade or two in specific reaches of the White River and several tributaries.

Key Indicators

1) Percent of White River having a less than 50 ft wide buffer strip
2) Miles of river highly impacted by sediment
3) Miles of White River impacted by removal of riparian vegetation
4) Percent fine sediment in spawning habitat in White River
5) Amount of LWD per mile in White River and tributaries
6) Number of salmonids per mile in the mainstem of the White River
7) Percent of the watershed in roads, and the proximity of roads to streams.
8) Percent pool area in White River and tributaries.

Key Questions

1) What are the past and present sources of sediment production in the upper White River watershed?
2) What is the threshold level of fine sediment in fish spawning and rearing habitat?
3) What is the past, present and desired future condition for Atlantic salmon and trout habitat and populations?
4) What is the current and past effect of human uses on stream channel morphology and hydrology, and aquatic (in-stream) habitat?
5) What is the extent of riparian vegetation removal/alteration from past or current land uses (for example, logging/road building/agriculture/development)?

ISSUE 2) PERPETUATION OF A WORKING LANDSCAPE

Issue Description

Forest management and timber harvesting is not occurring at the same level as in past decades. There is concern that the wildlife habitat, esthetics, forest products, jobs and revenues created by managing for a mosaic of forest conditions with pasture lands, is threatened due to changes in public values, and economic conditions. Perpetuation of a working landscape including sustainable forest management is desired to help produce goods, revenues, jobs, wildlife habitat and an interesting landscape, accessable to the public.

Local economies are strongly dependent on the use of these lands for timber production and on the annual revenues generated by forestry and other receipts. The revenues are used to support local schools and road systems. In the past decade the amount of forest management and harvesting being accomplished on GMNF land has slowly been reduced. Maintaining a mosaic of managed forest, shrub-land and pastures, through land management and silvicultural practices in the Upper White River Valley is recognized as key to preserving and enhancing the economic and rural qualities of local communities.

This issue was clearly identified during the step where public issues were identified. It is also referenced in the Hancock and Granville Town Plans.

On October 20, 2000 Public Law-106-393, the Secure Rural Schools and Community Self Determination Act was signed into law by President Clinton. The new law provides towns containing National Forest System land within their borders, an increased and predictable level of funding for local schools and roads. It will replace the 25 percent Fund put into place in 1908 and breaks the link between Forest Service payments collected from the sale and use of a variety of national forest products and services. The new payment formula stabilizes payment levels by averaging a states three highest payments between 1986 and 1999. The new law has a Title II and Title III (which started out as Senate 1288-the Community Forest Restoration Act). We are awaiting further national guidance on what the specifics are for implementation of the law. The new law is available on the web at http://thomas.loc.gov or hard copies of it can be obtained from the Forest Headquarters in Rutland VT.
Traditional land management opportunities such as grazing, timber harvesting and sale of forest products exist within the watershed. Implementation of land management projects coupled with payments from the new act would help sustain local communities. This would be accomplished by providing jobs, taxes and revenues back to the federal and state governments while perpetuating the working landscape.

Key Indicators

1) # of acres and percentage of the watershed in each Forest Type
2) # of acres and percentage of the watershed in various age classes
3) # of open areas (like former pastures) and acreage in open lands
4) # of acres of land suitable for timber management and acres with prescriptions for timber harvest
5) # of acres of land under permit or number of special use permits for forest products
6) Amount of timber harvested annually
7) # of acres of cultural treatments that are completed annually, such as thinning of young saplings, reducing shade over planted or natural seedlings and pruning of fruit trees
8) The amount of PILT and 25% Funds returned to towns with acreage in the National Forest

Key Questions

1) What is the array and landscape pattern of forested and non-forested plant communities in this watershed?
2) How does the current condition of forested vegetation compare with the historic range of variability?
3) What processes caused these patterns? (Windstorms, flood, insects, disease, land clearing, agriculture, timber harvesting, etc.)
4) How does the current condition affect future land management objectives or ecosystem function?

5) How will implementation of prescribed fire or timber management programs affect vegetation in this watershed?
6) How does current species composition and age class distribution compare to the desired future condition listed in the Forest Plan?
7) What are the histories and impacts of wind, flood, insect & disease, land use and timber harvesting events in the watershed?
8) How many acres of non-forested land (upland openings) need maintenance?
9) How many acres of suitable forestland have opportunities for harvest?
10) How many acres of non-native tree plantations occur in the watershed?
11) What is the difference between historic and current vegetation conditions?
12) Does the watershed have resource protection or enhancement needs that could be met by timber sale?
13) Will a portion of all GMNF timber sale receipts go to the 25% fund given to local NF communities?

ISSUE 3) TRANSPORTATION SYSTEM PLANS NEED UPDATING

Issue Description
There is no up to date transportation plan for the watershed. Without a plan we cannot make rational judgments about whether to implement proposed road closures or recreational trail developments. Recreational visits to national forests are increasing. While the biggest increase in use is from people seeking non developed sites to recreate (like a primitive campsite) more visitors to this Forest are enjoying snowmobile, hiking, and cross country skiing opportunities. Traditionally, our budget has been inadequate to maintain existing trails (all types) to FS standards. This increase in trail-based recreation comes at a time when we are receiving direction from congress to close roads that are not needed, or which are causing aquatic resource degradation. Since some roads and trails are causing erosion and sedimentation in the watershed, a plan addressing current and future needs is desired.

Key Indicators

1) Miles of trail/1,000 acres
2) Miles of road/1,000 acres
3) # Miles of road closed or decommissioned after 6/2000
4) # Miles stream improved due to road closure or decommissioning
5) # Miles trail constructed or reconstructed after 6/2000

Key Questions

1**)** Is the Upper White River WA too small a watershed for a comprehensive transportation analysis**?** Shouldn't this be done at the Forest Plan Revision level?
2) What is the optimum transportation network?
3) What roads should be closed or decommissioned?
4) Are more trails needed? If yes, where?
5) Are miles of existing roads and trails within Forest Plan management area guidelines?

6) Have we evaluated the cumulative effects of trails added to the system over the last decade? How will we do this for proposed new trails?

ISSUE 4) RECREATION SITE DEVELOPMENT AND MAINTENANACE

Issue Description

Important recreation maintenance and developments need to be completed in the watershed. Developed recreation sites are important to how the area is used and enjoyed. Sites occurring along the river and in uplands sites within the watershed are valued. Texas Falls Recreation Area is the largest and most popular of the White River Travelway Sites. Other sites include Hancock Overlook, CCC's Camp, Riverbend, and Peavine. Texas Falls Recreation Area was developed in the 1960's. The main attraction is the falls area, which consists of a short series of low falls and cascades flowing out through a small gorge along the Hancock Branch of the White River. As described in the Forest Plan, this 10 acre Special Area is listed on the State's register of Fragile Areas to protect its unique geologic and scenic features. Directly adjacent to the Special Area and also along the Hancock Branch is a picnic area. Rehabilitation on portions of the picnic area was done in the 1990's. Upgrades included construction of a picnic shelter, outhouse replacements, and gravel walkways. All of the facility upgrades met standards for accessibility. There remains more work to be done at Texas Falls and at other developed sites in the watershed.

Key Indicators

1) # of developed sites maintained and meeting all ADA standards
2) # of trails fully maintained and up to standards
3) # of trails relocated or closed per water protection needs
4) # of sites revegetated

Key Questions

1) Which developed facilities at the Texas Falls Recreation Area or other travelway areas do not meet accessibility standards for people with disabilities? What can be done to improve access?
2) What, if any improvements are needed to meet the demands of snowmobilers?
3) Are trees dying off at Texas Falls Recreation Area due to pedestrian trampling and soil compacting? If so, specify where this is occurring, if the vegetation is desired, and the appropriate solution.
4) How much change to the existing developments can occur to improve access to meet accessibility standards, improve snowmobile opportunities, and improve vegetation, without changing the character of the setting and therefore the publics experience at the site?
5) What type of development does the public want at Texas Falls Recreation Area?

ISSUE 5) PROTECTION OF RARE PANTS, WILDLIFE AND HABITAT

Issue Description

The potential exists for rare plants, wildlife, and habitat to occur in the analysis area. Some rare plants and habitats have been verified as existing in the watershed. These components of the ecosystem need to be protected.

Forest Service management has an obligation to ensure the long-term viability of all native species. This means that for species and natural communities that are rare, threatened, or endangered, a four-part strategy should be employed. This strategy should include monitoring of known occurrences, thorough review of ongoing management activities, inventory for potential habitat and occurrences, and active management or restoration.

<u>Forested Communities:</u> Some enriched northern hardwood stands and other areas near former homesteads in the watershed provide potential and known habitat for rare plants including Butternut, (*Juglans cinerea)*. The wet spruce/fir forests, and montane spruce-fir forests provide potential habitat for a variety of species, shown on the current Regional foresters Sensitive species list.

<u>Non-forested Communities:</u> Non-forested natural communities provide potential and known habitat for rare plants. Skylight Pond is a high elevation pond located near the Long Trail in the Breadloaf Wilderness. This pond, along with spring runs and seeps, beaver meadows and other open wetlands, provide habitat for Michaux's sedge, (*Carex michauxiana)*.

Open rocks, ledges and cliffs throughout the watershed such as Hat Crown, which is in the Wilderness; provide habitat for *Clematis occidentalis var. occidentalis* [Purple clematis], and *Cryptogramma stelleri* [Steller's cliffbrake]). Damp upland meadows such as those in the Texas Falls area provide habitat for *Sisyrinchium atlanticum* [Eastern blue-eyed grass]). The Breadloaf Wilderness Management Plan needs to include a section with provisions for monitoring and managing protection for the effected habitats.

<u>Rare Natural Communities:</u>

Significant Natural Communities that are rare include an intact, high quality acidic outcrop natural community (Hat Crown/Silent Cliff), and a small old growth patch of northern hardwood (Monastery Mountain), both of which are rare to non-existent elsewhere in the watershed. Hat Crown is in Breadloaf Wilderness and is protected from any form of vegetation management but not from hikers and rock climbers. The patch of old growth northern hardwood is not totally protected due to some of it being in an area suitable for forest management.

Key Indicators

1) # of identified TES occurrences, sites, and trends
2) # of acres identified as rich northern hardwoods, and wet and montane spruce-fir
3) # of acres of rich northern hardwoods where calcareous substrate is known
4) # of acres identified as the various non-forested natural communities

5) Changes in floristic species composition and importance, patterns of tree survivorship, and stream water chemistry (Ca, org. C) over time in permanent plots within a range of rich woods sites under a range of management regimes
6) Changes in floristic species composition and importance, patterns of tree survivorship, and stream water chemistry (Ca, org. C) over time in permanent plots within a range of wet and montane spruce-fir woods sites under a range of management regimes
7) # of acres of rare plant habitats and rare natural communities in the suitable timber base within the watershed
8) # of acres (and change in ac over time) of rare species habitat and rare natural communities in a formal protected status (e.g. special management area designation; site specific standards and guidelines in the Forest Plan)

Key Questions

1) Where are the rare plant and rare community occurrences in the WS, and how are they surviving over time?
2) Where are the rare plant and rare community occurrences in the WS, and how are they surviving over time?
3) Where is the rare plant habitat in the WS, and how is it distributed?
4) What proportion of each rare plant habitat type is occupied by rare plants?
5) Does regular forest management change floristic and survivorship patterns for plant species over time in forested rare plant habitats?
6) Does regular forest management change the underlying nutrient status and potential resilience of forested rare plant habitat over time?
7) What levels of protection are required for known rare plant and community occurrences?

ISSUE 6) PREHISTORIC SITE PROTECTION

Issue Description

We need to identify, evaluate and protect significant prehistoric archaeological sites, and Native American sacred and traditional use sites.

(a) Archaeological site identification and protection: historic preservation law [notably the National Historic Preservation Act, Archaeological Resources Protection Act] mandates inventory, evaluation and protection of significant heritage resource sites on federally owned lands. Based on site distributions elsewhere on the Forest and in Vermont, there are places with high potential for containing prehistoric sites in the study area. Easy public access & mixed ownership, implementation of public & private projects/undertakings, and incremental effect of natural processes (erosion, tree throws) all create potentially threatening conditions for prehistoric archaeological sites by increasing the chances for physically altering their condition (e.g., via vandalism or erosion).

(b) Native American Indian societies value some sites/locations for their sacred, spiritual and/or traditional use qualities (these are also "protected" sites per historic preservation statutes and/or the American Indian Religious Freedom Act, Native American Graves

Protection and Repatriation Act, and other federal legislation). In much the same way as (a), above, various pressures and processes within the watershed may alter the "sense of place" important to sites' spiritual context (e.g., perhaps "inappropriate harvesting methods" near sacred sites, altering viewsheds, or construction of new travelways).

(c) Evaluations and ecosystem management: our understanding of past ecosystem conditions can be enhanced through the evaluation and intensive investigation of archaeological sites. Contextual information about past land-uses and environments is potentially contained in site "features" (such as hearths or storage pits); this information takes the form of animal & fish remains, pollen, nuts, seeds and other carbonized organics; inferred landscapes from tool assemblages, site sizes, and the like. It would be instructive, for example, if we could recover salmon bones from sites prior to the Little Ice Age (i.e., about 800 AD) when conditions were similar to today. As we strive for an ecologically healthy watershed, this potentially useful information is being missed if we do not locate and evaluate relevant sites.

Key indicators:

(a) Archaeological site identification & protection
1: # acres surveyed for prehistoric potential (Phase I)
2: # acres tested to locate sites (Phase II)
3: # project/survey reports completed
4: # known/recorded sites
5: # known artifact collections in/from area
6: # sites reported damaged (per annum)
7: # sites monitored (per annum)

(b) "Traditional use" site identification & protection
1: # identified sacred/traditional use sites
2: # traditional use sites with management plan
3: # sites monitored (per annum)

(c) Evaluations & ecosystem context
1: # sites evaluated
2: # sites Determined Eligible to the NRHP
3: # sites intensively investigated (Phase III)

Key questions

(a) Archaeological site identification & protection
1: Where are prehistoric sites likely to occur in the watershed?
2: How does the distribution of different kinds of sites (i.e., sites containing different kinds of information) vary?
3: What physical condition are (known) sites in? [Monitoring question…]
4: How do site locations correspond with anticipated patterns of disturbance

(e.g., from projects, developmental pressure or natural processes)?

(b) "Traditional use" site identification & protection
1: What are the characteristics of sites with significance to contemporary Native Americans?
2: Where are these kinds of sites likely located within the watershed?

(c) Evaluations & ecosystem Context
1: What kinds of features will make the greatest contribution to our knowledge about the nature/condition of past ecosystems, and associated land-use histories?
2: What types of sites would be likely to contain these types of features?
3: In what locations/settings would these types of sites have the greatest likelihood of preserved features?

ISSUE 7) NATURAL RESOURCE INFORMATION SHARING

Issue Description

Information about natural resources in the watershed needs to be brought to schools and adults in the community. The upper White River watershed includes 3 town governments, numerous agencies and organizations, various civic clubs, 3 school systems, historical societies, etc. We all share this piece of the earth called the upper White River watershed. The river itself is often considered the barometer of our social, economic and environmental health. Taking actions that reflect an understanding of the inter-connectedness of social, economic and environmental elements will require new knowledge and leadership on the part of decision-makers.

The watershed has fantastic human, cultural and natural resources, but faces many challenges to achieve sustainable communities and natural resource use. We also believe that both the people and the land are "customers" of the upper White River Assessment project. The people have in the past and will continue into the future to receive services and products such as technical support, improved habitats and educational opportunities. The Land has served as a working landscape and will continue to receive consideration and treatments that will allow it to maintain or restore natural processes and functions that are critical to its integrity. We trust that citizens, communities and other key entities within the watershed will continue the grass roots flow of information and the desire to communicate ideas and feelings locally in a manner that will sustain communities, and leave future generations as the stewards of this watershed.

The concept of watershed restoration is not foreign to many citizens in the upper White River watershed. Over the past 5 years or so, the White River Partnership, (WRP, a locally led and community driven collaborative) has used several methods to engage citizens and communities in watershed education and stewardship. Although many citizens have been reached by WRP efforts to date, a heightened awareness of watershed issues, problems and opportunities must reach a greater number of people living and/or utilizing natural resources in the watershed so as many people can work collaboratively to enhance their economic, cultural and environmental assets. This can only be accomplished by reaching out to the public in as many ways possible. We also hope the public will view this project as a unique opportunity to improve their communities by working toward a common goal – improving the upper White River watershed.

Indicators for the Education and Outreach Issue

Key Indicators

Indicators that are likely to reveal the state of watershed education and outreach are:

1. number of schools with watershed curriculum
2. number of students completing a watershed curriculum/course
3. number of adult volunteers for watershed projects
4. number of towns providing funding, equipment, labor or materials for watershed projects
5. number of businesses involved in the White River Partnership's Community Collaborative
6. number of communication tools (e.g. Public meetings, news releases)
7. percent of watershed restoration project funding coming from partners

Key Questions for the Education and Outreach Issue

1. How many schools currently have a watershed curriculum or expose students to watershed issues and opportunities.
2. What programs, projects or educational activities currently exist to engage citizens and communities in watershed?
   projects and/or educational activities., projects
3. How are the media and private corporations involved in watershed related events and activities?
4. What opportunities exist to expand partnerships and financial resources.

STEP 3: CURRENT CONDITIONS

The purpose of this step is to present detailed information about ecosystem elements and conditions relevant to the issues.

Issue #1: Aquatic and riparian area degradation

<u>Core Question: Erosion Processes</u>
What are the past and current conditions and trends of the dominant erosion processes prevalent in the upper White River watershed? (Addresses Key Questions 1, 4 and 5)

The major erosion processes in the watershed are sheet and gully erosion, and stream bank sloughing. Periodic flooding events also contribute significant amounts of sediment naturally to the river. In addition, flooding in developed floodplains within the watershed can exacerbate streambank erosion and sedimentation of aquatic habitat. This occurred most recently in 1998 when erosion along roads was significant in the upper White River watershed. The major sources and impacts of erosion in the watershed are discussed below:

a) Erosion from roads

Highways and secondary roads (including many gravels roads) are an important source of sediment. This land use covers approximately 18,000 acres (4%) of the entire watershed. Although this seems like a relatively small percentage of the total watershed area, many roads parallel the mainstem and its larger tributaries. For example, the mainstem White River has a road along its entire length and for much of its length, has a road on both sides (VTANR 1997). Roads cross the mainstem 22 times alone and the input of sand and fine silt can be observed reaching the river at many locations.

Erosion off the land and within the stream channel is a natural process. However, increased or improper land uses can exacerbate erosion processes and cause harm to aquatic ecosystems. Based on surveys completed in 1999, roads on the Forest that contribute sediment to streams over the long term are FR 55, Texas Brook Road, and State Route 125. Each of these roads is estimated to be within 200 feet of a stream for one to two miles. State route 100 and the Howe, Thatcher, Clark, and Kendall Brook roads also contribute sediment to streams on private lands in the watershed, each being within 200 feet of a stream for approximately one mile.

Road use and maintenance are the primary sources of sediment. The current and historic delivery of sediment from these roads has not been quantified, nor do we fully understand the extent and severity of water quality and aquatic habitat degradation. However, our Fish biologists are monitoring bed load sediment in the White River to provide some insight into these questions. In addition, the State of VT Water Quality Division conducted water monitoring in Howe Brook in 1999 and found relatively high levels of sedimentation.

b) Stream bank erosion

Stream bank erosion/destabilization has been identified as a primary source of sediment to the watershed and significant contributor to degradation of aquatic and riparian habitats. A 1997 White River Assessment Report from the VTANR identified 31 miles of highly and moderately impacted aquatic habitat, with another 97 miles as threatened. The WRP stream bank erosion survey in 1998 identified 1.3 miles of eroded stream banks along the upper mainstem White River alone. Removal of stream bank vegetation frequently results in bank destabilization and is a major source of sediment to the river today. For example, land cleared right up to the stream bank or waters edge leads to increase erosion and accelerated bank failure and loss of productive land.

Stream bank erosion inventories have been completed for much of the upper White River and its NF tributaries. This data was collected via stream habitat surveys conducted by USFS fisheries personnel in the late 1980's and early 1990's. In addition, members of the

White River Partnership completed a streambank erosion survey in the late 1990's. Bank erosion sites were documented by GPS and maps were developed from both surveys.

A large portion of current bank instability and stream sedimentation can be attributed to the removal of riparian vegetation from such land uses as roads, intensively use recreation sites, forest management and agricultural production. In-channel alterations, particularly channelization following flood events and past commercial gravel extractions have also contributed to the problem. The following information from a 1975 Vermont Department of Fish and Wildlife report illustrates this point. Channelization of the upper White River following the June 1973 floods was found to increase the rivers width by an average of 3 %, and made it about 22% shallower than non-channelized sections. Although no quantitative data on sedimentation was collected, it is believe that this major river disturbance contributed large quantities of sediment to the river. Also, the resulting changes in channel width and depth still exist today in many section of the river.

Other minor sources of erosion are timber sales, recreation use, building/ home construction, and natural erosion. Based on Watershed Improvement Needs Inventories on NF Land and casual observations on private lands, these sources result in short term, localized, small amounts of erosion.

Periodic flooding events contribute significant amounts of sediment naturally to the river. Also, flooding in developed parts of the watershed can exacerbate streambank erosion and sedimentation of aquatic habitat. This occurred most recently in 1998 when erosion along roads was significant in the upper White River watershed.

Core Question: Hydrology

What are the current conditions and trends of hydrologic characteristics (including stream channel types, sediment transport and deposition processes) prevalent in the upper White River watershed? (Addresses Key Questions 4 and 5)

Within the White River watershed, USFS and VTDEC personnel conducted 52 miles of channel typing surveys during the summer of 1999 using the Rosgen Classification system (Rosgen 1996). This classification system assists in determining river stability, channel form, patterns and functions including sediment transport. Data from these surveys can provide a better understanding of the physical processes within a reach of river or throughout the watershed. For example, identifying whether a stream is aggrading, degrading or stable relative to sediment transport is critical in terms of protecting valuable habitat or prescribing measure to encourage river stability and enhance aquatic habitat.

Several channel types are found in the upper White River watershed. A brief description is as follows:

"A" channels are typically headwater streams having narrow, steep gradient channels containing predominately larger boulders. It transports small and large substrate sediment downstream and is a source of cold water, woody debris and occasionally to lower part of the drainage and watershed.

"B' channels are step pool streams having narrow and moderate gradient channels. The substrate generally contains small to medium sized boulders with some gravel and fine sediment. It also transports fine sediment and gravel and some cobble and boulders as well. These streams provide high water quality and important aquatic habitat for fish and macroinvertebrates.
"C" channels are pool: riffle streams having moderate to wide valleys with lower gradients. The substrate consists of a mixture of gravel, cobble, and small boulders. Most sediment is transported over a fairly narrow range of flows, generally at or near bankfull stage. These streams provide important high water quality and spawning and rearing habitat for fish and other aquatic biota.
"F" channels are typically degraded "C" channels that have become over widened and shallow with highly unstable banks. These channels provide poor habitat due to sedimentation and are wide and shallow. They can be major contributors of sediment from eroding banks.

Observing "F" channels in a watershed suggest that hydrologic changes and major channel adjustments have occurred within the watershed. Although it is difficult to completely explain cause and effects in large dynamic rivers such as the White River, common literature on watershed hydrology offers some possible explanations. Simply stated, river with long histories of multiple land use changes such as logging, agriculture and urbanization and road developments experience changes in the rainfall-runoff regime in such a way that large floods occur more frequently and the river's hydrologic regime becomes more "flashy". This flashy nature is typical in the White River watershed today. High water events occur more frequently in the smaller tributaries but are observed regularly in the mainstem. These hydrologic changes can cause significant geomorphic adjustments (e.g. "C" channels converting to "F" channels), as channels get larger, wider and disconnected from its floodplain. The river's ability to transport sediment downstream efficiently becomes diminished due to increased erosion from land use sources and accelerated bank erosion. As a result of these changes, smaller magnitude precipitation events now generate levels of geomorphic impact that had been previously associated with more extreme precipitation events. Also, high intensity summer thunderstorms and mid-winter rain and melting snow events contribute to current hydrologic conditions as do damaging winter and spring ice floes.

<u>Core Questions: Fisheries:</u>
What is the threshold of fine sediment in fish spawning and rearing habitat? What is the past, present and DFC for Atlantic salmon and trout and populations?

Wild trout populations have been declining in the Upper White River over the past twenty-five years or so. In 1972, the Rainbow trout population was estimated at 2844 per mile and totaled 21.4 lbs. Per acre based on data from a monitoring station located in the upper White River. In 1995, that same reach of the river had a Rainbow trout population estimated at 92 per mile and 0.6 lbs per acre. In addition, Atlantic salmon parr stocked as fry in the upper river have declined significantly in abundance from levels surveyed during the 1970's.

There are many factors that can cause a decline in a particular fishery. Some of these include habitat degradation, disease, predation, loss of food sources, and degradation of water quality, just to name a few. Over the past decade or so, fisheries agencies working in the watershed have examined water quality, macroinvertebrates, and fish population data but have not found any conclusive cause for the decline in wild trout numbers.

In the late 1980's the USFS in cooperation with the USFWS and VTFW conducted stream habitat inventories in the White River and its tributaries. These data indicate that the amount of pool habitat and quantities of LWD were limited in the watershed. Large woody debris abundance appears to be less than the natural or historic condition. This assessment is based on several factors; observations of increasing abundance of LWD in first and second order streams where maturing riparian forests are once again providing LWD to streams; indication that LWD placements via habitat restoration projects are improving and diversifying stream habitat and mimicking the natural woody debris ecological process; and evidence from an Undisturbed drainage in the WMNF that natural woody debris quantities are much higher than current conditions in managed drainages. Natural amounts of woody debris in Wonalanet Brook (WMNF) average approximately 250 pieces of LWD per mile in "A" channel types. There are about sixty percent fewer pieces of LWD in similar stream channels in managed forest in the GMNF than this apparent natural condition indicates.

The number of pools per mile also appears to be generally less than natural or undisturbed conditions. Currently, under summer low flow conditions, most surveyed GMNF streams (approximately 200 miles) rarely exceed 10% total pool area. Common literature in watershed hydrology indicates this figure should be higher. Also, the frequency of pools appears to be below natural levels. In most of our step:pool streams ("B" channels), pool frequency is only about 50 percent of the natural condition average. This is based on a pool frequency of about one pool per the total of five channel widths (e.g. A 20ft wide channel would have a pool every 100 feet on average).

Spawning and early rearing habitat conditions in the upper White River appear to be degraded by excessive substrate fine sediments. Studies of trout spawning success have indicated that survival is highly correlated to the percent of fine sediment in spawning gravel substrate. As the proportion of fine sediments reaches 30%, trout fry emergence is reduced by 40% (Everest and Harr 1982). Embryo survival also declined rapidly as the percentage of fine sediments increases.

Habitat surveys in the Upper White River indicate the percent of fine sediment in spawning habitat ranges from 21-53 %, with a mean of 33 %. Moreover, twenty-one (70%) of the thirty samples collected in the river in 1995 had fine sediment levels exceeding 30%. These relatively high levels of fine sediment coupled with low concentration of fish in this river section suggest sedimentation could be impacting habitat quality and fish recruitment. Fine sediment data are not available for tributaries in the upper White River watershed.

Water temperatures in excess of 70^{o} F can limit trout production and distribution. Juvenile Atlantic salmon have been observed to tolerate slightly higher water temperatures.

Thermal modifications or increased water temperature is believed to be a significant threat to aquatic biota and habitat in the watershed. Water temperature data from the White River above the confluence with Hancock Branch indicate maximum daily temperatures occasionally exceed 70^{o} degrees F during the months of June-August. Downstream from this point, water temperature exceeding 70^{o} degrees F become a more regular occurrence during the summer season. The primary reasons for increases in water temperatures are; loss of riparian vegetation which shades the river, storm water runoff from roads, especially paved areas, and river channelization that has resulted in wider and shallower waters with fewer pools.

Core Question: Vegetation
What are the current conditions and trends of the prevalent plant communities and seral stages in the watershed (riparian and nonriparian)? (Addresses Key Question 5)

Riparian Communities

Riparian areas (streamside forest) include the trees and other plants that live and grow near water on the banks of streams, rivers, ponds and lakes. Hardwood tree species and hemlock are common riparian species in the upland stream of the upper White River watershed. Along the mainstem river and valley bottom tributaries, sedges, willow, alder, pine, and hemlock are common.

During the 19^{th} century, the accepted practice was to construct new roads alongside the river or its tributaries. Road lengths within the riparian area are substantial as described in a previous section of this document. Agriculture, urbanization and development, and to a lesser extent logging, have also resulted in the removal of substantial amounts of riparian vegetation along the White River.

Data from a 1997 VTDEC report on buffer strips along the 53 mile mainstem White River riparian corridor indicates that approximately 51 % of the rivers' streambanks have buffer strips less than fifty feet wide. In the upper White River watershed assessment area, approximately 49 % of the streambanks have buffer strips less than fifty feet wide. These figures show that the loss of riparian vegetation is substantial.

The loss of riparian area and more specifically, the effect of land use and development activities in riparian buffer strips in the White River watershed appear to be reflected in the recent habitat surveys. These surveys show elevated sediment in spawning habitat, increased water temperatures, reduced amounts of LWD and a diminished potential for future recruitment of trees and logs to the stream for habitat diversity and complexity, as well as decreased pool habitat area.

Core question: What are the current conditions and trends of beneficial uses and associated water quality parameters?

The beneficial water uses and associated water quality for the basin are described in the White River Basin Assessment Report (ANR-DEC-Water Quality Division, 1997), page 9. The beneficial uses are aquatic biota/habitat, fish consumption, swimming, secondary recreation, drinking water, and agricultural water supply. The threats to water quality in the basin are listed and quantified on page 7 of the Report. Siltation, thermal modification, nutrients, turbidity, and pathogens are the most widespread threats to water quality, and to a lesser extent toxics, exotic species, metals, pH, organics, and inorganics. The cumulative result of these threats is the water quality needed to fully support the designated uses are not achieved 5-35% of the time (the percentage varies by designated use). The extent to which the water quality data for the basin represents water quality conditions in the Upper White River WA area has not been ascertained. However, personnel at the Water Quality Division suspect the extent and severity of water quality problems are lesser in magnitude in the WA area than the basin, because it encompasses the headwaters of the watershed, and the overall amount of land disturbance is less.

Issue #2: Perpetuation of a working landscape

Forest Resources

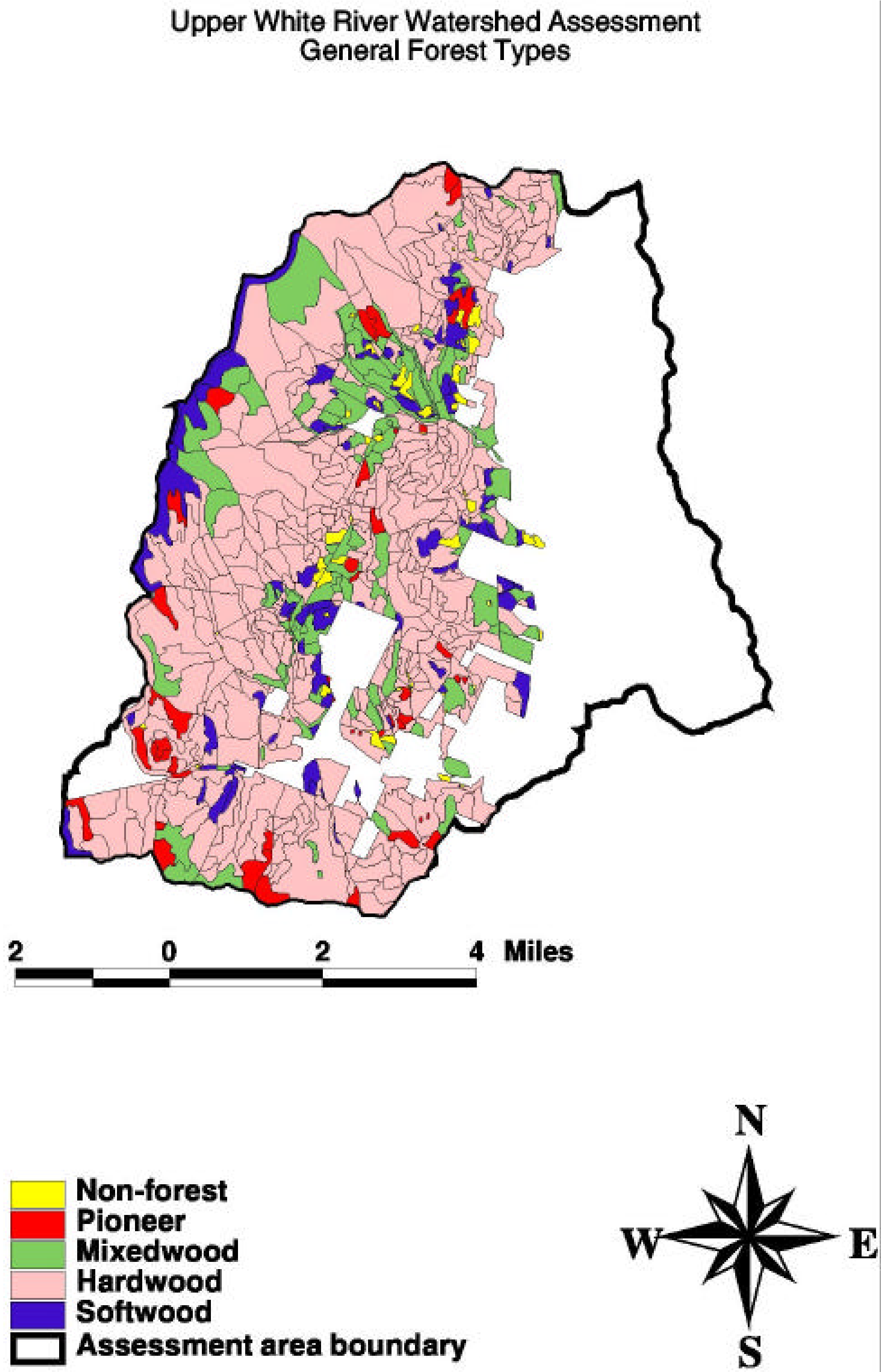
Core Questions

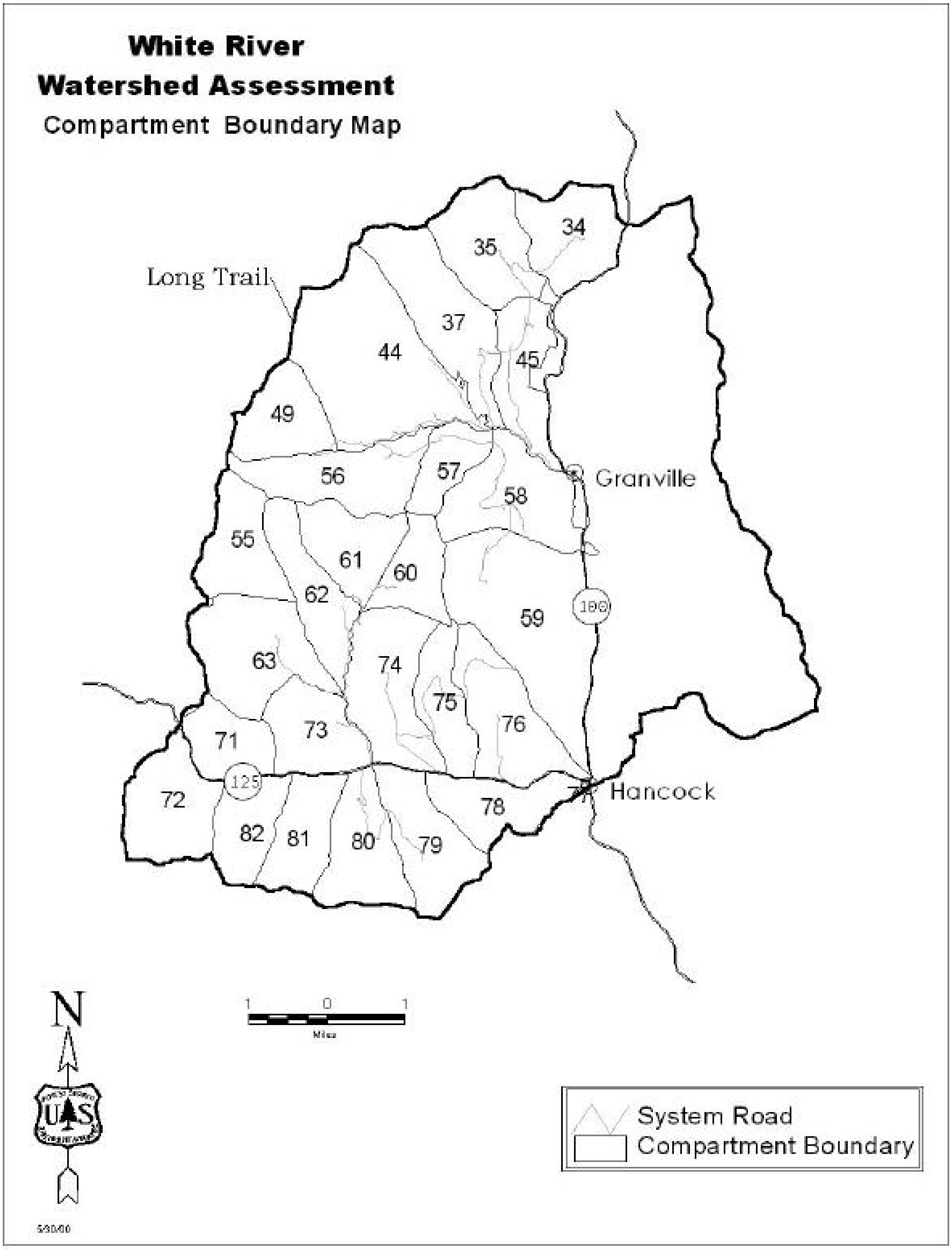
1) What is the array and landscape pattern of forested and non-forested plant communities in this watershed?
2) How does the current condition of forested vegetation compare with the historic range of variability?
3) What processes caused these patterns? (windstorms, flood, insects, disease, land clearing, agriculture, timber harvesting, etc.)
5) How does the current condition affect future land management objectives or ecosystem function?
6) How will implementation of prescribed fire or timber management programs affect vegetation in this watershed?
7) What is the comparison of current species composition and age class distribution with the desired future condition listed in the Forest Plan?
8) What are the histories and impacts of wind, flood, insect & disease, land use and timber harvesting events in the watershed?
9) How many acres of non-forested land (upland openings) need maintenance?
10) How many acres of suitable forestland have opportunities for harvest?
11) How many acres of non-native tree plantations occur in the watershed?
12) What is the difference between historic and current vegetation conditions?
13) Does the watershed have resource protection or enhancement needs that could be met by timber sale?
14) Will a portion of all GMNF timber sale receipts go to the 25% fund given to local NF communities?

Forest Types

Many species of trees are present on the GMNF including but not limited to American beech, sugar maple, red maple, yellow birch, white ash, and black cherry, red spruce, balsam fir, white pine, red pine, and hemlock, paper birch and aspen, red and white oak. Also present are permanent openings (old fields, pastures, lakes, ponds, and marshes).

Approximately 95 percent of the GMNF is forested habitat that is classified into five broad categories (see Figure 9): northern hardwoods (83% of the GMNF), softwoods (8%), aspen and paper birch (5%), openings (3%), and oak (1%). Forest age classes for individual stands of trees on the GMNF range from 0 years (new) to stands older than 120 years (Table 3). The forest is broken into compartments. Compartment boundaries follow drainages, ridgetops, roads and streams. There are 26 compartments within the analysis area, (see Figure 10). Within the compartments are stands, which are groups of trees of similar species and age growing on similar soils.


Upper White River Watershed Assessment
General Forest Types
2
0
2
4 Miles
Non-forest
Pioneer
Mixedwood
Hardwood
Softwood
Assessment area boundary
N
W
E
S


White River
Watershed Assessment
Compartment Boundary Map
Long Trail
34
35
37
44
45
49
56
57
58
Granville
55
61
60
62
59
100
63
74
75
76
71
73
72
125
Hancock
78
82
81
80
79
N
1 0 1
Miles
System Road
Compartment Boundary
5/30/00

Conditions in the watershed are very similar to the remainder of the National Forest in that the watershed is 99% forested. Northern hardwoods make up 82% of the trees, softwoods comprise 13%, aspen-birch 4% while wetlands and openings equal 1% (see tables 2,and 3). In some cases species composition is not within the desired ranges set in the Forest Plan. Young age classes that provide critical wildlife habitat for a range of species in the three main forest types are also lacking. Mature and overmature age classes occupy more than is desired for sustaining a range of optimum habitat conditions.

Timber harvesting can be used to convert greater amounts of northern hardwoods into lesser amounts of aspen-birch. Evenage systems such as shelterwood, delayed shelterwood and clearcutting work best at establishing new young stands of aspen-birch.
Evenage and uneven age systems can be used to convert mixed hardwood and softwood stands to softwood and to create new young stands of softwood. Selection cutting works well for regenerating species that are tolerant of shade.

Table 2. - Forest Types and Age Classes in the Green Mountain National Forest, VT, 1999.

Forest Type	Acres	%
Northern hardwoods	310,835	83
Softwoods	29,960	8
Aspen & paper birch	18,725	5
Openings	11,235	3
Oak	3,745	1

Age Class (years)	Acres	%
0-19	18,725	5
10-59	18,725	5
60-99	26,215	7
100+	71,155	19
80-99	101,115	27
100+	93,625	25
Unevenage	44,940	12

Table 3. Comparison of Forest Types in the Upper White River Watershed to Desired Ranges shown in GMNF Forest Plan, GMNF lands only, 2000.

Forest Type	Acres	Existing %	Desired % in Forest Plan
Northern hardwoods	18,613	82	61-78
Softwoods	2967	13	12-20
Aspen & paper birch	854	4	5-10
Openings	368	1	3-5
Oak	0	0	

Table 4. Current Age Class Distribution

Softwood Age Class (years)	Acres	Existing %	Desired % in Forest Plan' MA 4.1, 4.2
Regenerating 0-9	45	1	8
Young 10-39	230	8	24
Mature 40-99	1743	59	48
Overmature 100+	368	1	20
Unevenage	319	11	0

N. Hardwood Age Class (years)	Acres	%	Desired % in Forest Plan, MA 3.1,4.1
Regenerating 0-9	654	3	10
Young 10-59	3691	20	50
Mature 60-119	10636	57	40
Overmature 120+	2431	13	0
Unevenage	1201	7	0

Aspen-Birch Age Class (years)	Acres	%	Desired % in Forest Plan, MA 3.1,4.1
Regenerating 0-9	22	3	16
Young 10-39	84	9	48
Mature 40-59	306	36	31
Overmature 60+	425	50	5

Insect & Disease Impacts
Before the 1930's, native insects and disease outbreaks had a minor effect on the forest. Northern hardwoods in the forest were affected over time by native insects such as the Bruce Spanworm, Fall Canker Worm, Forest Tent Caterpillar, Maple Leaf Cutter and Saddled Prominent. However, native insect attacks were usually short duration with minimal mortality.

The spruce bark beetle outbreaks that Abbiati referred to in 1934 probably followed a weakening of the spruce caused by the conifer swift moth, a native insect. The conifer swift larvae cause damage to the roots of spruce and fir. The bark beetles described by Abbiati could have been drawn to the weakened trees causing a secondary attack.

In the 1930's the Balsam Woolly Aphid, a European insect, first appeared in Vermont and its presence became a problem for softwood species on the Green Mountain NF in the 1950's. Within the White River watershed the aphid killed many balsam fir and reduced the amount of fir found in the watershed, especially during the period of 1955-1980.

The Beech scale, also a European insect, first appeared in 1949 in Vermont. The killing front arrived in the White River watershed in the early 1960's and mortality remained high until 1978 until scale populations finally crashed. Many of the late 1960's era clear-cuts and shelterwood in the White River Watershed were in response to the salvage of beech. Beech scale-nectria complex is still a problem in the watershed.

In 1980-1982 gypsy moth and forest tent population levels increased.
Most defoliation occurred in oak-hardwood or hardwood stands in the Middlebury District with west or south facing aspects. Some minor amounts of defoliation by these pests and Saddled Prominent occurred in the watershed.

In 1989-90 Gypsy Moth populations again increased and the Forest cooperated with the State of Vermont Forest Protection staff to aerial spray a bacterial pesticide on about 3000 acres in the Middlebury district. No spraying occurred in this watershed.

Annual checks of insect, disease and forest health conditions are now made by staff of the USDA Forest Service State and Private forestry branch out of Durham NH. Aerial detection flights are coupled with on the ground field checks made in cooperation with GMNF and State of Vermont staff. While no large impacts due to disease or insects have been noticed recently, small patches of wind-toppled spruce have been noted by air.

Hemlock wooley adelgid are new introduced insects that can quickly kill hemlock trees and are wrecking havoc with southern New England hemlock forests. They are slowly creeping into northern New England. They were recently found in New Hampshire and Maine while another population seems to be holding just south of the Mass.- Vermont border. One location in Vermont several years ago was quickly controlled but forest pest staff keeps a look out for it because it can be so damaging to riparian area forests and deer wintering areas.

Timber Management in the early years

The Forest Service acquired most of the land in the White River watershed during 1936 and 1937. The two largest acquisitions were from Middlebury College. They were known as the Batell Lands and International Paper company lands. There were two small Lumber Company properties acquired, Farr Lumber Company and Rice Lumber Company. There were many smaller tracts that were acquired in 1936 - 1937, which were primarily farmsteads of 100-250 acres. Most of these were located in the lower elevations of the watershed.

The tract records of the Middlebury College and International Paper Company had timber cruise data and narratives. The cruises were conducted by E. Abbiati' party in 1934 and by Ranger Walter Averill in 1947. Their reports suggested that prior to acquisition, timber removal was based on salvage of large diameter red spruce and yellow birch.
The spruce was affected by bark beetles and by periodic windstorms causing blow downs and tilting of the trees. The yellow birch was affected by diebacks, foliage yellowing and crown dieback. Little reference was made to other species since there was little economic value in other species when compared to the larger red spruce and yellow birch. Averill suggested that there was little silviculture practiced but the cutting resembled individual tree or group selection. In areas of blowdown, clear cutting was practiced yet; unmerchantable trees were probably left standing.

The red spruce was sold to various sawmills in the area before acquisition. These included, Goodro of Middlebury, A. Johnson of South Lincoln, and Ward Lumber of Warren. The Blair Veneer Company of Hancock was the ultimate procurer of the yellow birch. The Conning Bobbin Mill of Rochester acquired some low grade of timber. In 1947 the Eaton Lumber Company was constructed in Hancock. This was later sold to Earl Cone. There was also evidence that portable circular mills were used throughout the watershed.

The A. Johnson Co. in Bristol, Granville wooden bowl Mill and the Chesapeake veneer mill in Hancock are still operating. Forestry jobs held by individual logging contractors and mill employees are still important to the area.

The first timber inventory on the Green Mountain NF was conducted in 1937 and it was conducted on all NF lands, approved for purchased lands or lands believed to be purchased. The party chief was a Junior Forester who was accompanied by ten Civilian Conservation Corps enrollees or locally hired laborers. The inventory was conducted by surveying lines across the forest in which plots were established systematically along the traverse. Forest cover typing was conducted along the line and areas were often typed by volume/acre estimates in addition to forest cover type. The information was separated by compartments and "logging units". The logging unit was based on what would be logical timber sale areas given the standards of the time. The Green Mountain NF based their early subdivisions or logging units on watersheds.

In 1941 the White River Timber Management Plan was approved. Unevenage silviculture was primarily prescribed for all but stands of shade intolerant tree species. The objective of the plan was to improve the quality of the timber in the watershed for the economic benefit of the local economy. Priority was given to direct harvest into high risk stands, areas of low quality timber and areas of higher volume where attention to stand structure could be started. The amount of cutting was regulated by volume control.

The 1950's Timber Management Plan had two main objectives: Community Support and Silvicultural improvement. There were over 30 mills within the Green Mountain NF working circle that were dependent on national forest timber. The objective in supporting the community was to "furnish on a sustained basis, the forest products that will contribute most to the economic welfare of the individual communities and wood using industries within the sphere of influence of the Green Mountain National Forest".
The silvicultural objectives were: " to furnish a continuing and increasing supply of high quality saw timber, improve growing stock of desirable species and to favor the production of all aged stands."

Trends
During the first 18 years of the White River Working Circle (Watershed) Plan, 58.8 million board feet of timber was harvested on national forest lands within the watershed. The average annual harvest was 3.2 million board feet and the annual allowable cut was calculated at 3.6 million board feet.

Most of the sales in the watershed were sold in the 2,000 to 2 million board feet size class. The amount of timber that could be sold in the compartment governed the sale size, which was usually delineated by drainages within the Watershed. The timber management plans also recognized a need to provide sales to smaller purchasers. Often compartments were designated in which only small sales would be made to satisfy this demand.
There was only one large sale of note conducted in the White River Watershed during this time. This was the Boyden Brook II timber sale, which included 3.1 million board feet. The sale included 663 acres within compartment 80. The sale was sold in 1964 to the A. Johnson Company.

While other timber sale activity occurred beyond the activities mentioned above, some records and details were archived and difficult to obtain for this analysis. GMNF databases and records on hand were used to construct timber sale history from 1965 through 2000.

In the 1970's, sales occurred and covered about 6000 acres, producing about 16 million board feet of sawtimber and pulpwood.

In the 1980's, many sales occurred in the watershed. They covered about 4800 acres of various even and Unevenage harvests, producing about 10 million board feet.

In the 1990's timber sales continued to be employed as a means to implement the Forest Plan and management area objectives although much less than previous years.
These sales covered about 1900 acres, involved even and unevenage systems and harvests producing about 8 million board feet. See Appendix H for more details on sale history from 1965 to present.

Period	Total acres cut in sales	Total volume produced (all prods)
1965-1970	3217	16.461 MMBF (mmbf = 1 million board ft.)
1970's	6096	15.788
1980's	4772	9.966
1990's	2542	7.980

The 1998 Ice Storm

In 1998, a large ice storm impacted New England and specifically this area. The worst of the thick glazing occurred on all vegetation above the 2000-foot elevation causing snapping and bending of tree boles and damage to tree crowns by loss of branches. This has increased the amount of woody debris on the forest floor and in local streams. Some trees have died since the ice storm but most are recovering. While hardwoods and softwoods were damaged, hardwood trees bore the worst of the damage. Individual and groups of trees at upper and lower elevations were also damaged and or tipped over by the weight of ice glazing. As the tree canopy was thinned due to branch and tree damage, there has been an increase of light to the forest floor. This has increased the amount of ferns in many locations. In addition, many plant species that thrive along wood roads and hiking trails in diffused light are occurring in these temporary gaps/openings.

The dropping of many tree limbs has increased fuel loadings and raised the concern about possible increased fire danger. To date, no lightning or human caused fires have occurred. Plans for spring 2000 prescribed fires include the burning of old field openings in compartments 44, and 59.

Salvage operations to harvest ice damaged timber occurred within a year on active timber sale areas and additional volume was added to existing sale contracts in Compartments 60-62 and 74 (Texas Falls sale), Compartments 59, and 74-76 (Gillespie sale) and in Compartment 35 (Moss Glen II sale).

USFS Researchers have provided management guidance for responses to this widespread ice damage. They have indicated that salvage of timber products should occur within five growing seasons of the event in order to capture financial return before stain and decay take their toll.

Forest Products Other Than Timber

At this time no permits for non-forest products occur for GMNF lands in the watershed.

Suitable Land base for Timber Management

Forested conditions are found on 95 percent of the GMNF's 374,134 acres of which approximately 141,000 acres are considered commercial forestland, of which 83 percent is saw-timber sized (generally > 8" DBH) and older than 60 years of age. From this land base the allowable sale quantity is about 15.7 million board feet per year.

Of the 374,134 acres comprising the GMNF, approximately 141,000 acres (38%) are considered to be commercial forest land, of which 83 percent is saw-timber sized (generally 8 inches dbh and greater) and older than 60 years of age. Timber harvesting through sales is the primary management activity that alters and/or disturbs the greatest acreage of forested habitat on the GMNF.

The average annual forest harvest between 1987 and 1996 was 8.2 million board feet, representing an average of approximately 1,900 acres treated annually.

In the watershed about 12,241 or about 53% of the acres are suitable for timber management. The proportion that these acres could contribute to the forest's annual Allowable Sale Quantity (ASQ) is about 1.4 million board feet per year.

<u>Current Timber Management Techniques</u>

At this time, the only active timber sales in the watershed are Texas Falls and Gillespie sales. Firewood cutting permits for only dead and down roadside material are currently being sold in the watershed.

Timber management techniques used on the GMNF include even-aged and uneven-aged stand management, reforestation and the cutting of firewood (cutting of dead or down trees). The different treatment and harvest techniques that could be used for specific management areas are described below. For the locations of these potential treatments, refer to the White River Harvesting Potential map in Appendix J.

Evenage Systems

Thinning reduces the number of trees in stands with greater than 80 percent relative density (approximately 71 percent canopy closure) to approximately 60 percent relative density (approximately 54 percent canopy closure), generally by removing smaller diameter trees. Open canopy conditions persist for 15 to 20 years following the thinning.

Acres of thinning available now = 521.

Shelterwood treatments establish seedling regeneration through the application of one or two preparation or seed cuts (removing selected trees in order to allow seed trees to flourish), followed by the almost complete removal of over story trees. Upon completion of the treatment, relative density is reduced from 80 percent or greater (71 percent canopy closure) to 30 to 40 percent relative density (less than 30 percent canopy closure).

Acres of shelterwood available now = 953

Delayed-shelterwood treatments establish seedling regeneration of shade-tolerant species (sugar maple, American beech, red maple) and intermediately shade intolerant species (yellow birch) in areas where the second cut of a standard shelterwood treatment (see above) is delayed for 40 to 60 years. The

relative density of 80 percent is reduced to 30 to 40 percent canopy closure in the first cut of the shelterwood treatment.
Delayed shelterwoods can be applied where Standard shelterwoods are prescribed to help meet specific resource objectives shown in the Forest Plan.

Clear-cut treatments remove all trees in the stands. Existing seedlings are the basis for regeneration. Clear-cut treatments are used primarily to regenerate ``low quality'' northern hardwood stands, regenerate aspen stands (in existing aspen stands) or to convert hardwood stands to softwood stands. Between 1987 and 1996, an average of 250 acres was clear-cut annually.
Acres of clear-cut available now = 247.

Improvement cut treatments modifies the age and size class by removing designated trees through commercial harvest.
Acres of improvement cut available now = 0.

Individual tree selection removes lower quality trees and salvages trees that would otherwise die (diseased or injured trees) and opens the canopy by reducing the number of trees in stands of greater than 80 percent relative density to approximately 60 percent relative density.
Acres of single tree selection available now = 77.

Group selection removes clumps of trees (usually ¼ to ½ acre) with the removal criteria that are similar to those for individual tree selection, although final relative density will be lower and may be as low as 50 percent relative density.
Acres of group selection available now = 710.

Overstory Removal removes overstory seed trees that were reserved during the previous treatment that are
Reforestation/TSI techniques may be incorporated with any of the above treatments. Seedling regeneration generally occurs naturally on the GMNF.
Acres of reforestation/TSI available now =1331

Firewood permits allow the cutting of standing dead or down trees. Approximately 50 to 150 personal use firewood permits (averaging about 2 to 3 cords of wood per permit) are sold each year. The cutting of road hazard trees and dead and down trees is allowed within 150 feet of most open Forest Service roads.

The amount of timber harvest using evenage systems is controversial with some people. The total amount of these types of harvests that can actually be implemented is based on purpose and need, MA, Plan Standards & guidelines and public input and support.

Forest Plan standards and guidelines were developed to minimize adverse effects to forest wildlife and water quality that may result from timber harvesting. These standards and guidelines include, among other things, criteria for snag and den tree retention, and maintenance of riparian vegetative buffer strips. Timber sale contracts must provide for the retention and protection of wildlife reserve trees, including snag and den trees.
The Forest Plan defines snags as dead or partially dead trees at least 6 inches dbh and 20 feet tall. Hard snags have essentially ``sound'' exterior wood and may be marketable. Soft snags are trees in an advanced state of decay. The Forest Plan defines den trees as live trees at least 15 inches dbh containing a natural cavity that may be used by wildlife for nesting, brood rearing, hibernating, or shelter.

Vegetative buffer strips adjacent to riparian areas are also addressed in the Forest Plan standards and guidelines. Filter strips are designed based on the slope and erosion potential of the soil (a table defining the various widths is found on page 4.19 of the Forest Plan). The filter strip separates roads; log landings, construction and other earth-disturbing activities from streams, lakes and other bodies of water. The root mat within the strip must be protected and soil must be left undisturbed. Vegetation within the strip that provides shade to a stream (buffer strip) must be maintained

Issue #3: Transportation System Plan Needs Updating

At this step in the process we determined the assessment area was too small to properly address the key questions Step 2, Question 8, in a strategic manner. This issue will be dropped and completion of a transportation plan should be deferred to a later time. A better assessment area would be the entire White River watershed, or the entire north half of the Forest (includes the White River, Mad River, Ottauquechee, Middlebury River, New Haven and Middlebury River watersheds). This also may be saved for Forest Plan revision.

Issue #4: Recreational development and maintenance

Comparatively, the Upper White River watershed area as a whole generates more recreation and tourism than most areas on the Green Mountain National Forest.

The primary uses are:

- Sightseeing and picnicking
- Primitive camping
- Trail uses
- Wilderness
- Fishing and hunting

A natural appearing landscape with distinctive features such as Texas Falls and Moss Glen Falls, rugged terrain typified by Granville Gulf and the Hancock Branch valley blended with the pastoral/farm foreground setting draw visitors to the area. Even with the limited amount of development along major state highways, those coming from more urban and suburban settings view the area as wild. The steep valleys make the summer green and fall colors more apparent making this a prime foliage viewing area. Most sightseeing is done on roads but facilities or features such as the Hancock Branch Overlook, Texas Falls Nature Trail, Silent Cliff, and Skyline Lodge are attractors. The lack of brush control in old fields will eliminate many of the views that make the remote parts of this area attractive for viewing scenery.

The Rob Ford meadows, upper Texas Meadows, and the National Forest roadsides along the White River tributaries make this watershed one of the more important for primitive camping on the National Forest in Vermont. Many of these sites are located less than 50 feet from streams. Dips and ditches on Level 1 maintenance roads accessing primitive camping areas at Rob Ford need maintenance. Off-road access points like the so-called "Command Post" in upper Texas Meadows need hardening. Overall, most primitive campsites are reasonably well vegetated and maintained. An active Low Impact Camping information effort has reduced the impacts created by this use. The lack of brush control in old fields will reduce the attractiveness of this area for camping and eliminate many of the views that make the remote parts of this area attractive for viewing scenery.

There are 36 miles of trails within the Upper White River watershed. Most of these trails lie on National Forest land. Most of the winter sports trails in this watershed follow logging roads. Because most timber harvesting occurs in winter, snowplowing during logging operations has been the main impact on these uses. The area is attractive and draws recreationists from Addison and Rutland counties during the winter because it receives more snow than adjacent lower lying areas.

The trail network here was reviewed during Opportunity Area Planning during the late 1980's. At that time, one new cross country ski trail was proposed to connect FR 39, Texas Gap road, with the terminus of the Hancock Branch trial to create a ski loop. Due to ongoing logging during the 1990s, this trail has not been built although a Decision Memo had been issued. No new snowmobile trails are proposed for the foreseeable future although a corridor snowmobile relocation at Route 125 is proposed to make that highway crossing safer for snowmobilers. The major effort on snowmobile trails has been to provide connections to trails on private land and to bring the trails in line with today's construction standards.
There have been neither few demands nor any dramatic opportunities for new hiking trails within the watershed. Most hiking and walking is done on the Long Trail, Hancock Branch trail, and the Texas Falls Nature trail.

In general the trail systems are in reasonably good condition. Maintaining erosion control structures and maintaining or replacing bridges has been a priority. The Clark Brook trail remains as one of the few trails with uncorrected flood damage. Repairs are funded and scheduled for summer 2000. Blazing and signing is generally good. Debrushing is a constant effort but with help from partners like GMC and VAST and our Wilderness Rangers, we have been able to keep most trails in the watershed reasonably well debrushed.

Picnicking occurs primarily at the Texas Falls recreation area. The area needs site rehab work to improve accessibility and replace unpleasant toilets. A design had been prepared in the past but lacks Forest consensus and NEPA environmental analysis so has not been totally implemented.

The Breadloaf Wilderness draws another segment of visitors to experience an area with less apparent influence from humans.

Streams in this area are aesthetically pleasing and attractive for fishing. They draw recreationists because of their general sparkling clarity, privacy, and close proximity to roads.

Hunting remains an important activity although less so than in lower elevation habitats associated with farms, large swamps, and oak stands. This is excellent bear habitat because of its relative remoteness and that draws hunters.

Issue #5: Protection of rare plants, wildlife, and habitats

<u>Current and Historic TES Plant Occurrences</u>
Known rare plant occurrences in the subwatershed have been identified over the past ten years through field surveys conducted by GMNF and partners (primarily Vermont Nongame & Natural Heritage Program - VNNHP). Known occurrences of rare plants are documented by the VNNHP in their database and in GIS coverage for the GMNF identified for this project as “Han_eor.shp”. EOR stands for “Element Occurrence Record” and is represented by a database record for every occurrence of a species that VNNHP tracks in their database. These include state listed, rare, and some uncommon species, as well as exemplary natural communities. Note that in some cases the GMNF tracks species as “R9 Sensitive” which the VNNHP does not track – these occurrences are not represented in this coverage. For the GMNF version of the GIS coverage, the only identifying information included is the “EO Code” – a unique value given to each Element Occurrence by VNNHP. The subwatershed coverage is simply a clip of the GMNF coverage.

In addition to recent known occurrences, occurrences have been identified in previous reports through research of historical records (herbaria, botanical logs and diaries, etc.) conducted by GMNF and others (notably Jerry Jenkin’s report on the rare plants and habitats of the GMNF from 1982). This information is not in an electronic or digital format due often to the vague location information associated with these records and the qualitative nature of the data.

A third source of information is the Significant Features Inventory conducted by the VNNHP on the GMNF from 1990-1997. During this inventory, polygons and points were drawn on 1:24,000 topographic maps to represent known and potential occurrences of rare species or exemplary natural communities. After the survey was completed, polygons representing known occurrences of both rare species and exemplary natural communities were digitized for GIS with each polygon coded by the quad sheet name and polygon number from the base quad sheets used for the inventory. In addition, significant features identified in the Forest Plan (usually MA 8.1 areas) were also added to this coverage. Currently, place names have yet to be associated with this coverage. For the subwatershed project, this coverage was clipped to the subwatershed boundaries and is known as "Han_rare.shp". Note that polygons in this coverage may represent EITHER rare species, exemplary communities, or significant features from the Forest Plan, which means that in some cases the polygons overlap with the points of the EOR coverage, and represent the same information.

In terms of rare plant species, this subwatershed contains three documented occurrences of R9 Sensitive species from the VNNHP database: Michaux's sedge (*Carex michauxiana*), known from Skylight Pond; Purple clematis (*Clematis occidentalis var. occidentalis*) and Steller's cliffbrake (*Cryptogramma stelleri*) from Hat Crown; the state historic species blue-eyed grass (*Sisyrinchium atlanticum*), was located in 1999 in the Texas Falls area and has not been put into the database yet, is the fourth documented species. Given its rediscovery, it has also been listed as R9 Sensitive. An old historic record of auricled twayblade (*Listera auriculata*), a globally rare, R9 Sensitive, and state listed plant, is known from somewhere in the mountains in Hancock. Further location information does not exist (the record is based on a very old herbarium specimen), and it's conceivable that the plant could be here, as it has not been searched for; however, appropriate habitat for it is limited. The southern most occurrences of the species in the U.S. are found in Warren. Butternut (*Juglans cinerea*), an R9 Sensitive species but one not tracked by VNNHP, is also known from the area, with documentation from the Gillespie mountain area. It is rapidly dying out in the area due to the spread of the butternut canker. In addition, there is a 1906 record for Showy ladyslipper (*Cypripedium reginae*), and R9 Sensitive plant, at Silent Cliff, which has not been verified, and it is not clear that any suitable habitat exists for it in that area. Another record for Steller's cliffbrake was recorded from Moss Glen in 1926, although this has also not been verified; suitable habitat may in fact exist there.

The R9 Sensitive designation for these species indicates that they are at risk either in terms of viability on National Forest System lands (National Forest Management Act concern), or in terms of trending toward federal listing (Endangered Species Act concerns). As Sensitive species, the FS is required to conduct biological evaluations of projects for these species to determine if the project puts them at further risk. In addition, these species receive priority for dedicated inventories and management to protect or enhance populations and habitats.

Appendix P displays the currently identified needs associated with these known occurrences. Only a small proportion of the lands in the subwatershed have been inventoried for rare species. However, of those species noted above, two (michaux's sedge and auricled twayblade) have very restricted habitat in the watershed and are unlikely to occur beyond their known or suspected locations; another two (butternut and the blue-eyed grass) could be much more widespread and have plenty of unsurveyed potential habitat. Steller's cliffbrake and Purple clematis have somewhat restricted habitat, although not all possible sites have been visited, including the Moss Glen historic record site. In addition, the Showy ladyslipper record needs to be verified and if not suspect needs to be field checked at the historic location.

In addition to the inventory needs, there is currently no monitoring plan established that dictates level and timing of monitoring for these sites. None of the current sites are targeted by state or regional groups for critical monitoring, and they have received little to no tracking since their first observation. Consequently, we have no trend data on survival or population dynamics for any of these sites. It is safe to say that populations in the restricted habitats are as secure as the habitat is secure; that is, so long as water quality is maintained at Skylight Pond, and the cliffs at Hat Crown are not disrupted, these species should be protected, although we have no way of knowing at this time if natural processes are creating increasingly unsuitable conditions for them. Currently, it has been 12 years since Michaux's sedge was first observed, and 7 years since the plants at Hat Crown were first observed. Monitoring at these sites is well overdue, although the original surveyors did not indicate any threats to the sites or plants, or potential viability concerns. The small population of Eastern blue-eyed grass discovered in 1999 was in a very vulnerable spot (along a logging roadside), but is also a ruderal species likely adapted to disturbance.

Current Rare or Significant Natural Community Occurrences

VNNHP and the Forest Plan have identified areas within the watershed on NFS lands considered of some significance at the state level – for their biological or ecological significance, or for their significant value to humans as identified during development of the Forest Plan. These areas are included in one or both of previously noted coverages: the "han_rare" coverage as polygons and the "han_eor" coverage as points. These areas are: <u>Texas Falls</u> (significant for recreational and geologic qualities – Forest Plan), <u>Hat Crown/Silent Cliffs</u> (significant for relatively intact examples of acidic outcrop and cliff natural communities), and <u>Monastery Mountain</u> (north face – significant for including a patch of old growth northern hardwoods and hemlock within a younger late successional forest). Currently, only the Texas Falls area is protected through Management Area designation and standards and guidelines designed to protect its unique features; the remaining areas do not have any site-specific standard and guideline protection, although they do occur in relatively protected management area (MA) designations (Monastery Mountain – mostly 2.2 and a little 6.1; Hat Crown/Silent Cliffs – 5.1, Breadloaf Wilderness). MA 5.1 is Federally protected Wilderness; MA 6.1 allows no timber harvesting and focuses on primitive recreation; MA 2.2 allows timber harvesting and focuses on semi-primitive recreation.

In addition to NFS lands, other known locations of statewide significance include Moss Glen Falls and Granville State Reservation (significant geologically and for scenic value of the gulf and falls). The area is managed by the State of Vermont. No other sites for rare or significant natural communities or phenomena are currently known or suspected within the watershed.

Currently, there is no formal monitoring plan for either Monastery Mountain or Hat Crown/Silent Cliffs. Based on reports of the original surveyors of these sites, there do not appear to be any threats to the integrity of either site. For Monastery Mountain, there was a recommendation that the site would be useful for forest-interior bird monitoring. To date, no further action or monitoring has taken place at either of these sites. The monitoring plan developed for the Forest Plan in 1988 calls for monitoring geologic quality at Texas Falls to protect the area from all but natural changes. It is not clear that any monitoring of Texas Falls for this feature has been conducted; although there have not been any reports of deterioration of the geologic values of the site.

TES Plant Species Habitats and Distribution

<u>Enriched Northern Hardwoods</u>
Rich northern hardwood forests provide habitat for 12 R9 Sensitive plant species. One has a documented occurrence within the watershed, and given the prevalence of limy bedrock in the watershed, there are likely more occurrences of these species. As discussed in Step 2, rich northern hardwoods develop in areas where at least one, and perhaps several, of a certain set of conditions exist: limy bedrock near the surface, or limy basal till near the surface, or where springs and seeps exist that carry water that has leached calcium from nearby bedrock or limy till; where soil conditions are mesic through most of the year, often in certain cove-like landscape positions; and where colluvial processes operate, moving detritus downhill to collect in pockets on the slope and in piles at the toeslope, acting as a compost pile and feeding nutrients into the system. Identification of sites for these conditions has proven to be difficult, as they tend to be local features (5-20 ac). This means that mapping efforts for bedrock, soils, parent material, and even ELTs, do not recognize this small a unit. However, we have found their occurrence frequently enough that we believe they are recognizable, and should be mapped. Maps of areas of basal till from ELT maps, limy bedrock from the Doll (1960) map, stands of northern hardwood forest types at least 50 years old and with site indices of at least 60, and areas that are known to be rich through past surveys, have been created in GIS and can be used to target surveys for rich woods. These GIS coverages in combination indicate a great deal of potential habitat in the watershed. Currently, this habitat occurs in a variety of management areas, and without surveys in the Wilderness, we cannot predict its representation in protected status.

<u>Wet Spruce-Fir Woods</u>
This natural community provides habitat for two R9 Sensitive plant species. It is particularly prevalent along the Texas Brook drainage, where GIS maps indicate the presence of wet ELTs. Other areas indicated in GIS maps include patches along the upper White River, and at the head of Piper Brook. The Piper Brook area is of particular interest, because in that area most of the predictors of rich woods and wet spruce converge, including wet soils, stands with swamp spruce-fir forest type, limestone bedrock, basal till soils, and known rich woods in the vicinity. This area should get some high priority inventory attention.

For the most part, the most prevalent potential habitat is currently occupied by planted exotic conifers (e.g. Norway spruce). It is not clear whether the species composition has any effect on the potential of the area for rare plants, but there should be an effort to restore this area to native species, per executive orders that have been issued recently saying as much.

Montane Spruce-Fir Woods
This community provides habitat for 3 R9 Sensitive plant species. Currently, none are known from the watershed, but there has never been a comprehensive inventory of this forest type, as it generally occurs above elevation limits for timber harvesting. Known occurrences of the habitat are well mapped in the Forest Service's timber database (CDS) and stand coverage in GIS. However, the Forest's LTA coverage gives a picture of area that can be potentially suitable habitat within another generation of the forest. The "Upper Mountain Slope" LTA predicts that spruce-fir would be the dominant natural community, based on an altitude/latitude algorithm developed for the Appalachian Mountains across their full extent. It's likely that the harvest of red spruce from these sites in the early 1900s created a forest generation with limited red spruce reproduction, as has been found on the White Mountains (Leak, 1999). While it's not clear why red spruce didn't reproduce well after this initial harvesting, it is clear that spruce is returning to these areas, and in another 100 years may start to dominate these upper slope forests. We should consider maintaining or enhancing that conversion

Softwater Ponds
Skylight Pond is the only known high elevation softwater pond in the watershed, and it's unlikely, given recent pond surveys, that others exist in the watershed. These ponds are easy to recognize from the air, and have been known for many decades. Skylight Pond, as a softwater pond, offers potential habitat for 18 R9 Sensitive plant species, but only one is known to occur there. This habitat has been surveyed once recently (1988), but does not have much if any historical data preceding that. While this was part of the high-altitude pond survey conducted for the Forest by Jerry Jenkins in 1988, it is not part of Vermont's Acid Precipitation study, and so does not have any water quality or aquatic species data. Jenkins (1988) does report on some of the plants associated with the pond edge and bog mats lining the pond, but was unable to gather data on aquatic plant species. As most of the R9 Sensitive species associated with ponds are aquatics, this pond may harbor suitable habitat for or occurrences of these species, unbeknownst to us. This pond should be surveyed further for these species and habitat.

Spring Runs & Seeps
Spring runs and seeps are not communities that are well mapped, or well-understood in terms of predicting where they may occur and if they are suitable for rare plants. These communities are frequently found in ordinary northern hardwoods and spruce-fir stands, but are often associated with basal till soils. Areas with these ELTs (3a, 3b, 3c, 3d) may provide conditions where seeps and springs may be found. Areas that have rich northern hardwoods are often seepy as well, and so in searching for rich northern hardwoods one may do well to search seeps in these areas. Four R9 Sensitive plant species may find suitable habitat in these areas, although none are known currently from the watershed. Other seepy areas include flats along rivers and streams, and in wet spruce-fir forests (as described above). These areas are not currently mapped in spite of their frequency and potential suitability for rare plants, primarily due to their small extent at any one location. Given there's no definitive way to predict their exact location, using symbols to note their

location during vegetation, soil, or ecological inventories would be helpful. These locations could then be further reviewed by a botanist to determine suitability.

Open Wetlands/Beaver Meadows/Peatlands

These wetlands provide potential habitat for 13 R9 Sensitive plant species, although not all wetland types are equally suitable for all 13 species. We can predict where such wetlands may occur by looking at wet ELTs and stands identified as non-forested wetlands. However, many of the smaller wetlands may not be identified in this way, especially in the Wilderness where stand inventory is old and wetlands were a less important feature to identify. During the VNNHP features inventory of the Forest, no wetlands were identified for review in the watershed. However, there are known wetlands that have not been surveyed for habitat suitability or rare plant occurrence in the watershed, and there does not appear to be any reason not to suspect these areas as having at least potential habitat. There is also a known boggy fringe around Skylight Pond, as noted earlier. However, Jenkins (1988) indicated that this pond has indications of beaver influence, where the bog mat may have been flooded previously, and so the habitat may not have been stable for long enough to be suitable for the boggy plants.

As noted above for seeps and below for outcrops, the most reliable way to identify the locations for these habitats is to have those conducting inventories in the area note their location when they find them. Wetlands are not difficult to delineate, and there are many courses offered to assist in wetlands delineation.

Outcrops/Ledges/Cliffs

These areas in the watershed tend to be at moderate to high elevation, and are often acidic. They are often indicated on the Forest's ELT maps as ELT 2d or 21d, although not all are likely to be noted. In addition, ELT 013b, while the dominant ELT at the highest elevations along the main ridgeline, also predicts a high probability of finding bare rock, outcrops, and ledges. Topographic maps, low altitude flight reconnaissance, and field surveys may be more effective ways to identify locations for this habitat. There is a gradient in quality of rare plant habitat from acidic to limy, and from outcrop to cliff. Limy, high elevation outcrops and cliffs, when compared to acidic versions, are rare, and provide habitat for several R9 Sensitive plants species (16 for limy, as compared to 2 for acidic). Cliffs, simply by occupying more area when compared to outcrops, provide more opportunities for colonization and are may be better able to sustain populations of rare plants. Within the watershed, the Hat Crown/Silent Cliff area is the only documented site for the limy version of this habitat; this site may also be acidic in places as well. (This points out one of the problems with predicting where the limy rocks will be. There are many occurrences of limy components of otherwise acidic bedrock formations that are not mapped and appear to be unpredictable. So simply identifying where limy bedrock formations or mapped limy members of formations coincide with steep landscape positions will not give you all potential habitat.) Further down the White River watershed, one of the state's finest examples of the high elevation limy cliff community is found at Mt. Horrid, and the site at Hat Crown/Silent Cliffs could very well be a much smaller extension of this limy rock outcropping at a relatively high elevation. This site is set at an elevation of 2000'-2500', whereas the cliffs at Mt. Horrid tend to be above 2500'.

GIS can at least show us where the steep, shallow ELTs are located, with the occurrence of mapped limy bedrock, which can give us a start at predicting how this habitat is distributed in the watershed. Much of this type of habitat is located in the Wilderness, and is generally so extreme that timber harvesting is not recommended. (Our Forest standards and guidelines recommend avoiding harvest in the steep and/or high elevation ELTs [2d & 2b]). VNNHP during its features inventory of the Forest identified several potential outcrop sites in the watershed (it was through this effort that Hat Crown/Silent Cliff was determined to be of some significance). Several sites along the main ridge were visited and rejected as suitable; these will need to be reviewed against the additional species on the R9 list added since 1993. However, the ELT maps indicate additional potential habitat that was not identified or reviewed by VNNHP, and these areas should also be verified in the field. Given that all occurrences of this habitat are not likely to be identified using secondary sources of information, it would also be very helpful to have those conducting vegetation, soil, or ecological inventory note locations for outcrops, cliffs, and ledges, so that these can be further reviewed by botanists for suitability.

Proportion of Rare Plant Habitat Occupied

We currently do not have enough data on any of the rare plant habitat to address this question in a meaningful way. Our ability to predict distribution of habitat has been hampered by lack of research and lack of any kind of ecological mapping over the last decade at least. Our ability to inventory for potential rare plant habitat has been hampered by inventory focus on functional resource areas that do not include this habitat, and the decline in any inventories completed on the Forest recently. Understanding the extent to which suitable habitat is likely to be occupied by the target species will assist in reviewing management projects, defining survey needs, and analyzing effects. Currently, given our knowledge, we must take the conservative approach and assume that all potential habitat is occupied during environmental analysis. Although an inefficient approach, there is no data to analyze to suggest a different approach.

Management Effects on Long-term Habitat/Population Viability

To the extent that the Forest provides suitable rare plant habitat that is unoccupied, and that this habitat is not necessarily represented in some meaningful way in a protected management category, it is critical that we start to develop an understanding of how forest management of all kinds effects the sustainability of the ecological processes that initially define the suitability of the habitat. Although studies have been undertaken to address this issue in the White Mountains and the Adirondacks, the greatest difference between these areas and the Forest is the extent of our rich northern hardwoods habitat. Currently, no known rare plants are associated with "standard northern hardwoods", which is the dominant forest type in most of the White Mountains and Adirondacks outside of spruce-fir. This is also the forest type where we are starting to see declines in sugar maple reproduction that may be linked to long-term calcium depletion. On the GMNF, our bedrock is schisty, with numerous small veins of calcareous bedrock scattered about, and our timber as a result is of the third highest value in Region 9.

On the surface, we might assume that therefore we are well buffered from effects of acidic deposition, that our ecosystems are resilient as they regenerate profusely, and we have no sugar maple reproduction problem here. By extension, we could hypothesize that our habitat suitability for rare plants is not affected. However, we have not tested this assumption in any meaningful way. We have no data for rich woods comparing harvesting regimes with unharvested forest in terms of floristics, patterns of survivability, or nutrient status. We have no idea where the threshold lies between buffered rich hardwoods and unbuffered and therefore vulnerable northern hardwoods. We do not know if our systems, even when disturbed by harvesting, have some sort of homeostasis that will perpetuate nutrient levels into the foreseeable future – but that is our working assumption right now.

Given the work being done on forest ecosystems surrounding us, we greatly need this research extended to the Green Mountains to test the hypothesis that our actions are not disrupting ecological processes in these rich woods in any meaningful way. We currently do not have any answers to those questions. I proposed establishing a series of permanent plots in managed and unmanaged rich northern hardwoods, in the watershed and beyond, in collaboration with NEFES and others, to answer questions regarding differences in floristic patterns, species survivability patterns, and nutrient status. In conversation with Steve Fay of the WMNF, he suggested an easy measure of nutrient status to start with would be stream water chemistry. Until we start this kind of research, there will continue to be conflict between management desires and rare plant issues in these areas, and on the larger issue of the ability to harvest high quality hardwoods from these sites in the face of research suggesting vulnerability of northern hardwoods to calcium depletion and subsequent disruption of underlying ecological processes.

For wet spruce-fir woods, where we routinely do forest management using winter logging and winter-use trails, as well as in montane spruce-fir where past management practices had an effect, we also need to take a similar approach to understanding the underlying processes that perpetuate these habitats and our effects on them. There is even less research in this area, and my suspicion is they are far more vulnerable than rich northern hardwoods.

In the remaining habitats, simple monitoring will help determine what sorts of activities may be having impacts, and then studies can be designed to answer these questions. For the most part, these sites are not affected by more than natural processes as well as large-scale human processes that we can only measure rather than control (e.g. global warming).

Levels of Protection

Conservation biology principles need to be applied to determine what proportion of the habitat types supporting rare plants should be protected. In some cases, that proportion will depend upon the habitat specificity of the rare plant (e.g. cliff-dwelling species), while in other cases it will depend upon the distribution of suitable habitat and this habitat's resilience and resistance to perturbations. Smaller protected areas can be provided to small discreet populations that are relatively isolated from nearby habitat; larger areas will be needed to provide sustainable habitat conditions when some of that habitat may be disrupted an moved to an unsuitable condition for a period of time.

Currently, the Forest Plan provides no specific protection for any of the known sites, or for the habitat in terms of rare plants. Cliffs and steep places are protected from harvesting, but not from recreationists; some wetlands are protected from harvesting and others are not, while none are protected from recreation specifically. The Wilderness offers protection for two known sites and an undetermined amount of habitat; however, there are no site-specific standards and guidelines for the known sites, nor any specific direction regarding how such guidelines would be developed for the Wilderness, and how recreational use should be weighed against conservation goals.

There are two general needs associated with protection of rare plants and rare plant habitat in the watershed. First, known sites need to have site-specific protection, either via management area designation or site-specific standards and guidelines. In either case, this would require a Plan amendment. Second, a landscape-level analysis is needed to determine the appropriate mix of management strategies relative to the distribution and amount of these rare plant habitat types. A certain proportion of these habitats, at certain scales, need to be protected to offer baseline conditions as a comparison for management impacts, as well as to provide bioreserves for species of limited distribution or dispersal

TES Wildlife Species and Habitats

Threatened and Endangered species

The current federal listing of Threatened and Endangered species relevant to this sub-watershed is:
Bald eagle (*Haliaeetus leucocephalus*)
Indiana bat (*Myotis sodalis*)
Canada lynx (*Lynx Canadensis*)
Eastern Cougar (*Felis concolor*)
Eastern timberwolf (*Canus lupus*)

<u>Bald eagles</u>

There is no known Bald eagle nesting sites in Vermont, GMNF or within the watershed. Bald eagles are thought to occur in Vermont only when they pass through the state during migration. Bald eagles are noted each year along the shore of Lake Champlain and along the Connecticut River. Occasional sightings have been reported near other large water bodies like Somerset and Chittenden reservoirs. After a review of the Biological Assessment for the activities listed in the GMNF Forest Plan, the US Fish and Wildlife Service has agreed with the Forest Service and has concluded that a no effect determination is warranted for the bald eagle.

<u>Indiana bat</u>

Bats have historically been observed in various hibernacula within and near Vermont However, the most recent population count demonstrated a 60 percent decline in the range-wide population since regular surveys began across the northeast in the early 1980s. The Vermont department of Fish and Wildlife began systematically surveying mines and caves for hibernating bats in the late 1980s. In 1992, three hibernating Indiana bats were observed during a winter survey in Dorset/Aeolus cave on privately owned land adjacent to the GMNF. Further surveys of Dorset/Aeolus Cave documented two Indiana bats in 1993 and one in 1998.

Most recently, monitoring for the Indiana bat (*Myotis sodalis*) and other bats has occurred in the Greeley talc mine in Stockbridge over 10 miles to the south of the UWR watershed. VNNHP personnel and others conducted monitoring. Indiana bats had historically been found in this cave and bat numbers have declined since monitoring began in 1935. No Indiana bats were found during surveys in 1999. A report of finding an Indiana bat was made in 1998. In 1999 that report was corrected once the bat was correctly identified instead as a northern long eared bat (Myotis septentrionalis).
Two other bat hibernacula occur at the western border of the GMNF. One is near Dorset, VT and the other is across Lake Champlain near Hague, New York. While we do not have specific evidence that Indiana bats occupy GMNF habitat, both hibernacula are close enough to the GMNF and this watershed that bats could use the forest during summer.

<u>Canada lynx</u>
The lynx was listed as threatened by US Fish and Wildlife on March 24, 2000.
The State Fish and Wildlife Department considers the Lynx extirpated from Vermont. In fact, we have no evidence of a breeding population ever occurring in Vermont (A. Elser, Vermont Department of Fish and wildlife, in litt. 1998). Currently, lynx are not thought to occur in Vermont. No reintroduction efforts are planned for Vermont at this time.

<u>Eastern cougar</u>
Occasional sightings of large cats are made to State ANR and Forest Service staff. Several reports about large cats crossing State Route 125 in Ripton, and being seen on Forest or adjacent private lands have been made over the last decade. Individuals making these reports claim to have seen a mountain lion or eastern cougar (*Felix concolor)*. These reports are unconfirmed as, State Fish and Wildlife personnel, VNNHP staff and Forest Service employees have never seen or confirmed evidence of these occurrences. Droppings collected purportedly from a sighting of an adult cat and two kittens in the Northeastern Kingdom town of Craftsbury in 1994 were confirmed as cougar feces. No reintroduction efforts are planned for Vermont.

<u>Eastern timber wolf</u>
The State Fish and Wildlife Department considers the eastern timber wolf extirpated from Vermont. No sightings of eastern timber wolves have occurred in this area. No reintroduction efforts are planned at this time.

Sensitive Wildlife Species
In terms of status, all species noted below have been recommended for listing as Sensitive for Region 9 of the Forest Service; this designation indicates that these species are at risk either in terms of viability on National Forest System lands (National Forest Management

Act concern), or in terms of trending toward Federal Listing (Endangered Species Act concerns). The FS is required to conduct biological evaluations for these species to determine if any project puts them at further risk. In addition, these species receive priority for dedicated inventories and management to protect or enhance populations and habitats**.** Only a small proportion of the lands in the subwatershed have been field inventoried for TES species. In addition, the local but frequent occurrence of the enriched northern hardwood community found so far in the area provides potential habitat for several additional rare plants, and indicates that additional habitat probably exists in the area.

Pygmy Shrew
This subwatershed also contains one documented occurrence of a Sensitive wildlife species from the VNNHP database, a pygmy shrew (*Sorex hoyi*) found in the Patterson Brook basin. The pygmy shrew occurrence consists of one individual found during a small mammal trapping research project not designed specifically for locating this species. Its distribution and habitat within the subwatershed are uncertain at this time.

Bicknell's Thrush
In addition to the shrew, additional rare plant and animal habitat exists in the subwatershed for other species. The GIS polygon coverage includes two areas (Mt. Roosevelt to Mt. Wilson, and Bread loaf Mtn.) identified as Bicknell's thrush habitat (*Catharus bicknellii*), although the thrush has not been documented there.

Jefferson Salamander
Distribution is restricted to vernal pools below 1200' elevation in Vermont. GIS mapping of wetland sites has identified potential suitable habitat. It has not been documented here. Surveys to determine occurrence is needed within these areas.

Wood Turtle
The turtle has not been documented here. Surveys are needed to gather information on occurrence and habitat requirements for wood turtles.

Odanata
Species recommended for R9 Sensitive include several odonates (dragonflies and damselflies) that have not been surveyed for in wetlands and riparian areas in the subwatershed. Surveys are needed to gather information on occurrence and special habitat requirements for dragonflies and damselflies to develop reference conditions.

Issue #6: Prehistoric site protection

(a) Archaeological site identification, evaluation and protection

Very few sites are known in the UWRW (in fact, the VT Division for Historic Preservation has one recorded site – at the base of Blair Hill -- for the whole study area). This is commensurate with the amount of survey effort: i.e., there are only a couple of reports on file with the State [e.g., from Act 250 or Federal Section 106 compliance projects], and the few FS reports resulted in avoidance of areas with potential rather than further investigation [see, for example, treatment of the "back" of Blair Hill as part of the recent Gillespie Timber Sale].

1: Where are prehistoric sites likely to occur?
Potential for sites in selected areas is high. For example, Texas Falls, Blair Hill, Pleiad Lake, gaps & passes, terraces along the White River and West Branch (and some primary feeder streams), and the edges of wetlands and ponds outside of FS ownership (e.g., Kendall Brook beaver meadows, among other areas) are all high potential zones. In addition, locales with vistas or in association with steatite sources would have potential.

Despite a desire on the part of archaeologists within the state to generate and use a true spatial/locational "predictive model" for identifying sites, current advice from the Division for Historic Preservation is that neither our data base nor our methods are yet sophisticated enough to warrant adoption of any particular systematic or automatic model (although the results of the VT Agency of Transportation's effort – presently under contract to a consultant – to do so are seen as very promising). Instead, they recommend simply applying "locational criteria" as part of walkover reconnaissance activities (I think they are essentially saying that the GIS or any other automated technology is not yet fine-tuned enough to ferret out the small-scale combination of factors leading to a conclusion of "high potential" at the on-the-ground scale). Such criteria include drainage, slope, aspect, proximity to water, travelways, lithics and natural landmarks, and more.

2. How does the distribution of different kinds of sites vary?
We only have answers for this at a very gross scale. Essentially (and intuitively), there is a strong trend toward horticultural/agricultural (and fishing) village/base campsites along the lower terraces and floodplains, lithic workshops (at outcrops) and "traditional use" sites at higher elevations and vistas, and hunting/gathering sites scattered throughout the area. There are so few burials known throughout the state that there is no reliable pattern that can be inferred at this point.

3. What physical condition are sites in?
Since there is only one recorded site, and I am unfamiliar with its particulars, this is a question that will have to be part of a monitoring effort once sites are discovered.

4. How do site locations correspond with anticipated patterns of disturbance?
We do not have enough data to answer this question definitively, but informed speculation is that many of the same factors making an area attractive in the past (e.g., water, vistas, drainage, slope) makes them attractive today. Thus, an increased emphasis on site discovery (vs. site area avoidance) during "compliance" archaeology would increase our sample size.

Key indicators:

#acres surveyed (Phase I)	750+/-
#acres tested (Phase II)	10

#reports completed	6?
#known/recorded sites	1
#artifact collections	??
#sites reported damaged	0
#sites monitored	0

(b) “Traditional Use” site identification, evaluation and protection

Four areas of contemporary significance to Native Americans have already been identified: the location of these areas warrant confidentiality, but are generally located near Texas Falls (oral history), Blair Hill (reported by the New England Antiquities Research Association; site visit by Abenaki Research Project folks), and along Clark Brook (brought to light when assessing Rainbow Family Gathering impacts in the early 1990s). This non-systematic sample is consistent with a long-standing Abenaki claim that the White River drainage has a rich Native American history, which is poorly known/documented due to a lack of research/survey.

1: What are the characteristics of sites with significance to contemporary Native Americans?
There is no one answer to this question; in addition, it is probable that Forest Service personnel are not best suited to answer it. Summits, vistas and natural landmarks would among the relevant starting points. Native American involvement in site identification surveys would be an appropriate “action item”.

2: Where are these kinds of sites likely located within the Watershed?
Examples cited above give some indication; further survey work needed to answer this question more specifically.

Key Indicator

#ident’d “traditional” use sites	4
#trad’l use sites w/ mgt plan	0
#sites monitored (per annum)	2

(c) Evaluations and ecosystem Context
No sites have been intensively evaluated/investigated to date. Preservation of features within sites that contain organic (or carbonized) remains is relatively uncommon in the northeast’s acidic soils, but does occur (for example, recent analyses at the Skitchewaug Site along the Connecticut River in Springfield yielded the earliest domesticated corn in northern New England). Along the White River, historically frequent large scale flooding events have probably reduced the preservation potential of valley-bottom sites (i.e., the sites are gone!), but first and second terraces, and bedrock-protected stream-side locations, may offer good preservation potential.

Additional survey and site investigation would provide an opportunity to evaluate the common, but poorly documented, representations about low-presence/no-impact “presettlement” populations in the study area (as represented, ironically, in Brian Hawthorne’s “vegetative reference condition” summary report for this Assessment).

1. What kinds of features will make the greatest contribution to our knowledge about…ecosystems and… land-use histories?
Within prehistoric archaeological sites, fire hearths and storage pits tend to retain the greatest amount of organic or carbonized/organic materials for analysis. (In addition, as B.Hawthorne’s report suggests, natural features such as ancient ponds, bogs, wetlands offer the opportunity to do palynological cores reflecting changes, which may complement such analyses).

2. What types of sites would be likely to contain these types of features?
Just about all site types have the potential to have hearths (which may contain the charred remains of nuts, seeds, bones, wood). Storage pits are generally associated with more sedentary, horticultural societies – both later in time and generally lower in elevation than other sites types/time periods. Thus, sites in association with floodplains.
3. In what locations/settings would these types of sites have the greatest likelihood of preserved features?
Our sample size is very small, but we know that the floodplain along the White River has been pretty well scoured over time, we also know that the slopes in much of the watershed would be prohibitive (or at least discouraging) for agriculture, and finally, we know that the highest elevations have little or no potential or history for long frost-free seasons, so by process of elimination we would expect that the lower hills and $1^{st}/2^{nd}$ terraces would be prime “preservation” areas.

Key Indicator:

#sites evaluated	1?
#sites Eligible to the NRHP	0
#sites intensively investigated	0

Health of the Resource: Sites located out of the floodplain/valley bottoms probably are in pretty good shape; those in the bottom lands could be poor given development and agriculture, but more dramatically the damage done by the erosion effects of major flood events like those of 1830 and 1927 (perhaps a 100 year pattern through time?).

Issue #7: Natural resource information sharing

Vermonters, and particularly citizens of the White River watershed, have a long history and affinity to their watershed. Many people have made their living from the land through such occupations as farming and logging, while others maintained a “closeness” to the watershed by observing natural events such as the violent floods throughout the 20^{th} century. These events have provided a certain degree of natural history and public education about natural resources and watershed health for many of its citizens.

In 1996, the GMNF, the Northeastern Area State and Private Forestry and the George Aiken Resource Conservation and Development Council, along with many others, helped to form the White River Partnership: a locally led and community driven collaborative between communities, citizens, conservation groups and Federal and state agencies. The mission of the partnership is to help local communities balance long-term cultural, economic and environmental health of the watershed through active citizen participation and continues to strive towards these goals today.

The Partnership has used several methods to engage citizens and communities in watershed restoration efforts and education; public forums to identify issues, visions and actions; field days and "explore your Watershed lectures"; Adopt-A-Salmon Family classroom watershed education curriculum; recreational events such as Paddle Fest Days, and Eco-Heritage tours to name a few.

It is widely recognized by many people in the watershed that in order to be successful more citizens must participate and engage as customers and partners in their watershed's future. Without this level of participation and local involvement, there is the potential of losing public and private support including human and financial resources. Therefore, we feel it is very important to continue to bring information about natural resources in the watershed to the schools and adults in the communities.

STEP 4: REFERENCE CONDITIONS

In this step we explain how ecological conditions have changed over time. The purpose is to develop a historical perspective for comparison with current conditions. We think of the "reference condition" as being hundreds to thousands of years of continuous ecosystem change. Reference condition descriptions are presented by major resource area.

Aquatic and Ripairan Areas

<u>Core Question: Erosion and Sedimentation Processes</u>
What are the historical erosion processes within the watershed (e.g., surface erosion processes, mass wasting)? Where have they occurred? (Addresses Key Questions 1 and 2).

Historical mass wasting erosion processes are not documented for the Upper White River watershed. It is likely however, that mass wasting was not a significant erosion process given the soil types present and the dense vegetation found in undisturbed riparian areas. Historical surface erosion occurred on stream bottom and banks and from upland areas disturbed by natural flooding or high precipitation events and possible wildfire. Management activities such as road building and maintenance, timber harvesting, clearing of streamside vegetation for agriculture, pasture and rangeland, and gravel mining and extraction have also contributed significantly to surface erosion over the past century or so.

In general, watershed health regarding erosion and sedimentation processes was likely at its worst between 1850 and 1950. In the 1960's changes in land use and extensive reforestation of the landscape coupled with a change in the environmental conscience of society lead to improved land ethics and stewardship. However, significant amounts of erosion from gravel roads in the watershed and the lack of riparian buffer strips along stream banks persist as sources of stream sedimentation today.

There are currently two models or measures recently developed to predict surface erosion in a watershed. To our knowledge neither have been applied in the upper White River watershed. We believe our best indicator at this time is to identify sedimentation levels in critical fish spawning and rearing habitats that provide insight to the natural erosion/sediment conditions of the watershed. This measure serves as the proxy for predictive models and can provide information on the effects of erosion and sedimentation during and following management activities as well as cumulative erosion effects.

A large body of scientific literature exists on the effects of erosion and stream sedimentation on both resident and anadromous fish species. Many native species inhabiting the White River watershed are adversely affected when sediment levels exceed 20% fines and silt (stream bottom material less than ¼ inch in diameter). Because river systems are dynamic, we presume that there is considerable variability in annual sediment production and sedimentation delivery in the watershed due to environmental and other factors. However, we believe that because natural fish production is diminished when sedimentation exceed 20% fines in spawning habitat, it is a good indicator of biological health and target reference condition. This figure is also the desired future condition for trout and salmon spawning habitat in the Forest Plan.

<u>Core Question: Stream Channel and Hydrology</u>
What were the morphological characteristics of stream valleys and the general sediment transport and deposition processes in the watershed? What are the historical hydrologic characteristics (e.g. peak flows, minimum flows) and features (e.g. cold water seeps, groundwater recharge areas) in the watershed? Addresses key question 4.

Although there is currently no information about the natural range of fine sediment in the watershed, it is safe to assume that land management and development activities have likely impacted sediment transport and deposition processes in the watershed by changing the amount and timing of sediment to the stream. Large inputs of sediment from natural or management related disturbances can reduce the channel gradient by filling pools and can lead to drastic adjustments in channel morphology. A couple examples of this occurred following channel dredging following floods of the 1970's and 1998. These actions resulted in filling pool habitat and widening of channels. In addition, many river sections have lost their connectivity to the floodplain. This has resulted in changes of channel types particularly shifting of "C and E" channel types to "F" channels that are indicative of degradation.

The reference condition for the valley portion of the upper White River should be comprised of a mixture of type C and E channels that exhibit pattern, profile and dimension typical for these stable channel types. This should include width:depth ratios, channel cross-sectional area and entrenchment that are within the channels natural range. This could take decades to occur naturally but in some cases it may be possible to expedite channel evolution through corrective restoration actions.

Most upland "A and B" channels are currently within the range of natural conditions for channel entrenchment, cross sectional area and width:depth ratios. However, these assessments are based on data compiled from many sites throughout the eastern United States. Vermont specific data for these stream variables is currently in the developmental stage. As this data becomes available, the reference conditions may be adjusted for these upland stream channel types.

Changes to the hydrologic characteristics and features of the watershed are less known. However, there is considerable documentation in the literature that flow regulation from human impacts, especially dams, roads, development and land use changes, can affect a streams hydrologic and ecological characteristics. The ideal reference condition would mimic the pre-disturbance flow regime. However, this would be impractical given the human needs and values that exist today in the watershed. But it should be our goal to attain or recover as much as possible of the rivers' former flow regime.

Flow regulation can affect the timing, magnitude, duration and frequency of flows in a river. Magilligan and Nislow (1999) analyzed seven unregulated streams in the Connecticut River Basin, including the White River, in order to establish the regional natural flow regime and demonstrate how it was changed over the 20th century due to on-going land use changes. They found that peak flows declined over time and that low flows have steadily risen over a period dating back to 1915. The increase low flow over time reflects the increased re-forestation in Vermont over the 20th century. In the early part of the century, the lowest 1-day minimum flow average occurred on September 23; whereas, the 1-day minimum flow has become progressively earlier over the years and now occurs, on average, on August 11th of the year. The decrease in the date of minimum flow reveals the increased regional recharge in conjunction with landscape re-vegetation and increased soil infiltration. They believe this late summer/early fall timing of the minimum more closely approximates the pre-disturbance hydrologic regime that aquatic biota have evolved to expect in this watershed and region. Also, snowmelt runoff peaked earlier and larger in the 1920's than today, due to greater exposure of the snowpack to direct sunlight. These higher peak flows likely resulted in significant geomorphic adjustments such as changes in channel cross-sectional, bed elevation and planform morphology that still exist today. The DFC would include restoration of river channels and floods via locally developed regional hydrologic curves and channel classification as described above.

Core Questions for Fisheries Resources

What are the past, present, and DFC for trout and salmon populations and habitat?

Historically, the White River supported two native salmonid species, the Brook trout and anadromous Atlantic salmon, and several other non-game species such as Black nose Dace, Slimy sculpin, and White suckers. Rainbow and brown trout populations exist in the river but these species are not native to the watershed. There is limited historic population data for trout and salmon population. There are anecdotal accounts of trout abundance and salmon migrations in the watershed in the late 1900^{th} century. Definitive information on trout population started in the 1950's when "modern day" fish sampling technology became available to biologists. Juvenile salmon population data collection began in the 1970's in parts of the watershed. Information on the abundance of non-game species is limited to species composition and relative abundance. Trout and salmon populations today have declined substantially below levels observed in the 1970's. Water quality and macroinvertebrate studies aimed at identifying factor for the precipitous decline in the fisheries have been inconclusive. Based on the earlier population assessments, the reference condition should have trout numbers exceeding 3,000 per mile and approximately 30 lbs. per acre, juvenile Atlantic salmon production would be approximately 10-20 per 100 yd2 of habitat. It is important to note that fish production will vary by channel type, elevation, water chemistry, and other biotic and abiotic factors so the reference conditions cited above are general figures for the species identified.

It is difficult to estimate the historical or reference habitat condition in the Upper White River watershed because there are no known undisturbed areas. Scientific studies by Lichen and Bilby 1982 indicate habitat conditions particularly in smaller upland streams contained much higher quantities of woody debris than exist today. In fact, many of our streams today are conspicuously lacking woody debris. This condition has also affected how sediment is transported in these streams. Without wood in the stream channel, sediment and spawning gravel quickly moves downstream with high flows and is not trapped and collected throughout the stream as fish and macroinvertebrate habitat. Rearing habitat is also good with an abundance of large woody debris in the stream. Currently, the GMNF Land Management plan calls for 52 pieces of wood per mile. Based on stream habitat restoration work, channel morphology studies, and reference work in an undisturbed reach of Wonalancet Brook in NH, woody debris quantities should be much higher than Forest Plan levels. We believe a range from 150-250 per mile is desirable for the stream types found in the watershed.

The number of pools were likely greater under reference conditions than exist today. Again, the effects of land use changes of the past century or so, significant in-channel modifications from dredging and gravel extractions we believe has resulted in fewer pools, distributed further apart and of lesser quality (e.g. less hiding cover and shallower). Empirical hydrologic data for moderate to high gradient streams suggest pool habitat should comprise at least 30% of the stream area. The desired future condition in the Forest Plan is a range of 15-30%. Based on current stream habitat surveys, most Forest streams rarely exceeded 10% pool habitat during summer flow conditions. By implementing fisheries/stream habitat restoration projects and monitoring their effects, many stream segments have reached the DFC and have maintained those levels for several years. This figure represents habitat suitability requirements for Management Indicator species and other native fish species and a desirable level to sustain viable fish populations on the Forest. Additionally, pool frequency in step:pool system like much of the GMNF should approximate a 1:4 ratio, that is, 1 pool for every 4 channel widths. With less sediment and larger pools in the streams, overwintering conditions were also better in the pools and substrate of the larger streams in the watershed.

Core Questions on Riparian Conditions
What was the riparian condition in past year and to what extent has riparian vegetation been affected by past and current land uses.

Riparian vegetation along the streams in past years was probably healthier than it is today. The riparian area likely consisted of mixed age classes of trees and shrubs adjacent to stream channels. The larger and taller overstory vegetation played a major role in riparian and aquatic habitat quality and quantity. Prior to road building, expansion of agricultural practices, tree harvest and development in the upper White River watershed there were likely more closed canopies of healthy timber stands along the streambanks. Early settlement and land clearing as well as log drives associated with logging in the late-1800's to mid-1900's had profound impacts on riparian and aquatic habitats. There are numerous historical accounts of logs being sluiced down both small and large rivers during spring freshets. The degradation of riparian and stream habitats likely persisted for several decades until land use and cultural changes in the watershed and throughout Vermont occurred.

Today, riparian areas in the headwaters of the Upper White River continue to recover and have characteristics closest to the reference conditions. That is, the second or third growth riparian stands are now approximately 100 years old and provide improved streambank stability, shading to keep water temperature cool for native aquatic organisms, and some large woody debris (LWD) to the stream and forest floor. However, in reference areas, riparian vegetation would produce more large woody debris to the stream channel, and provide abundant cover and diversity so critical to spawning and rearing fish and other aquatic organisms. The riparian conditions were also conducive to filtering sand and silts from the stream at high water periods, and buffering erosion from the hillsides.

To illustrate this, current stream habitat surveys from small streams within the upper watershed such as Clark and Patterson brooks contain quantities of LWD ranging up to 80 pieces per mile. As previously cited in another section of this assessment, we believe the reference conditions for small streams up to approximately 30 feet wide should contain upwards of 200 pieces per mile of LWD. A quote from Zadock Thompson's Natural History of Vermont (1853) probably best describes the reference condition of Vermont watersheds "Before the country was cleared, the whole surface of the ground was deeply covered with leaves, limbs, and logs and the channels of all the smaller streams were much obstructed by the same. The consequence was that, when the snows dissolved in the spring, or the rains fell in the summer, the waters were retained among the leaves, or retarded by the other obstructions, so as to pass off slowly, and the streams were kept up nearly uniform as to size during the whole year. But since the country has become settled and the obstructions, which retarded the water, removed by freshets, when the snows melt or the rains fall, the waters run off from the surface of the ground quickly, the streams are raised suddenly, run rapidly, and soon subside".

Vegetation

Core questions: What is the array of vegetation and how does it compare to past conditions? What environmental and/or biotic (disturbance regimes, species competition dynamics) processes maintain them?

According to Brian Hawthorne who conducted research for this project, (Hawthorne, 2000.), paleo-ecological research specific to the watershed, Hancock or Granville could not be located at this time. Palynological studies for similar areas in New England were found. The nearest site was Little Rock Pond in South Wallingford Vermont on the GMNF (McDonnell, 1989). McDonnell's analysis was made in conjunction with William Patterson of the University of Massachusetts, Amherst and provides a paleo-environmental reconstruction for a site in central Vermont.

Following the retreat of the Wisconsin glacier more than 12,000 years before present, there was a period where the pollen record for the Little Rock Pond site in South Wallingford VT shows a tundra assemblage consisting primarily of dipoxylon pine (jack pine, *Pinus banksiana*), spruce and non-arboreal pollen (mostly Cyperaceae, with some Gramineae, *Artemisia* and *Ambrosia*).

Spruce pollen, most likely white spruce (*Picea glauca*) (Patterson, pers. Comm.), replaced the tundra assemblage. This mirrors similar time transgressive vegetation changes elsewhere in New England (Davis 1983). As spruce pollen declined, Ambrosia pollen reached levels similar to those of the recent settlement period and alder (Alnus) reached its post Wisconsin peak. These changes suggest that climate warming forced the spruce to move north across the landscape, creating substantial open areas.

These gaps in the environment were filled by birch. Betula pollen reached its highest peak since glaciation during this period, but declined and was replaced by pine and oak, resulting in a Pine-Oak-Birch forest. The increase in pine pollen was nearly entirely haploxylon pine, representing an increase in white pine (*Pinus strobus*). The increase in the haploxylon/diploxylon ratio suggests a warmer, drier climate.

The peak of this ratio and of the overall level of pine pollen coincided with the beginning of an increase in hemlock (*Tsuga Canadensis*), birch and beech (*Fagus grandifolia*). The Pine-Oak-Birch forest was replaced by Hemlock-Birch-Beech, with the first maple pollen (*Acre saccharum* and *Acre rubrum*) appearing at this time (Hawthorne, 2000).

This assemblage went through several shifts in relative species dominance. For example, a second increase in the haploxylon/dipoxylon ratio coincided with a temporary decrease in hemlock and increase in beech, possibly indicating the results of another period of climate change. Ultimately, the hemlock sharply declined and did not rebound, resulting in a northern hardwood Beech-Birch-Maple-Hemlock community common today in the Green Mountains. This hemlock decline has been observed elsewhere in New England approximately 5000 years before present (Webb 1982, Allison et al. 1986) and serves to date the emergence of the northern hardwood forest at the Little Rock Pond site in the mid-Holocene epoch (Hawthorne, 2000, see Appendix K for the entire report by Brian Hawthorne).

With the decline of hemlock, oak followed by white pine began to increase again, resulting in a familiar oak and pine component along with the northern hardwood forest. These proportions remained relatively stable until hemlock again began increasing and pine decreasing 2-3000 years ago. Several fluctuations in pollen levels occurred over the following millennia, but the general assemblage remained stable (Hawthorne, 2000).

Beginning about 500-600 years ago, beech and hemlock levels began a decline that continues to the present. A study in north central Massachusetts (Fuller et al 1998) found a similar pattern of beech and hemlock decline, and the author's note that the timing of this decline corresponds with the beginning of the Little Ice Age around AD 1450. The Little Rock Pond pollen record shows a concomitant increase in a cold-tolerant genus, spruce, supporting the theory that the beech and hemlock decline beginning in the centuries preceding European settlement was due to a cooler climate (Hawthorne, 2000).

<u>Vegetation Change in the Settlement Period</u>

Although the conveyance records for many of the tracts in the watershed included volume estimates for major timber species, these timber cruises included insufficient information on non-timber species. In Appendix K, Figures 3 and 4 show the percentage occurrence in the survey witness tree data from 1787 and 1935 for the entire watershed. Figure 5 shows the change in percent occurrence from 1787 to 1935. Figure 6 shows the same change relative to the 1787 percentage. Note that the figures for cherry in 1787 were derived from a single tree, and the very large apparent increase is probably spurious.

It appears that likely that the decline in beech can be attributed to the climate changes discussed above. Although beech has been in decline in recent years due to the beech scale nectria complex, the change from 1787 to 1935 predates the onset of this pathogen. There is no evidence of any cultural history that would result in a decrease in the amount of beech (Hawthorne, 2000).

Cluster analysis and ordination of the vegetation in 1935 and the change between 1787 and 1935 by tract were inconclusive, possibly due to the small total number of trees counted for each tract. Figures 7a-c show the change in percentage species occurrence by tract. Once digitized maps of the tract locations are available, this data should be incorporated as a separate GIS layer (Hawthorne, 2000).

<u>Survey Bias</u>

To analyze whether surveyors had a bias for some tree species over others, the mean distance for each species or genera (shown on Table 1 in Appendix G) was calculated and compared pair wise for all species with more than 1% representation. If surveyors preferred one species over another, they would be likely to select a tree even if it were not the closest tree to the corner. This would result in a larger mean distance. The results showed only a few cases at a 95% confidence level where the confidence levels did not overlap. Six species or genera were preferred over cherry (*Prunus serotina*). Beech, birch and maple were preferred over hemlock. Beech and maple were preferred over spruce. All other pairings of species showed no significant difference in the means of their distances from the survey corners. The only pairs where the bias amounted to more than 5 % of the mean of either member of the pair were the six pairs involving cherry (average of 24.5%), and beech vs. hemlock (5.5%). This implies that a probable bias in the survey data is an understatement of the amount of cherry present in 1935 (Hawthorne, 2000).

Due to the destruction of the original field notes from the town lotting survey, stake to tree distances were not available for the 1787 survey. An earlier study of town lotting surveys in Chittenden County (Siccama, 1971) found no species bias among the surveyors of those townships (Hawthorne, 2000).

Four hundred years ago, New England was forested with a wide range of tree species that varied regionally with climate and soil conditions. Although temperature and the length of the growing season declined generally, to the north the variation in elevation in valleys and mountains and the moderating influence of the ocean produced a complex geographic pattern in vegetation. There were treeless patches of tundra on the very highest mountains while more northern and higher elevations were dominated by red spruce and balsam fir intermixed primarily with paper birch. Broad areas of Vermont were covered with northern hardwood-hemlock forest, dominated by long-lived shade-tolerant species such as sugar maple, beech, and yellow birch. Paper birch was locally common along with white pine, pin cherry, white ash, and black cherry, especially on disturbed sites. To the south and at lower elevations, the oaks increased, first red, then black, and then farther south, white (Foster 2000).

Disturbances

The predominant natural disturbances in the watershed are wind, fire and pathogens. Although major damage from wind is infrequent, central Vermont is subject to occasional catastrophic hurricanes (Smith, 1946). Although the hurricane of 1938 caused only minor to moderate damage in central Vt, the eye of the storm did track nearly across the watershed (Foster, 1988) Estimates for the mean return period for wind disturbance in forests in the Northeast range from 1000 to 2000 years (Whitney, 1994). Others feel natural disturbance such as wind-throw occurring from hurricanes occurs (> 200 yrs. apart), and more frequent smaller storms occur (every 75-200 yrs, Foster, 2000).

In addition, floods, fire, insect and disease outbreaks helped create the forested and non-forested communities and habitats. Presumably, patterns in forest structure would have resulted from the tendency for the strongest winds in New England hurricanes to come from an easterly direction. On exposed- level or east facing slopes, (predominant in the WS), intense winds would have initiated patches of younger dense forest strewn with mounds resulting from the roots of downed trees and decaying wood. In narrow valleys and on leeward west facing slopes, extremely long intervals without such damage would have led predominantly to old-growth conditions. The actual effects of hurricanes on forest composition in these areas were probably minor. In fact, there is no indication of a pre-European hurricane in the pollen record of vegetation change (Foster, 2000).

In contrast fire has left a definitive record in the form of charcoal and vegetation change in wetland and lake sediments. Fire in New England is generally interpreted as purposeful burning by Native Americans to improve hunting and village sites. Fire is also the major means by which a relatively small population of fewer than 150,000 individuals lacking domesticated animals or widespread agricultural practices could have an extensive impact upon the landscape. Fire and local human activity are also primary means by which young and open vegetation and its associated early successional plant and animal species may have been maintained in a largely forested landscape. Based on a handful of early quotes from Thomas Morton, William Wood and others from very few localities, extreme pictures of Native American activity and the resulting vegetation have been depicted: frequent, or even annual burning that created open, parklike forests, savannas of grass and interspersed trees, extensive sandplain grasslands, and mosaics of active agriculture and successional vegetation on fallow fields and abandoned villages (Foster 2000).

The paleoecological record provides no support for these visions and when coupled with other historical data paints a very different picture of the broad landscape. Sites from central Massachusetts uplands show evidence of fires and vegetation dynamics but only at 100-year intervals or longer (Foster, 2000). Palynogical studies of charcoal in stratified sediments in the Northeast suggest return periods of 800-1400 years (Patterson and Backman, 1988). Unfortunately, charcoal studies have not been completed for the Little Rock Pond samples (Hawthorne, 2000). Although infrequent, the effects of the fires modified this forested landscape as sprouting and successional species such as birch, chestnut and oak prevailed for more than 250 years after each fire. In the Berkshires and uplands of northern Vermont, an even lower frequency of fire is recorded, presumably due to wetter conditions and lower Native American populations (Foster, 2000).

Pathogens have played an important role in the composition of New England forests. These include the hemlock pathogen of 5000 years B.P. (Allison et al., 1986), beech bark disease, spruce budworm and the 20th century chestnut blight and gypsy moth infestations. Although no documents detailing the effects of these specific pathogens have been included for this project it can be safely assumed that these types of pests occurred here, some still do and are a major source of vegetation disturbance in the watershed (Hawthorne, 2000, Casey, pers. Comm., 2000).

<u>Processes that Formed the Relevant Forested Communities:</u>

The processes that create enriched northern hardwoods include geologic, geomorphic, and colluvial processes. These communities occur where there is limestone in the bedrock or in the hard pan, that is near or leaches to the surface; where a basal till hardpan is present that restricts drainage enough to keep the site mesic, but not a wetland, and encourages lots of seeps and springs; and where steep slopes encourage downward movement of soil and detritus, which collects in small pockets and at toe slopes where it composts and creates high nutrient levels. Where all three processes coincide is where the highest likelihood of finding rare plants exists. It is likely that most of the rich woods in this watershed have been affected by previous logging over the past 150-200 years. These areas tend to be quite productive, and where the slope gradient was not prohibitive, they were logged. There is very little information on the effects of logging on the plant diversity and rare plant habitat quality of rich woods. Consequently, we have no real sense of how different, if at all, these rich woods communities are from those one may have found during pre-history. As they also tend to occur frequently but at a local, patchy scale, it’s very unlikely that any of the early land survey records can indicate an early historic distribution pattern for these communities. Some research is taking place at Mt. Equinox, looking at effects of agriculture on rich woods. There are indications that diversity is reduced in rich woods with an agricultural history. One of the problems we face in sorting out the effects of logging on rich woods is the basic research that is still missing that would describe the detailed ecology of this natural community. Although we can describe in general terms the processes that form and maintain these sites, we do not know the relative importance of these various processes in providing high quality communities and rare plant habitats at any given site. Consequently we cannot sort out the difference in a logging effect from a site effect.

The processes that form wet spruce-fir forests include hydrologic and microclimatic processes, as facilitated by topographic position. These communities form in areas of restricted drainage (basal till hardpan) on flat surfaces (small plateaus, benches, or concavities) where cold-air drainage is facilitated and/or elevation is high enough to favor spruce and fir. The processes that form montane spruce-fir include climatic and soil development processes. These communities form within an elevation zone where temperatures are low enough and conditions are extreme enough to favor dominance by red spruce and balsam fir over northern hardwoods. In this zone, soil forming processes are slow, and consequently acidic organic matter accumulates with low rates of decomposition; in many places bedrock is shallow to the surface, favoring species with shallow root systems and low nutrient needs. Although most of the stands of spruce-fir (wet or montane) today originated from early logging of red spruce, the conditions tend to be harsh enough on the montane sites that logging occurred only once around the turn of the century, and may not have had dramatic effects. The wet sites may have been repeatedly harvested, as soil moisture conditions were not of general concern during the early 1900s, and sites were easy to get to and operate in due to gentle grades. However, as in the case for rich woods, we have no information on the effects of early logging on the plant diversity or rare plant habitat quality of spruce-fir forests. Based upon general ecological principles, however, it is reasonable to speculate that montane spruce-fir forests in this WS bear more resemblance to their prehistoric counterparts than the wet spruce-fir forests; for these wet forests, we cannot even speculate as to the prehistoric composition, given the repeated logging over the past 150 years.

Conclusion

The largest changes in vegetation since glaciation have apparently been due to variations in climate and pathogens. The pollen record suggests that the periods of these variations range from several millennia down to several centuries. A gradual changing forest has progressed from a Jack Pine-Tundra assemblage (10,000 years BP), through successive forests dominated by White Spruce, Birch, Pine-Oak, Hemlock-Birch-Beech and Beech-Birch-Maple-Hemlock. From the onset of the Little Ice Age (500-600 years B.P.) until settlement (ca 200 B.P), the composition of the forest was shifting away from a heavy dominance by beech towards spruce.

The decline in beech has been continuing since settlement, although spruce has also decreased in the settlement period. The largest increase of an individual species since settlement has been cherry (Prunus serotina), as evidenced by a nearly nine-fold increase in cherry trees among witness trees, despite surveyor bias against cherry trees in the 1935 survey. This species has seeds that can survive several decades in the forest floor, germinating only when a large gap has been opened to allow sunlight to enter. The decrease in spruce and increase in cherry reflect over a century of timber harvesting. These compositional changes are much smaller than the climate-induced change in the amount of beech present. Although one could specify the reference condition of the watershed as the condition of the forest immediately prior to settlement, that beech-dominated Northern Hardwood-Hemlock association was already being altered by climate changes before the European settlers arrived. Perhaps the best solution is to see the forest condition not as static, but rather as a dynamic pattern, varying with long-term climate change and short term pathogen outbreaks (Hawthorne, 2000).

Recreation

Core questions: What is the kind of recreational use that took place and where did it occur? What are the uses now and where do they occur?

According to historic data in town plans, the population of much of the watershed peaked in around 1880. Current plans recognize that the economic well being of the towns and region are inextricably tied to the natural resources. Using the land for subsistence was more important then, whereas we have become importers of resources and food from global sources. Today we have much more leisure time and money so recreation and aesthetics are much more important today.

The Two Rivers-Ottauquechee Regional Plan covering this watershed calls for: improving public access, providing management and information about outdoor recreation opportunities, development of greenways and recreation corridors, to maintain access to private land through the traditional means of landowner permission, to ensure that roadways and town centers are safe for bicycle and pedestrian traffic, and to maintain a healthy natural environment. It especially emphasizes maintaining aesthetic qualities along ridgelines and travelways.

Public works projects in the mid 60’s created or updated many of the developed recreation sites we have today including Texas Falls. During the 60s, 70’s, and 80s, many of the historic roads were re-built to today’s standards. Many new roads and spurs were added for extraction of forest products - primarily timber. Since then, the function of these roads has changed and expanded. They now serve as recreation opportunities themselves (for viewing scenery, skiing, and snowmobiling) and as access to recreation opportunities.

<u>Trails</u>

Many of the trails used in the watershed piggyback on transportation systems first used as homestead access or for logging access. Notable exceptions include the main Long Trail (built and rebuilt and relocated many times since 1910) and small segments of the snowmobile trail system.

In general, the trail systems are in reasonably good condition. Persistent efforts during the 80s and 90s have improved the locations and condition of many trails. Maintaining erosion control structures and maintaining or replacing bridges has been a priority.
There have been neither few demands nor any dramatic opportunities for new hiking trails within the watershed. The Clark Brook Trail remains as one of the few trails with some uncorrected flood damage. Repairs were funded and scheduled for summer 2000. Blazing and signing is generally good. Debrushing is a constant effort but with help from partners like GMC and VAST and our Wilderness Rangers, we have been able to keep most trails in the watershed reasonably well debrushed.

The number of snowmobilers and cross country skiers exploded during the mid-70s outdoor recreation binge resulting from post war economy boom and baby boomers reaching young adulthood (among other reasons.) At the time, there were fewer interconnected trails for snowmobiling but travel distances were much shorter than today. Snowmobilers were primarily local residents. Cross-country skiing occurred but this was not a hotbed of ski activity. Today, snowmobilers use the area during low snow times elsewhere and for access to other parts of the state by through travelers. Cross-country skiing has become a more important activity in the area compared to the mid 60's and 70s.

Developed Sites

As mentioned previously, Texas Falls is the only developed site. It requires rehabilitation and maintenance.

Undeveloped Sites

Primitive camping requires little in the way of capital investment, thus it grew in popularity during the inflation wracked years of the 70s and 80s as urban and suburban populations expanded. This combination of economy and increasing population created a desire to find inexpensive, remote getaways such as National Forest primitive campsites.
Opportunities for camping sites and picnic areas were developed to meet the needs of a growing population of recreationists. The old fields and open lands that were part of the landscape has changed. The lack of brush control in these old fields has reduced the attractiveness of this area for camping and eliminated many of the views that make the remote parts of this area attractive for viewing scenery

Trends

While we do not have statistically accurate data on the amounts of recreation use, we can draw conclusions from current research on demographic trends in recreation, from data we have collected, or from empirical observations when they can be used somewhat reliably.

Formally declared Wilderness did not exist in the watershed. In 1984 however, Congress established the Breadloaf Wilderness.
It is likely that highway related recreation activities (front country) will remain important and probably increase. Similarly, our Wilderness data shows a significant increase in the number of people using the Breadloaf Wilderness between 1985 and 1996. Use since 1996 has been steady with weather related ups and downs. The increased use has occurred at

destination points like Skylight Pond or Sunset Ledge (outside the upper White river watershed.) We expect the number of people entering the Breadloaf Wilderness, specifically for the Wilderness experience, to remain steady or gradually increase. The amount of cross-country ski use is declining. Snowmobiling use appears to have peaked. We do not have good information on trends for picnicking. Fishing remains steady statewide though we have no information specific for the Upper White River Watershed. Similarly, the amount of hunting is slowly but steadily declining though information is not specific to this watershed. During the current economic growth period, the amount of primitive camping has declined.

Rare Plants

Core question: What environmental and/or biotic (disturbance regimes, species competition dynamics) processes maintain them?

"Given the extensive forest that predominated in most of New England, many features that are now uncommon in our landscape would have been widespread. Most obvious and abundant would be the structural elements of old and deep woods- massive windthrow mounds and pits from roots, large decaying boles of fallen trees, and dense jumbles of coarse woody debris in brooks, streams and rivers…..meanwhile, many common successional and open-land species of plants, insects and birds that surround us today would have been uncommon, clinging to ridge tops, cliffs, and bluffs, or the edges of Native American villages where harsh environments and disturbance kept sites open and dynamic….What you can say about the New England landscape in the time before European arrival is that it was always changing; that it was varied and followed its own vagaries rather than the more arbitrary divisions of ownership and land use that drive the modern pattern" (Foster 2000).

The types of non-forested communities such as upland meadows, shrub and grasslands that exist today were not as widespread in pre European New England. Following European settlement, the effects of agricultural land clearing that occurred in the eighteenth century followed by large scale sheep grazing in mid to late nineteenth century in Addison County likely had major effects on forest and non forest vegetation in the watershed. This period of land clearing and increases in sheep pastures and grazing peaked in the late nineteenth century, resulting in a landscape that was only about 20% forested. Indeed, sheep ranching was so widespread, Addison County was known as the Marino sheep capital of the world.

There are strong correlations between plant community composition, soil type, soil moisture, landform type and elevation. The soils and geology of the watershed are within one distinct physiographic province.

The combination of colluvial landforms associated with limey bedrock created pockets of rich northern hardwoods. These areas occur more frequently within portions of the Rochester District on the east side of the Green Mountains. These areas have deep organic soil layers, higher pH levels and high site indexes supporting excellent timber growth and habitat that supports plant communities uncommon to the remainder of the northern hardwood forest.

Processes that Formed the Non-forested Communities:

The non-forested communities of interest, primarily wetlands of various types and exposed surfaces, form through a variety of processes, including hydrologic, glacial/geomorphic, and geologic. Most of our cliffs and ledges were formed through geological processes several million years ago via mountain building. Glacial/geomorphic processes contribute to the formation of the ponds, wetlands, and spring runs and seeps through development of basal till hard pans in the soil that restrict drainage, and the carving out by glaciers of bowls and concavities where water and organic material can gather and accumulate. Damp upland meadows are interesting in that they are not associated with wetlands per se, and are likely an artifact of land clearing by humans. Allowed to regenerate to forest, these areas will become forests, and most likely may be damp but not wet forests. The rare species associated with these openings likely evolved in the drier portions of wetland environments. Beaver have a strong influence on development of certain types of habitats within wetlands, including this habitat, but on a shorter time scale (15-30 year cycles).

Processes that Maintain these Communities:

Maintenance of these communities is accomplished primarily through natural processes that don't necessarily involve humans. The processes that maintain them in many cases are the same processes that created them (especially for cliff communities). However, while these communities may progress along quite nicely with these natural disturbance regimes, the influence of humans and changes in distribution of creatures that may find this habitat desirable means we cannot be sure that the historic regimes will perpetuate the community of interest. At cliff sites, natural disturbance like severe wind exposure, vulnerability to periodic drought, and regular sloughing off of rocks are agents to which the species associated with these habitats are adapted. However, heavy severe trampling of cliff tops by humans, and increased severity of weather systems are perhaps beyond the normal range of disturbance experienced historically by these species, and add to their vulnerability.

Disturbance through windthrow and wind/ice breakage typical along the mountain slopes of the Forest continue to contribute organic matter to the soil surface, which in rich woods can enhance nutrient status through a "composting" effect. The range of wind and ice disturbance that the forested communities are exposed to involves extremely rare events that damage large acreages, and quite frequent events that damage one to a few trees at a single site. Even hurricanes are much more prevalent further east of the Green Mountains. Disturbances that are large, frequent, and at regular intervals are not necessarily within the natural range of disturbance that prehistoric versions of these communities were exposed to; this is, however, a familiar set of conditions over the past 200 years. Again, it is not clear, given previous land use history and changes in disturbance patterns in these areas, that reverting back to a more prehistoric disturbance regime will recreate rich northern hardwoods in the future that mimic those few high quality examples still remaining in the state, especially given our lack of understanding of the detailed ecology of this natural community.

The influence of beaver in wetland environments is significant in creating complexity within wetlands and adding habitats and consequently niche space for additional species. Through the wide but fairly regular swings in moisture regime and plant succession in these areas, habitat for rare species such as *Sisyrinchium* are regularly created, and likely could be found at any point in time within a large beaver meadow complex. The human process of clearing land to create open habitat that is perpetuated as open graminoid and/or brush, with patches of bare soil for colonization, will possibly maintain rare plant habitat in areas that are moist due to some restricting layer. Although not necessary, it's likely to augment beaver processes that would create similar habitats in wetlands.

In areas where beaver are not prevalent, long-term development of wetlands and ponds in relative isolation from disturbance contributes to the characteristics that make these habitats unique. These characteristics include large accumulations of organic matter leading to peatland development, and relatively stable water depths and pond inputs leading to development of bog mats on pond edges and stable pond bottoms and water quality where aquatic plants can find secure habitat. It is unclear the extent to which rare plant habitat in wetlands or ponds has been suitable for a long time due to the total absence of beaver (i.e. habitat not suitable for beaver), or just became suitable during the period of beaver extirpation (1900) and subsequent recovery. It's not clear if beaver ever inhabited Skylight Pond, for instance.

Climate is also an important factor controlling both the development and maintenance of these communities. Many of these rare plant habitats are associated with communities dependent upon the altitudinal climate break between mountain slope hardwoods and upper mountain slope spruce-fir, and with historic annual precipitation. Changes in climate, whether human induced or part of a global cycle, will force changes in the altitudinal break, and we will likely see enhancement of some communities at the expense of others. It is unclear at this point who the winners and losers will be, although most models suggest a warmer climate, which would indicate some loss of montane spruce-fir habitat.

<u>Changes in these Communities:</u>

Currently, it is not clear that there are any significant changes occurring in any of these natural communities that are having dramatic effects on the viability of these communities or rare plant occurrences. All of the known sites are protected under Forest Plan standards and guidelines, and some by management area designation. None of the known occurrences or sites are monitored regularly for population status or site condition. There is no research in the watershed or nearby focused on these habitats and the management regimes they are subject to documenting effects of these regimes. It is clear that most of the managed forest within the watershed does not bear much resemblance currently to what we suspect the communities were like in pre-history.

Beech is certainly far less dominant today, and the effect of the short- or long-term extirpations of certain species (e.g. beaver, chestnut, passenger pigeon) is not known. We do know that the frequency of occurrence of rich northern hardwood communities has been greatly underestimated in this watershed, especially relative to its value both commercially for timber and for levels of diversity of plants and animals. These areas also appear to be some of the most resilient and resistant to forest management, but without research characterizing this there's no way of knowing if this is so. We also know that few if any of these rich sites were recognized during early land surveys, and so we have no prehistoric baseline for comparison within the watershed. It is unclear how much of a resemblance the non-forested habitats bear to prehistoric conditions, although we suspect it's a closer one.

We can say that even-aged management over a large portion of the forested landscape is not consistent with prehistoric patterns of disturbance; however, we cannot either qualify or quantify the effects of that change in pattern, or that this has resulted in major change or increased vulnerability of certain species. The evidence for a potentially negative effect on biodiversity in general from past agricultural land use in forests is becoming clearer. However, lack of research in both rich woods and spruce-fir woods (wet and montane) relative to this management regime limits our ability to estimate changes in suitability or threats to viability of habitat or species.

Rare Wildlife

Core questions: Where is the TES habitat in the watershed?

Threatened, Endangered and Sensitive Species and Habitats

"Given the extensive forest that predominated in most of New England 400 years ago, many features that are now uncommon in our landscape would have been widespread. Most obvious and abundant would be the structural elements of old and deep woods-massive windthrow mounds and pits from roots, large decaying boles of fallen trees, and dense jumbles of coarse woody debris in brooks, streams and river. Meanwhile, many common successional and open-land species of plants, insects and birds that surround us today would have been uncommon, clinging to ridge tops, cliffs, and bluffs, or the edges of Native American villages where harsh environments and disturbance kept sites open and dynamic" (Foster 2000).

Since old growth forests were widespread, the types of non-forested communities such as upland meadows, shrub and grasslands that exist today were not as widespread in pre European Vermont. Following European settlement, the effects of harvesting timber and agricultural land clearing included extermination of large predators like wolves, cougar. Large-scale agriculture and sheep grazing in mid to late nineteenth century in Addison County likely had major effects on keeping bounties for predators in place.   This period of land clearing and increases in sheep pastures and agriculture peaked in the late nineteenth century, resulting in a landscape that was only about 20% forested thus limiting habitat for large predators and their prey alike.

Bald eagle

The specialized requirements of bald eagle do not exist within the watershed. The reference condition is that this watershed is not important for bald eagles or they may have the White River corridor only. The downstream reaches of the White River more closely resemble the type of waterway utilized by bald eagles and they have been seen along the Connecticut River.

Indiana bat

Surveys of hibernating bats in Vermont caves date back to the early 1930s (Trombulak and Parren *in litt* 1998). Between 1934 and 1946, Indiana bats were documented in low numbers (<100) in the Ely Copper Mine and Plymouth Caves, and in higher numbers (<270) in Dorset/Aeolus Cave and Nickwacket Cave. However, by 1994, Indiana bats had disappeared from the Ely Copper Mine, Plymouth Caves and Nickwacket Cave, and were found in very low numbers in Dorset/Aeolus Cave (1 to 8 bats). Only one Indiana bat was found in the most recent survey (1998) of Dorset Cave.

Canada lynx

In Vermont, only four verified records of historic lynx occurrence exist (Mckelvey et al. 1999b) In the mid-1900s, it was reported that Vermont had not had a documented breeding population of lynx for several decades (Osgood 1938 in Vermont Department of Fish and Wildlife 1987). In fact, we have no evidence of a breeding population ever occurring in Vermont. Since 1972, the lynx has been listed by the State as endangered. The last verified occurrence was from 1968, with periodic reports since then. Vermont naturally supports less lynx habitat than we previously presumed, based on analyses by McKelvey et al. (1999b). Furthermore, lynx habitat in Vermont is somewhat isolated from that in New Hampshire. Therefore, one must conclude that lynx occurrence in Vermont is so poorly documented, and, based upon the limited extent and dispersed nature of suitable habitat, lynx were probably never abundant or persistent over time.

Eastern cougar

Some historic references stated that cougars were not common in Vermont but troubled early residents, "The Panther….has never been abundant… but they were formerly much more common in Vermont than at the present day and have done much injury by destroying sheep and cattle" (Titcomb, 1901). "By February, 1779, at the first session of Vermont's legislature, a bounty was placed on wolves and panthers. Although the last bounty was paid in 1896, panthers were nearly exterminated by 1850. The last report of a cougar killed was in Barnard in 1851. A panther was thought to have been seen by several observers in the vicinity of Randolph in 1940. From 1940 to 1945 there have been many panther reports carried by the press in the state" Leonard E. Foote, A History of Wild Game in Vermont, Third Edition Revised, 1946. Occasional unconfirmed sightings are still reported, however state biologists believe they are not eastern cougars.

With a major increase in population and development since those times, cougar preference for residing in areas isolated from human activities limits suitable habitat in Vermont.

Cougar home ranges are not known for the New England but they are known in western states to travel between 20 and 30 linear miles during hunting trips. Western home ranges may exceed 30 square miles (19,200 acres). The approximately 63 square miles within the watershed could potentially be a suitable reference size needed for Eastern cougar if there was a resident population in Vermont

Eastern Timber Wolf

Timber wolves were widespread in Vermont although early residents were not fond of them and this set the tone for early observations.

"One of the most common and noxious of all our animals is the wolf…" "They are not often seen in the day, but in the night venture into our yards and barns.- these animals are yet in great numbers in this state; they destroy many of our sheep in the night; find a safe retreat in our woods, and mountains; but are gradually decreasing, as our settlements increase and extend. – The wolf is a very prolific animal"…Samuel Williams LL.D. Natural and Civil Histories of Vermont, 1794.

"Bears and wolves prowled around the clearings…wolves were shot and trapped for their skins (Wells, 1923), In the first settlement of the town (Peru)…wolves roamed in the forest unmolested" (Batchelder, 1891), "At the time the settlement of Salisbury began, wolves were very numerous…(Weeks, 1860) Leonard E. Foote, A History of Wild Game in Vermont, Third Edition Revised, 1946.

The conditions that provided suitable habitat for Eastern timber wolves before and during early European settlement or during the agricultural growth period may be irretrievably lost in Vermont.

Sensitive Species

Eastern small-footed bat

Our staff has found no reference information about this bat.

Recent efforts that have been established for monitoring woodland bats on GMNF will provide valuable information about conserving habitat and documenting occurrence. The terms and conditions in the Biological Opinion on the Effects of the GMNF Land and Resource Management Plan and other Activities on Threatened and Endangered Species in the Green Mountain National Forest will be beneficial to Eastern small-footed bats. Retention of roost trees and a better understanding of summer foraging habitat will ensure conservation of important habitat.

Bicknell's Thrush

Bicknell's thrush was thought to be a subspecies of the gray-cheeked thrush. Since it was only very recently identified as a separate species, little is known about this bird for the reference conditions.

We do know it frequents areas of spruce/fir habitat above 3000' elevation. These locations within the watershed are limited to ridgetops in Breadloaf Wilderness adjacent to the Long Trail corridor

Jefferson Salamander

Distribution is restricted to vernal pools below 1200' elevation in Vermont. GIS mapping of wetland sites has identified potential suitable habitat. Determining occurrence is needed within these areas.

Wood Turtle
There is a need to gather information on occurrence and habitat requirements for wood turtles to develop reference conditions.

Odanata
Information on occurrence and special habitat requirements for dragonflies and damselflies is needed to develop reference conditions.

Other RFSS Species

There has been a determination that habitat requirements of other RFSS species are not found within the watershed. Any future management activities within the watershed will require the proper environmental and biological evaluations to determine the effects of projects and activities on Federally Listed Species, Regional Forester's Sensitive Species, and Species of Concern.

Prehistoric Land-use

The conditions described in the terrestrial reference condition for this area for the distant past was integral to understanding the presence of people on the landscape for the last several thousand years. Studies of pollen and spore analyses from the region and comparative data, indicates that from ca.11,500-9,000 before the present (BP), a post-glacial aeolian tundra-desert gave way to a "park" tundra with spruce, fir & birch. These forests supported herds of barren ground caribou, and numerous smaller mammals and bird populations. Mega-fauna – for example, mastodons -- may have been present briefly, but they are unlikely to have been here by the time people arrived, approximately 11,000 years ago. In contrast, recent thought is that bird flyways – which have remained relatively unchanged -- were a significant attraction.

By 7,000 BP there are hardwoods in the Champlain Valley, with conifers dominating in the uplands. Continued warming trends led to mixed hardwood forests at higher elevations. "Modern" climatic conditions were probably in place by around 3000 BP, although various peaks-and-valleys in temperature and moisture regimes continued to the present. This affected both the vegetation mixes and fish/wildlife species and, by direct extension, subsistence patterns for people. The extent to which this model for the Champlain Valley changes when applied to the White River valley has not been well documented. Some differences could occur due to the White River valley's protected nature, range of elevations, and Land Type Associations.

Human use of the landscape during the Paleo-Indian and Early/Middle Archaic sequences (ca. 11,000-6,000 BP) was largely restricted to hunting, gathering, fishing, and establishment of domestic sites. The bedrock types in the White River area would not have encouraged quarrying for raw material to make stone tools. This would have been more likely to occur on the quartzite-based western side of the mountains and in the quartzite and chert beds of the Champlain Basin.

The implications of the prehistoric period on the reference condition of the watershed are minimal. Some modification of plant communities occurred through harvest and selective protection; some animal populations were controlled through hunting & trapping; and the use of fire as a habitat management may have occurred. However by-and-large, human populations are perceived to have been too small during this period to cause profound effects on the environment.

In contrast, Late Archaic and Woodland Period societies (ca. 6,000 BP to 1600+ AD, including European colonization) had an increasingly noticeable affect on the environment. Larger populations, new technologies, an evolving subsistence strategy, and associated increases in the size and duration of occupation of villages, all lead to both more intensive and more extensive effects. The major human actions which changed the environment were: the intentional encouragement and protection of plant communities; burning to open up the understory and enhance game habitat, targeting berry and mast species, and contributing to an oak presence; quarrying steatite (perhaps south of the Upper White River Watershed) to make soapstone bowls; the development of agriculture over the last 2000 years, requiring cleared fields, some near streams and rivers; and biodegradation of local environments associated with, for example, long-term village locations.

In summary, subsistence activities and residential sites would have had an effect on the health and diversity of the forest community, size and behavior of wildlife species, and fragmentation of the forest. It also increased sedimentation rates in the streams near villages. The Native Indian population was displaced through disease and war, starting in the 18th century; thus, the patterns of their lifestyle is now known only through archaeology, oral histories and a handful of early settlers' or explorers' accounts.

Historic Period

The arrival of Europeans changed everything. After more than a century of socio-economic disruption, demographic demolition, and three wars involving Indians and Europeans, Hancock and Granville were incorporated in 1781. The next 150 years witnessed more major changes to the landscape and impacts on the environment than the cumulative impact of 10,000 years of Native American land use.

Logging has been a major, continuous focus in the area from earliest settlement to today. In addition, dairy and (later) sheep farming have been traditional economic pursuits. The infrastructure aspects of this largely "industrial" setting (homes, farms, schools, mill sites, transportation systems, etc.) tended to cluster in Hancock and Granville, and along five linear stretches: Route 100, Route 125, the Texas Gap to Granville Road, the White River and Rob Ford area northwest of Granville, and the roads up Kendall, Clark, Thatcher, and Howe Brooks on the East side of the study area. Within National Forest System lands, much of this infrastructure now exists only as archaeological sites and some potential "cultural landscapes".

One could broadly characterize the historic land-use patterns as having the major mills, dairy agriculture, town administrative and commercial centers and transportation depots in the valleys and low hills. Logging camps, smaller mills, farms and villages, sheep pasture, and orchards dominated the mellower uplands. The highland areas received little settlement but extensive logging and grazing use.

Mining for talc and Verde antique marble occurred in isolated locations and had very local environmental impacts. Rail line spurs to the mines may have had a greater impact than the mining. Gravel pits had a larger affect on the landscape and drainages.

STEPS 5 and 6: SYNTHESIS AND RECOMMENDATIONS

ISSUE #1: Aquatic and riparian area degradation

Desired Condition: Riparian and aquatic ecosystem function, structure, and processes are restored to the extent possible, considering the social and economic needs of people living in the watershed. Water quality standards (chemical, physical, and biological) are met, riparian buffer strips are in place, and stream flows are at or close to that needed to maintain a properly functioning channel (a state of dynamic equilibrium). Major sources of sediment and pollution are minimized and aquatic habitats and populations are improving because habitat components such as LWD, appropriate stream temperatures, spawning gravels, and pools exist. Water and soil resources are recovering from the negative effects of acid deposition. Land uses and management in the watershed support achievement of the desired condition. This desired condition is reflected in the Forest Plan goals, S&Gs, and (see Plan, pages 4.04-4.05, 4.19, 4.37, and 4.37-1 through 4.37-3). The desired condition applies to all lands in the watershed.

Findings	Priority	Strategic Recommendations	Tactical Actions (next 2-3years)	Indicators
Many riparian areas along the main stem of the White River and Hancock Branch lack forested buffer strips. This is a primary reason for the increased flows, stream bank instability, water temperature increases, and sedimentation in the watershed.	1	Establish forested buffer strips where they are currently lacking.	We have no jurisdiction on privately owned lands. However, we can work with the White River Partnership to promote, seek funding for, and in some cases assist in the implementation of buffer strips.	a) # Miles of stream with newly established forested buffer strips
Flow frequencies, peaks and volumes exceed reference conditions. This has resulted in increased channel instability, stream bank erosion, and aquatic habitat degradation.	2	Identify the few most important actions that could be taken to move existing flows toward reference conditions. Implement these actions.	Identify the most important actions. Do this working with the White River Partnership and other interested entities. Develop a long-term action plan to implement these actions.	a) Important actions are identified; b) Action plan is completed
The sediment load in the main stem of the White River is high (well above reference conditions). This is degrading aquatic habitats. Similar condition probably also exist in Hancock Branch.	3	Determine what the biggest sources of sedimentation are. This will include assessing land use practices. Implement actions to correct the biggest sources of sedimentation over the long term.	a) Work with the White River Partnership and other interested entities to identify and prioritize the most important sediment sources. Develop an action plan and begin implementing projects to reduce or eliminate these sources of sedimentation. b) Inventory and correct sources of sedimentation along Forest Service roads (roads are a known source of sedimentation).	a) # of sediment control projects implemented; b) # of tons of soil prevented from entering streams

Findings	Priority	Strategic Recommendations	Tactical Actions (next 2-3years)	Indicators
Acid deposition has caused pHs to decrease in some streams and lakes in the watershed (for example, Skylight Pond). This has resulted in and aquatic habitat and population degradation.	4	Support efforts to reduce acid deposition over the long term.	a) Fulfill the Forest Service responsibilities for implementation of the regional haze regulations; b) Support ANR efforts to reduce acid deposition in waters classified as impaired due to acid deposition.	a) Are FS responsibilities for implementing the regional haze rules being fulfilled? b) Is the FS providing support to the ANR to correct impaired waters?
The lack of large woody debris (LWD) in streams and rivers has resulted in increased stream velocities and sediment movement, and decreased quality of aquatic habitats.	5	Add LWD to streams, which have buffer strips, and flow volumes and frequencies approaching the reference condition.	Add LWD to appropriate streams.	a) # miles of stream where LWD meets the desired condition due to our actions

ISSUE #2: Perpetuation of a working landscape

Desired Condition: The watershed contains a variety of vegetative conditions and types to enhance diversity, meet habitat needs for wildlife and to provide wood products for people. That we as land stewards continue to nurture and protect the complex, interrelated, forest ecosystem considering the social, spiritual and economic needs of society. That decisions about timber harvesting and other management activities that involve use and conservation of natural resources to sustain and enhance diversity of plant and animal communities. Soil productivity is maintained, water quality and the quality of life in the watershed is improved. The desired future condition is also reflected in the Forest Plan, Goals (see Plan pages 4.06-4.08, and Management Areas 4.59-4.75, and 4.91-4.134.

Findings	Priority	Strategic Recommendations	Tactical Actions (next 2-3years)	Indicators
The amount if timber produced and acres harvested in the 1990's is about 50% less than in the three previous decades.	1	Include timber sales as part of total forest stewardship objectives. Use sales to help meet specific goals, objectives and to generate revenues. Maintain our ability to sustain and enhance diverse plant and animal communities while meeting societies needs.	Use opportunities for timber harvest listed in this analysis as a basis for out year sale planning and proposals	a) The number of acres treated by timber harvest. b) The amount of volume produced and revenues created.
Current age class distribution is not within the desired ranges shown in the Forest Plan. Young age classes for specific wildlife habitat needs are lacking in the watershed.	2	Plan for timber sales to include harvests that create changes in age classes, especially in the 0 – 9-year age class.	Plan future sales that specifically use some amount of evenage regeneration systems such as shelterwood, delayed shelterwood and clearcutting to create these young stands of trees.	a) The amount of acres harvested by shelterwood, delayed shelterwood and clearcut. b) # of Environmental documents needed for implementing fore work. c) Change in % of age classes toward ranges in Forest Plan.
Forest tree species composition is not within the desired ranges shown neither in the Forest Plan nor near the reference condition. There is too much northern hardwood (82%), too little softwood (13%), aspen-birch (4%) and upland openings (1%). NF lands are 99% forested.	3	Provide timber sales and vegetation management that converts northern hardwood stands to softwood, pioneer species and openings	Select best locations for conversion by consulting Land Type Association and Ecological Land Type maps, public input, field conditions along with Forest Plan MA prescriptions, Standards and Guidelines.	a) Amount of increase in new softwood, aspen-birch and upland opening stands. b) Changes in acres and % change toward range listed in F Plan.

ISSUE #3: Need improved transportation plan

Desired Condition: We have an up to date transportation plan for NF lands based on a transportation analysis. The analysis identifies which roads are logical for decommissioning, whether any new recreation trails (or associated facilities) are needed, and the desired management objectives and maintenance levels for all roads.

Findings	Priority	Strategic Recommendations	Tactical Actions (next 2-3years)	Indicators
An up to date transportation plan is needed for the watershed. This should be done at a larger watershed scale, encompassing the entire White River watershed (or larger?)	1	Complete a transportation plan for the entire White River watershed. As part of the plan, identify management objectives for each road, and decommissioning opportunities.	a) Complete the transportation plan using the roads analysis process; b) Implement road decommissioning opportunities.	a) Is transportation plan done? b) # miles of road decommissioned

ISSUE #4: Recreation development and maintenance

Desired Condition:
Unique public recreation opportunities in the watershed are maintained according to the Management Area (MA) emphasis, ADA laws and Forest Plan guidelines. Recreation use is sustained and enhanced by improving public access and the conditions of developed sites, trails, primitive campsites and vistas. Future decisions are based upon improved site inventories and data collected about forest visitor, and what the public wants. Recreation sites do not contribute to soil erosion or reduction in water quality.

Findings	Priority	Strategic Recommendations	Tactical Actions (next 2-3years)	Indicators
There is much ice storm damage to some recreation trails. This makes hiking the trails difficult.	4	Bring all trails having ice damage back to standard by removing fallen trees in the trail.	Remove ice storm trees from the Clark Brook trail.	# miles of trail brought back to standard
Texas Falls recreation facilities do not meet accessibility standards. Facilities need to be upgraded to comply with federal laws governing accessibility.	2	Implement the Texas Falls accessibility improvements as designed.	a) Obtain the capitol investment funds to do the improvements; b) Implement the design	Is it done?
A lack of brush control in some openings has reduced their attractiveness for camping wildlife habitat, and eliminated vistas.	5	a) Maintain the openings for camping, wildlife and vistas. b) Maintain safe off road parking for dispersed sites	a) Maintain openings used as campsites b) List in order of priority c) Create hardened gravel car pads	a)# acres of openings maintained b) # of parking pads created
There is a backlog of maintenance for trail debrushing, bridge inspection, and maintenance of trail drainage features.	3	Maintenance and inspections are better incorporated into long range maintenance plans	Specific proposals for each site will be developed and incorporated into the annual program of work.	a) # of miles of trail debrushed as a % of the total target. b) Trails are debrushed once every four years. c) Bridges are inspected every other year. d) # of waterbars, dips and culverts maintained.

ISSUE #5: Protection of rare plants, wildlife and habitats

Desired Condition:
We work for the continuation of ecological processes that sustain their presence and viability, at appropriates scales, within the ecosystems contained within the watershed and those connected to them. All occurrences of sensitive plants are viable and at least maintaining themselves, and they are monitored regularly to track changes. Sensitive species' habitat relationships have been deduced and the appropriate level of protection determined. Rare communities in the watershed are designated as special areas to protect their unique values, and are considered for potential designation as Research Natural Areas.

Findings	Priority	Strategic Recommendations	Tactical Actions (next 2-3years)	Indicators
We are unsure if the Indiana bat or pygmy shrew use habitat in the watershed. If bat or shrew habitat exists we need to protect it.	1	Inventory the bat and shrew occurrence and habitats as part of a forest-wide program.	a) In areas where summer logging is planned, monitor bat occurrence using mist netting; b) Develop a long term, forest-wide bat and shrew monitoring program	a) # of bat/shrew occurrences and trends; b) # of habitat sites and trends; c) Trends in % of suitable (vs. unsuitable) habitat in actively managed, and passively managed areas; d) % of watershed inventoried for significant natural features, habitat, and disturbance events.
We do not know if changes are occurring in the long-term viability of forested communities or rare plant habitat and occurrences and if management is influencing these changes.	1	Inventory and monitor key vegetative communities, known occurrences and track changes in floristic composition over time. Do this as part of a forest-wide inventory and monitoring project.	Develop and begin implementation of an inventory plan.	a) # of TES, sites and trends; b) # of acres identified as rich n.hdwds wet and montane spruce-fir; c) # of acres of rich n. hardwood where calcareous substrate is known; d) Change in floristic sp. comp. and importance, patterns of tree survivorship, H_2O chemistry (Ca, org. C) in permanent plots within range of managed rich woods, wet and montane spruce-fir.
Two significant natural features, Hat Crown/Silent Cliff and Monastery Mountain old growth patch, have no special protection (including an appropriate management area (MA) designation and standards and guidelines (S&Gs).	2	Provide special protection through a MA designation and S&Gs.	a) Amend the plan to provide special protection for these two areas; b) Establish permanent plots to monitor ecological changes in the significant natural features over time.	a) Is the amendment done? b) Is monitoring at the long-term plots being done?

ISSUE #6: Prehistoric site protection

Desired Condition: The location, significance and condition of prehistoric archaeological sites and Native American sacred and traditional use sites are known for the study area. One or more of these sites has contributed to our understanding of past ecosystem(s) conditions through field investigation and analysis of preserved "features" (e.g., hearths or storage pits). Land management activities use this information to help form their long-term goals, and implementation of projects includes provisions to protect sites.

Findings	Priority	Strategic Recommendations	Tactical Actions (next 2-3years)	Indicators
There is a lack of knowledge about the distribution & significance of prehistoric sites in the watershed	1	Inventory, evaluate and protect prehistoric archaeological sites.	a) Locate collectors/collections in the area to establish already known information b) Implement a two-year inventory to identify prehistoric sites. Emphasize inventory in high potential areas. Incorporate site into the GIS database.	a)# collections documented b)# acres surveyed c)# sites
There is a lack of knowledge about the distribution of Native American traditional use sites in the watershed	2	Enhance our knowledge of traditional use areas in the watershed. Use our Partnership with the Abenaki Research Project (ARP) to accomplish this.	a) Have ARP conduct interviews with elders and other contacts. b) ARP and FS people work together to become familiar with sites on the ground. c) Establish site management plans	a)# interviews b)# sites c)# site management plans
Archaeological sites have not contributed to our understanding of ecosystem history because we have not intensively investigated even one.	3	Select a site with intact features to investigate intensively.	a) Create a list of evaluated candidate sites from completed inventory. b) Work with either the VT Archaeological Society +/or the Univ. of Vermont to select one site; establish a "Passport in Time" (volunteer) project or other initiative to conduct field work.	a)# sites evaluated b)# sites eligible to the National Register c)# sites intensively investigated

ISSUE #7: Natural resource information sharing

Desired Condition: The Forest Service and other Partners in the watershed take a coordinated approach to sharing natural resource information, providing consistent and factual messages, reflecting an ecosystem approach to management, and focusing on what people need to know to support sound natural resource and socio-economic decision making. Through information sharing we also encourage people to be involved in on the ground watershed restoration activities, and we listen to and respect people's opinions.

Findings	Priority	Strategic Recommendations	Tactical Actions (next 2-3years)	Indicators
There is a need to share natural resource, historic, and socioeconomic information about the watershed with people living in or near the watershed.	2	Determine what information is most important to share, who it need/wants the information, and the best format or methods for sharing the information (e.g., pamphlets, field sessions, the internet, GIS, hands-on participation in restoration projects etc.). Share information based on these findings.	Work with the WRP to develop and implement a short and concise information sharing strategy to reach the desired condition. In this strategy, identify priorities for people/groups we want to reach, what information should be shared, and the methods. As the strategy is developed, take advantage of current opportunities to share information in a variety of ways.	Is strategy developed? # of information sharing actions implemented/year # of participants in watershed projects/year (includes educational projects and restoration projects)

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APPENDIX B - Sources on Rare Plant Species Information

Known occurrences of rare plants or animals have been documented by the VNNHP in their database and in GIS coverage for the GMNF identified for this project as "Han_eor.shp". EOR stands for "Element Occurrence Record" and is represented by a database record for every occurrence of a species that VNNHP tracks in their database. These include state listed, rare, and some uncommon species, as well as exemplary natural communities. Note that in some cases the GMNF tracks species as "R9 Sensitive" which the VNNHP does not track – these occurrences are not represented in this coverage. For the GMNF version of the GIS coverage, the only identifying information included is the "EO Code" – a unique value given to each Element Occurrence by VNNHP. The watershed coverage is simply a clip of the GMNF coverage.

In addition to recent known occurrences, occurrences have been identified in previous reports through research of historical records (herbaria, botanical logs and diaries, etc.) conducted by GMNF and others (notably Jerry Jenkin's report on the rare plants and habitats of the GMNF from 1982). This information is not in an electronic or digital format due often to the vague location information associated with these records and the qualitative nature of the data.

A third source of information is the Significant Features Inventory conducted by the VNNHP on the GMNF from 1990-1997. During this inventory, polygons and points were drawn on 1:24,000 topographic maps to represent known and potential occurrences of rare species or exemplary natural communities. After the survey was completed, polygons representing known occurrences of both rare species and exemplary natural communities were digitized for GIS with each polygon coded by the quad sheet name and polygon number from the base quad sheets used for the inventory. In addition, significant features identified in the Forest Plan (usually MA 8.1 areas) were also added to this coverage. Currently, place names have yet to be associated with this coverage. For the watershed project, this coverage was clipped to the watershed boundaries and is known as "Han_rare.shp". Note that polygons in this coverage may represent EITHER rare species, exemplary communities, or significant features from the Forest Plan, which means that in some cases the polygons overlap with the points of the EOR coverage, and represent the same information.

APPENDIX– C   Needs Associated with Known and Historic Rare Plant Occurrences, D. Burbank, 2000

Species	Location	Last Obs.	Needs
Sisyrinchium atlanticum Eastern blue-eyed grass	Texas Falls	6/1999	Monitoring plan
Juglans cinerea Butternut	Gillespie	6/1997	Monitoring per Gillespie EA
Clematis occidentalis var. occidentalis Purple clematis	Hat Crown	7/1993	Monitoring plan and visit
Cryptogramma stelleri Steller's cliffbrake	Hat Crown	7/1993	Monitoring plan and visit
	Moss Glen	1926	Field search
Carex michauxiana Michaux's sedge	Skylight Pond	8/1988	Monitoring plan and visit
Listera auriculata Auricled twayblade	Hancock	1916-1936	Field search – low priority as the historic record has no supporting herbarium specimen for critical review.
Cypripedium reginae Showy ladyslipper	Silent Cliff	1906	Occurrence verification and field search.

Appendix – D. Federal endangered, threatened, proposed, and Regional Forester's Sensitive Species for the GMNF, October 2000.

Scientific Name	Common Name	Federal Status 2000
FEDERAL ENDANGERED, THREATENED, AND PROPOSED		
MAMMALS		
Canis lupus	**Gray wolf**	**LE**[a]
Felis concolor cougar	**Eastern cougar**	**LE**
Lynx canadensis	**Canada lynx**	**LT**[b]
Myotis sodalis	**Indiana bat**	**LE**
BIRDS		
Haliaeetus leucocephalus	**Bald eagle**	**LE**
REGIONAL FORESTER'S SENSITIVE SPECIES		
MAMMALS		
Myotis leibii	**Eastern small-footed myotis**	**S**[c]
BIRDS		
Catharus bicknellii	**Bicknell's thrush**	**S**
Falco peregrinus anatum	**American peregrine falcon**	**S**
Gavia immer	**Common loon**	**S**
AMPHIBIANS		
Ambystoma jeffersonianum	**Jefferson salamander**	**S**
REPTILES		
Clemmys insculpta	**Wood turtle**	**S**
MOLLUSKS		
Alasmidonta varicosa	**Brook floater**	**S**
Lasmigona compressa	**Creek heelsplitter**	**S**
INSECTS		
Aeshna tuberculifera	**Black-tipped darner**	**S**
Aeshna verticalis	**Green-striped darner**	**S**
Arigomphus furcifer	**Lilypad clubtail**	**S**
Calopteryx amata	**Superb jewelwing**	**S**
Cicindela marginipennis	**Cobblestone tiger beetle**	**S**
Gomphus* (=*Phanogomphus*) *descriptus	**Harpoon clubtail**	**S**
Gomphus adelphus	**Mustached clubtail**	**S**
Lanthus vernalis	**Southern pygmy clubtail**	**S**
Lestes eurinus	**Amber-winged spreadwing**	**S**
Ophiogomphus* (=*Ophionurus*) *mainensis	**Maine snaketail**	**S**
Somatochlora elongata	**Ski-tailed emerald**	**S**
Somatochlora forcipata	**Forcipate emerald**	**S**
Somatochlora minor	**Ocellated emerald**	**S**
PLANTS		
Agrostis mertensii	**Arctic bentgrass**	**S**
Aureolaria pedicularia	**Fernleaf yellow false-foxglove**	**S**
Blephilia hirsuta	**Hairy woodmint**	**S**
Calamagrostis stricta* ssp *inexpansa	**New England northern reed grass**	**S**
Cardamine parviflora	**Small-flower bitter-cress**	**S**

Scientific Name	Common Name	Federal Status 2000
Carex aestivalis	Summer sedge	S
Carex aquatilis	Water sedge	S
Carex argyrantha	Hay sedge	S
Carex atlantica	Prickly bog sedge	S
Carex bigelowii	Bigelow sedge	S
Carex foenea (=*aenea*)	Bronze sedge	S
Carex lenticularis	Shore sedge	S
Carex michauxiana	Michaux sedge	S
Carex schweinitzii	Schweinitz's sedge	S
Carex scirpoidea	Bulrush sedge	S
Clematis occidentalis var *occidentalis*	Purple clematis	S
Collinsonia canadensis	Canadian horsebalm	S
Conopholis americana	Squaw-root	S
Cryptogramma stelleri	Steller's cliffbrake	S
Cypripedium parviflorum var *parviflorum*	Small yellow ladyslipper	S
Cypripedium parviflorum var *pubescens*	Large yellow ladyslipper	S
Cypripedium reginae	Showy ladyslipper	S
Desmodium paniculatum	Paniculate tick-trefoil	S
Draba arabisans	Rock whitlow-grass	S
Dryopteris filix-mas	Male fern	S
Eleocharis intermedia	Matted spikerush	S
Eupatorium purpureum	Sweet joe-pye-weed	S
Geum laciniatum	Rough avens	S
Isoetes tuckermanii	Tuckerman's quillwort	S
Isotria verticillata	Large whorled pogonia	S
Juglans cinerea	Butternut	S
Juncus trifidus	Highland rush	S
Lespedeza hirta	Hairy bush-clover	S
Listera auriculata	Auricled twayblade	S
Littorella uniflora	American shore-grass	S
Muhlenbergia uniflora	Fall dropseed muhly	S
Myriophyllum farwellii	Farwell's water-milfoil	S
Myriophyllum humile	Low water-milfoil	S
Panax quinquefolius	Ginseng	S
Pellaea atropurpurea	Purple-stemmed cliffbrake	S
Peltandra virginica	Green arrow-arum	S
Phegopteris hexagonoptera	Broad beech fern	S
Platanthera orbiculata	Round-leaved orchis	S
Polemonium vanbruntiae	Eastern jacob's ladder	S
Potamogeton biculpatus	Snail-seed pondweed	S
Potamogeton confervoides	Tuckerman's pondweed	S
Potamogeton hillii	Hill's pondweed	S
Prenanthes trifoliolata	Three-leaved rattlesnake-root	S
Pyrola chlorantha	Green pyrola	S
Ribes triste	Wild red currant	S
Saxifraga paniculata	White mountain saxifrage	S
Scheuchzeria palustris ssp *americana*	Pod-grass	S

Scientific Name	Common Name	Federal Status 2000
Scirpus subterminalis	Incomplete bulrush	S
Sedum rosea	Roseroot stonecrop	S
Selaginella rupestris	Rock spikemoss	S
Sisyrinchium angustifolium	Narrow blue-eyed grass	S
Sisyrinchium atlanticum	Eastern blue-eyed grass	S
Solidago squarrosa	Stout goldenrod	S
Sorbus decora	Northern mountain-ash	S
Sparganium fluctuans	Floating bur-reed	S
Torreyochloa pallida (= *Glyceria fernaldii*)	Fernald alkali grass	S
Utricularia geminiscapa	Hidden-fruited bladderwort	S
Utricularia resupinata	Northeastern bladderwort	S
Uvularia perfoliata	Perfoliate bellwort	S
Vaccinium uliginosum	Alpine bilberry	S
Woodsia glabella	Smooth woodsia	S

[a]Species is federally listed as endangered under the ESA.
[b]Species is federally listed as threatened under the ESA.
[c]Species is listed on the USDA Forest Service Region 9 RFSS li

APPENDIX - E   White River Partnership & Public Issues

From six public meetings, mailings to 11,000 households throughout the watershed in 1996, 150 responses were returned indicating what was on peoples minds. The responses fit into the following seven issues.

1. Water quality
2. Riparian habitat
3. Stream bank erosion
4. Public awareness about problems with the river
5. Public access to the river
6. Point and non-point source pollution
7. Maintaining a working landscape

APPENDIX F - Forest Service Issues in the Upper White River Watershed

The Upper White River Analysis Team identified the following issues in late 1999 during a ”brainstorming” session. Issues are grouped by subject area.

Riparian/Aquatic/Fish

Aquatic and riparian habitats, and water quality are degraded as a result of:
- Pollution (includes temperature, sediment, chemicals, and nutrient)
- Lack of shade
- Loss of the riparian buffer strip
- Streambank erosion
- Sediment from roads

Pollution prevention & monitoring is needed
Don't have a current & comprehensive inventory of pollution sources
Decline in native and naturalized fish stocks and habitats
Real or perceived lack of funding and knowledgeable people to secure funding for restoration projects
Increased understanding, involvement and support is needed to effectively do to restoration work in the Watershed
Channelization in response to flood damage needs corrected
The river is unstable (more than normal) due to people activities & development; the river is less able to absorb large floods
Water quality at Skylight Pond is impaired - what do we need to do to correct this?
Lack of public awareness, involvement and input regarding problems and progress
Remove gravel from the river to stabilize banks
See a greater need for environmental education in the schools around the rivers
Concerns about the impacts of roadside herbicide use near streams
Some issues raised by the public (at the public White River Partnership meetings) may not strongly apply to the upper part of the watershed
Lack of large woody debris in streams
There are conflicts between recreation uses (primarily dispersed use) and maintaining water quality in adjacent streams
Class 4 roads are causing much sedimentation because there are no Best Management Practices governing their use and maintenance
There are barriers to fish migration, thus population fragmentation; we don't know the extent of this
Some disagreement lingers as to what the past and reasonable present role of salmon is in the watershed

Land ownership

High federal ownership decreases the tax base and increases property taxes
Not enough public access to the river
Property tax impacts of farmers and forestry

Land and Water uses

The mosaic, practices and esthetics of traditional forestry and pastureland uses are being Threatened (a mix of forestry and pasture land uses are threatened); want a working landscape
Gravel extraction has been curtailed due to legislation
There is disagreement regarding the environmental effects and benefits of gravel extraction

Problem solving

People at the local level feel they don't have enough control over problem solving in the Watershed
Need to increase environmental education in schools in the Watershed (hands on, in touch with the river)

Recreation

People want more recreation and trail opportunities near the river(s)
Conflicting recreation issues, such as boaters vs. anglers on the White River
Don't have a transportation plan for the watershed
Lack of N.F. access for swimming on the White River
Liability is a concern at swimming holes on N.F. land
We are not providing adequate access for people with disabilities to view Texas falls
Texas Falls picnic area accessibility needs to be improved
Texas Falls recreation developments are not up to standard
At Texas Falls Meadow, resource degradation is going on due to dispersed camping use.
Some views in Breadloaf Wilderness are being lost because they are not maintained due to wilderness standards
Primitive campsites along rivers may be impacting water quality
We do not have adequate resources to maintain existing recreation sites
Recreational opportunities are being lost as open meadows such as Rob Ford and Texas Meadows are becoming more shrub and tree covered
Rainbow gatherings have adversely impacted water quality; this is a concern for future gatherings
The shortfall in road and trail tread maintenance may have adversely impacted soil and water resources, or will if the shortfall continues
Unauthorized ATV use has caused soil damage
Cross-country skiing opportunities have been reduced due to road plowing to accommodate timber hauling

Vegetation

We are unsure if tree age class and species distribution are concerns in the watershed (lack current data) FS Silvex data is at least 15 years old, and data is lacking on some MA 9.2 lands. This will hinder Plan Revision efforts.
Upper elevation stands have extensive ice damage, which may become a forest health and habitat concern
On Monastery Mountain, we need to further define the site and protect it adequately
At Skylight Pond, we need to decide if the CNRA should become an RNA; we also don't know why the pH has gone down (even though there is calcium rich bedrock nearby)
We don't know why the spruce/fir zone in parts of the watershed is less extensive than expected, and whether this is an ecological problem
We are unclear about the distribution of rich productive woods, and what that means to sustainability, and inherent levels of biodiversity
We don't have consensus on the importance of and best management of rich woods
Noxious weeds exist, such as Japanese Knotweed, and we don't know the extent of the problem in the Watershed.
Rare plants concern - only a few of the rich woods and wetlands have been surveyed
We have a historic record of a state listed and globally rare plant in Hancock (an orchid) but we have not located the site or the plant
There is a lack of large floodplain forests; don't know what these forests would look like
There is a lack of large contiguous tracts of mature forests on all landscapes in the Watershed (most notably on the lower mountain slopes and flood plain)

Wildlife

There is heavy bear hunting in the area - what are the impacts to bear populations?
We are not sure if the state rare shrew occurs elsewhere in the watershed (beyond an identified area), so what if we need to do something to protect it?
We are uncertain to what extent Bicknell's Thrush occurs in the watershed, and if any of our recreational activities are affecting it
We are uncertain if there are rare bats that use the watershed in the summer (Indiana & Eastern small footed bats, which are Federally listed and rare state listed)
For the Lynx (proposed for federal listing), we need to determine what we need to do to improve its habitat (the watershed contains potentially the best lynx habitat on the Forest)
Moose hunting is a new use of the Watershed - we don't know if new resource conflicts will arise as a result of this
If we improve habitats for lynx, how will that affect habitats for other species?
There is a loss of upland game habitat for grouse, woodcock, etc.
Snowshoe hare habitat has declined
Upland opening and early successional habitats are being lost due to lack of maintenance or timber harvest

Heritage

Predictive models indicate that there should be a significant number of prehistoric archaeological sites in the study area, but few have been identified due to a lack of extensive, systematic testing.

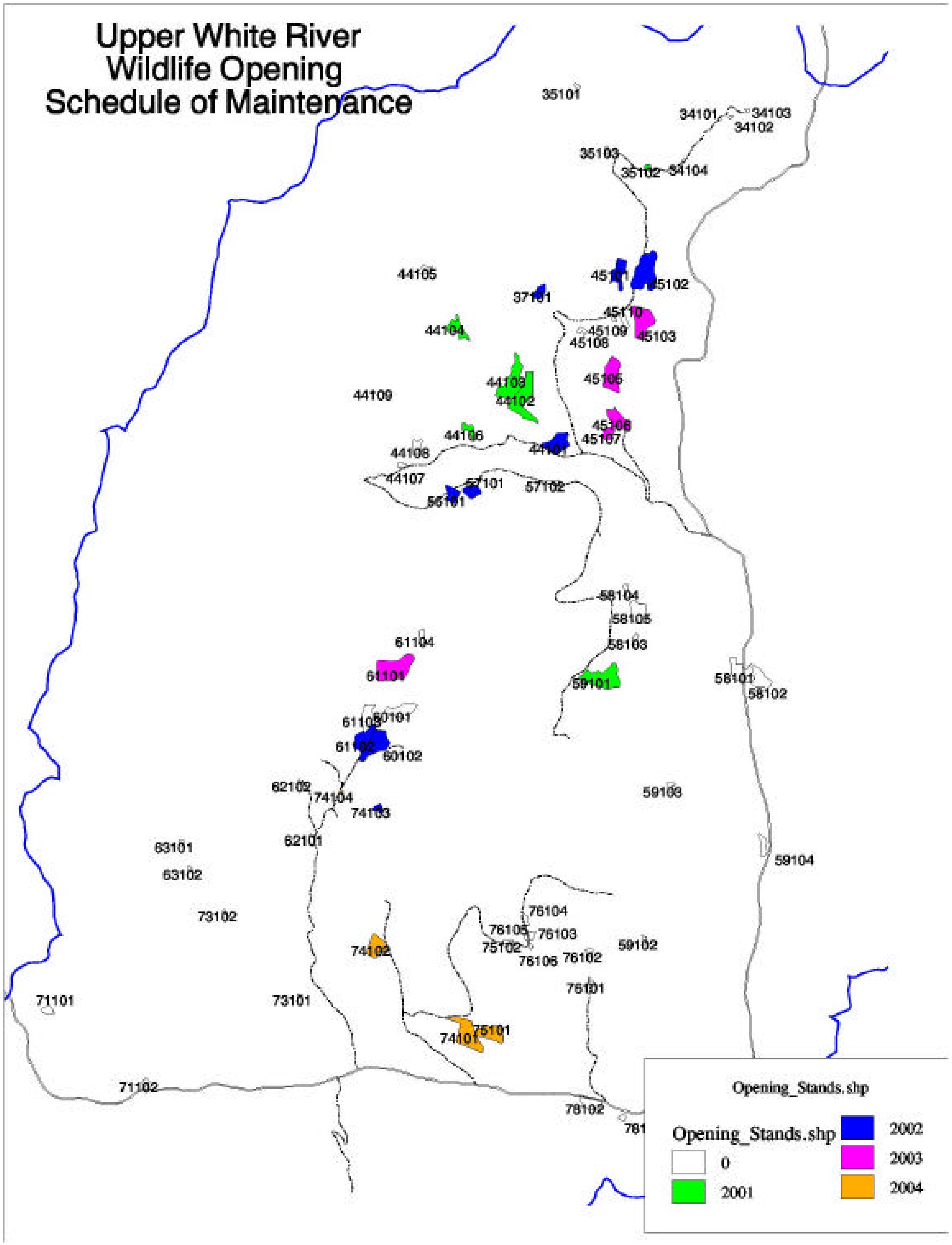
Numerous historic period archaeological sites have been identified in the study area, but research and evaluation studies (and agreement on evaluation criteria within the state) leading to determinations of significance are lacking.
Abenaki belief that Texas Falls was the site of traditional uses has not been well documented.

Public Outreach

Need to bring information about the watershed (all resources) to schools and adults in the community

Values (What do people value about the watershed?)

The White River because it is the longest free flowing river in VT
Clean water, such as for swimming and to maintain water quality
Native, healthy aquatic & terrestrial organisms all the biota
An aesthetically pleasing landscape, being very dissected high relief terrain
Healthy riparian zones fostering healthy aquatic organisms
High quality recreational fishing
Satisfaction about making the environment better.
Broad based, locally driven, understanding, support & participation for Watershed activities.
Maintaining the special characteristics of special areas
Low property taxes on farmers and forestry
Being able to interact with the river; Being able to connect to nature in the watershed
A working landscape with viable agriculture, forestry, gravel extraction and other uses; The landscape produces products and supports traditional land uses
Children are well versed in environmental education, and in touch with the river environment
Assurance of access to the river, with a trail network in the basin
Have natural areas without development
Neighbors and communities working together to solve problems
Control over & involvement in planning & what happens in the watershed
Economic benefits and jobs in the communities while preserving environmental quality
High quality river and wildlife habitats
Tangible, visual evidence of historic land-use patterns in the form of archaeological sites, Stonewalls, cultural landscapes, old transportation systems and culturally modified vegetative communities.


Upper White River
Wildlife Opening
Schedule of Maintenance
35101
34101
34103
34102
35103
35102
34104
44105
45101
45102
37101
45110
44104
45109
45108
45103
44103
44102
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73102
76104
76105
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75102
59102
76106
76102
76101
71101
73101
74101
75101
71102
78102
Opening_Stands.shp
0
2001
2002
2003
2004

COMPSTAND	COMP	STAND	ACRES	MA	VEG TYPE	PLANNED	ACTIVITY 1	FUND	ACTIVITY 2	FU
35102	35	102	3	3.1	53	2001	BURN or DEBRUSH	HFPM/BDBD		
44102	44	102	20	4.1	52	2001	BURN or DEBRUSH	HFPM/BDBD	MECH MOW	UNFU
44103	44	103	23	4.1	52	2001	BURN or DEBRUSH	HFPM/BDBD	MECH MOW	UNFU
44104	44	104	8	6.2	53	2001	BURN or DEBRUSH	HFPM/BDBD	MECH MOW	UNFU
44106	44	106	4	4.1	53	2001	BURN or DEBRUSH	HFPM/BDBD		
44108	44	108	8	4.1	52	2001	BURN or DEBRUSH	HFPM/BDBD		
56101	56	101	6	3.1	52	2001	BURN or DEBRUSH	HFPM/BDBD		
57101	57	101	8	3.1	51	2001	BURN or DEBRUSH	HFPM/BDBD		
59101	59	101	20	4.1	52	2001	BURN or DEBRUSH	HFPM/BDBD		
37101	37	101	6	4.1	52	2002	BURN or DEBRUSH	HFPM/BDBD		
44101	44	101	11	4.1	51	2002	BURN or DEBRUSH	HFPM/BDBD	MECH MOW	UNFU
45101	45	101	10	3.1	52	2002	BURN or DEBRUSH	HFPM/BDBD	MECH MOW	UNFU
45102	45	102	23	3.1	56	2002	BURN or DEBRUSH	HFPM/BDBD	MECH MOW	UNFU
60102	60	102	17	4.1	51	2002	BURN or DEBRUSH	HFPM/BDBD		
61102	61	102	10	4.1	52	2002	BURN or DEBRUSH	HFPM/BDBD		
74103	74	103	2	4.1	53	2002	BURN or DEBRUSH	HFPM/BDBD		
45103	45	103	15	3.1	0	2003	BURN or DEBRUSH	HFPM/BDBD		
45105	45	105	13	4.1	52	2003	BURN or DEBRUSH	HFPM/BDBD		
45106	45	106	9	4.1	52	2003	BURN or DEBRUSH	HFPM/BDBD		
45107	45	107	5	4.1	52	2003	BURN or DEBRUSH	HFPM/BDBD		
61101	61	101	18	4.1	52	2003	BURN or DEBRUSH	HFPM/BDBD	MECH MOW	UNFU
74101	74	101	19	2.1	52	2004	BURN or DEBRUSH	HFPM/BDBD		
74102	74	102	12	4.1	52	2004	BURN or DEBRUSH	HFPM/BDBD		
74104	74	104	2	4.1	52	2004	BURN or DEBRUSH	HFPM/BDBD		
75101	75	101	11	2.1	51	2004	BURN or DEBRUSH	HFPM/BDBD		
34101	34	101	1	3.1	50	0				
34102	34	102	1	3.1	52	0				
34103	34	103	1	3.1	50	0				
34104	34	104	1	3.1	50	0				
35101	35	101	1	5.1	53	0				
35103	35	103	2	3.1	51	0				
37102	37	102	2	4.1	53	0				
44105	44	105	3	6.2	53	0	MECH MOW	UNFUNDED		
44107		44	107	4.1	53	0				
44108	44	108	8	4.1	53	0				
44109	44	109	1	4.2	53	0				
45108	45	108	2	3.1	53	0				
45109	45	109	4	3.1	53	0				
45110	45	110	1	3.1	53	0				
57102	57	120	2	3.1	53	0				
58101	58	101	12	2.1	51	0				
58102	58	102	9	2.1	63	0				
58103	58	103	3	4.1	53	0				
58104	58	104	3	3.1	53	0				

COMPSTAND	COMP	STAND	ACRES	MA	VEG TYPE	PLANNED	ACTIVITY	FUND	ACTIVITY	FU
58105	58	105	9	4.1	65	0				
59102	59	102	1	2.1	56	0				
59103	59	103	2	2.1	56	0				
59104	59	104	4	9.2	66	0				
60101	60	101	10	4.1	51	0	MECH MOW	UNFUNDED		
61103	61	103	8	4.1	65	0	BURN	UNFUNDED		
61104	61	104	1	4.1	52	0				
62101	62	101	1	4.1	53	0				
62102	62	102	1	4.1	53	0				
63101	63	101	1	4.2	51	0				
63102	63	102		4.2	51	0				
71101	71	101	13	5.1	53	0				
71102	71	102	1	2.1	51	0				
73101	73	101	2	2.1	51	0				
73102	73	102	1	4.2	51	0				
75102	75	102	2	2.1	51	0				
76101	76	101	2	4.1	52	0				
76102	76	102	2	4.1	53	0				
76103	76	103	1	2.1	51	0				
76104	76	104	2	2.1	53	0				
76105	76	105	1	2.1	51	0				
76106	76	106	1	2.1	51	0				
78101	78	101	1	2.1	51	0				
78102	78	102	6	2.1	51	0				

APPENDIX – H UPPER WHITE RIVER WATERSHED

TIMBER SALE/HARVEST HISTORY 1965-2000

Sale Name	Acres In Sale Area	Volume (MBF)
1965		
Gulf Brook II	508	1647
Tucker Brook	264	2673
	772	4410
1966		
Austin Brook	153	484
Texas Gap Pulp	230	2315
	383	2799
1967		
Texas Gap Pulp	145	793
Bear wallow	960	2870
Tucker brook	228	652
	1043	5376
1968		
None		
1969		
Stetson Hollow	588	2201
Hancock	210	1023
Slab Bridge	221	652
	1019	3876
1970		
Hat Crown	281	1453
1971		
Stetson Hollow Pulp	5	23
Hat Crown east	237	815
	242	1080

1972		
Hancock North	350	1200
Clark brook	240	561
Piper Brook	294	785
	1057	2705
1973		
Clark Brook II	421	1050
1974		
None		
1975		
Deer Hollow	920	1628
1976		
None		
1977		
Hermit Place	235	1512
1978		
Childs Mt.	1160	1754
1979		
Bostwick sale	290	327
57 sale	480	837
Taylor Brook	760	881
Texas Gap	250	2561
	1780	4606
1980		
Tucker brook	68	272
1981		
Hermit Place II	235	446
1982		
Piper brook	900	578
Patterson brook	350	640
	1218	1208
1983		
George Brook	74	754

1984		
Killoleet	32	169
Childs Mt.	240	1170
	272	1339
1985		
Piper Brook II	90	354
Bowl Mill II	65	441
Deer Hollow II	317	798
	472	1593
1986		
Clark Brook	132	733
1987		
Killoleet II	32	177
1988		
Texas Gap III	560	188
George Bk	1175	330
Clark brook II	246	713
	1881	1231
1989		
Moss Glen	123	556
Patterson brook	165	657
	288	1213
1990		
Thresher Hill	279	
1991		
Little deere	62	210
Taylor Brook III	57	355
Albee Brook II	233	961
		1426
1992		
Gulf brook	162	572
Horsetail	10	22
Boyden Brook	307	399
Texas Falls	210	1890
	527	2301
1993		
None		
1994		

Austin Brook	35	184
North Texas	48	309
	83	484
1995		
Camp K	266	600
1996		
Clark brook III R	66	316
1997		
Moss Glen II	155	348
Gillespie	518	1814
	673	2162

1998
None

1999
None

2000
none

APPENDIX – I List of Projects

During the public meeting in Hancock VT, people requested a Project List based on the Findings and Recommendations. Listed below are some of the projects that GMNF staff will work on during the next two to three years in the watershed. Some work will be incorporated into site-specific projects.

ISSUE #1: Aquatic and riparian area degradation

Finding: "Many riparian areas along the main stem..."
Project: Work with the Partnership to identify opportunities where the FS can assist in establishing forested buffer strips. Assistance can be in providing trees and labor.
-Incorporate reach stability assessments of channel pattern, dimension and profile in riparian restoration design.
-Work with WRP and Towns to develop riparian corridor FS acquisition plan that serves needs of Ag community, towns and resource protection.
-Establish, mark and plant riparian buffers along all FS conservation easement lands and newly acquired lands along the upper White River.
-Develop knotweed control/eradication strategy.

Finding: "Flow frequencies, peaks and volumes..."
Project: No specific actions now.
-Work with Dartmouth and FS research to develop actions for restoring quantity and timing of flows.

Finding: " The sediment load in the main stem of the White River..."
Projects:
1) Initiate a sediment budget study to identify and quantify the largest sources of sediment in the watershed. This work will be done as a UVM graduate student project.
2) Implement 1-2 soil and water improvement projects/year, using recent inventory information. Each project will eliminate an erosion or sedimentation source.
-Complete erosion inventory on mainstem in section upstream of Buffalo Road to Maston Brook
-Overlay erosion inventory on FS channel morphology inventory to identify groups of erosion sites within homogenous channel types that can be treated as one project/reach area.
-Beginning upstream and working downstream, stabilize high and moderate erosion rate sites identified in WRP inventory.
-Incorporate reach stability assessments of channel pattern, dimension and profile in bank/channel restoration design.
-Encourage WRP to work with Towns on "Better Back Roads" projects on town roads.
-Implements Granville channel/habitat restoration project with WRP, ANR and USF&WS and private landowners.

Finding: "Acidic deposition has caused pHs to decrease..."

Project: On a continuing basis, work with the State of VT Air Quality Division and other federal and state agencies to implement the Regional Haze regulations. These regulations, when implemented, will decrease acid deposition significantly over the next 50-60 years.

Finding: “The lack of large woody debris...”
Project: -Incorporate LWD into all bank/channel stabilization projects.
-Conduct one small LWD placement project on White River tributary each year.

ISSUE # 2: Perpetuating the Working landscape

Finding: “The amount of timber produced and acres harvested within the watershed in 1990’s is about 50% less than in the three previous decades.
Project: Complete a site-specific NEPA environmental assessment on vegetation management aimed at maintaining diverse plant and animal communities while meeting societies needs for wood products. Currently planned for fiscal year 2001.

Finding: “Current age class distribution of forested stands across the upper watershed is not within the desired ranges shown in the Forest Plan”. Young aged stands in the new to nine-year old age class needed for specific wildlife habitat are lacking.
Project: During the assessment, analyze stands identified as candidates for regeneration harvests (shelterwood, delayed shelterwood and clearcut). Harvesting some of these stands would provide for the establishment of new young forested stands in the needed age class.

Finding: “Composition of the forest types in the upper watershed are not within the desired ranges shown in the Forest Plan nor near that shown in the reference condition”. Currently there are too many northern hardwoods (82%), too little softwood, (13%), aspen- birch (4%), and upland openings (1%). NF lands are 99% forested.
Project: During the assessment, analyze stands and ELT’s for potential conversion (cut hardwoods growing over softwoods, regenerate aspen, apply selection cuts to encourage shade tolerant species like softwoods and beech).

ISSUE # 3: A transportation system plan is needed.
Findings: An up to date transportation plan is needed for the whole watershed. This should be done at a larger watershed scale, encompassing the whole White River watershed.
Project: The next downstream portion of the watershed will undergo assessment in fiscal year 2001. Analysis of the current system and future needs will be assessed at that time but most likely this is a huge issue crossing over watersheds needing to be done during Forest Plan revision.

ISSUE # 4: Recreation Development and Maintenance

Finding: There is ice storm damage to some hiking trails.
Project: Sections of the Long Trail, Clark Brook trail and some snowmobile trails that were damaged have been debrushed and brought to standard. More work on these trails is ongoing as staffing and budget allow.

Findings: Texas Falls recreation facilities do not meet accessibility standards. The facilities need to be upgraded to meet federal accessibility laws.
Project: More NEPA analysis is required for some of the more complex portions of this proposal such as trail access to the falls area. Other tasks such as improving trail accessibility and fire grates in the picnic area are being planned in fiscal year 2001 and 2002.

Findings: "A lack of brush control in some upland openings has reduced their attractiveness for dispersed camping, reduced habitat for wildlife and eliminated some vistas".
Project: A capital investment proposal for this work was not selected to allow work on this at this time. Different sources of funding are being investigated now. In addition, analysis for designation of appropriate sites and what will be done with them will occur in fiscal year 2001.

Findings: "There is a backlog of maintenance for trail debrushing, bridge inspections and trail drainage features".
Project: Some more work to correct the total backlog of maintenance is being planned for fiscal year 2001. This is an ongoing project where debrushing, inspections and maintenance of drainage features is planned and implemented on alternating years.

ISSUE # 5: Protection of rare plants, wildlife and habitat.

Findings: "We are unsure if Indiana bats and pygmy shrew use habitat in the watershed. If bat or shrew are using habitat we need to identify it and protect it".
Project: Bat boxes will be established one location in conjunction with other locations on the forest to census bat use in fiscal year 2001. Mist netting of bats will occur as well.
Findings: " We do not know if changes are occurring in the long term viability of forested communities or rare plant habitat and occurrences. If so, we do not know if management is influencing these changes".
Project: The GMNF will cooperate with White Mountain NF and the Northeast Forest Experiment Station on a study of this problem during Forest Plan revision, starting in fy 2002.
Findings: "two significant natural features, Hat Crown/Silent Cliff and Monastery Mountain old growth patch, have no special protection including management area designation and standards and guidelines".
Project: Monitoring Plans and field visits will start in spring 2001 and continue for the next five years.

ISSUE # 6: Prehistoric Site protection

Findings: " There is a lack of knowledge about the distribution and significance of prehistoric sites in the watershed".
Project: Initial reconnaissance and condition surveys will be conducted during FY01. This is essentially a "scoping" (Phase I level) that will identify where more intensive surveys (i.e., systematic test pitting, or "Phase II" level work) will be undertaken – probably not until 2002.

Findings: " There is a lack of knowledge about the distribution of Native American traditional use sites in the watershed".
Project: We will use some of our "inventory" budget to help fund this activity through our Cost Share Agreement with the Abenaki Research Project. This will be started in 2001, but will be an on-going/multi-year effort, moving forward incrementally, so it is unlikely to be completed in one year.

Findings: "Archeological sites have not contributed to our understanding of ecosystem history because we have not intensively investigated even one".
Project: Not on the horizon for 2001-2002; Phase II surveys (above) identify good candidate sites, an intensive investigation (Phase III) would be undertaken in 2003/04.

ISSUE #7: Natural resource information sharing

Finding: "There is a need to share natural resource, historic, and socioeconomic information with the public."
Project: Complete a needs assessment for the proposed Rochester office interpretive trail and outdoor learning center. Initiate the site design. Find cooperators who would be willing to help implement the project.

APPENDIX – J   White River Watershed Harvesting Potential Map

This is a large format GIS map printed on a plotter. A hard copy will only be made for a few copies of the assessment. Contact C. Casey if you need to review this map.

Reference condition of vegetation in the Hancock subwatershed

Green Mountain National Forest
Vermont

Prepared by:
Brian Hawthorne
University of Massachusetts, Amherst
January, 2000

Table of Contents

Abstract

This vegetation reference condition for the Hancock sub-watershed attempts to answer questions regarding the broad patterns of vegetation change since glaciation, the historic array and landscape pattern of vegetation during the current climatic period, and the processes that caused these patterns. It is intended to identify the nature of fundamental natural or human-caused changes to vegetation patterns and structure.

The pollen record from a nearby site suggests a Jack Pine–Tundra assemblage (10,000 years BP) followed by successive forests dominated by White Spruce, Birch, Pine-Oak-Birch, Hemlock-Birch-Beech, and Beech-Birch-Maple-Hemlock. Since the beginning of the Little Ice Age (500-600 years B.P), the forest has been shifting away from Beech and towards Spruce. The decline in beech appears to be continuing since settlement, as evidenced by a comparison of witness trees in pre-settlement and 1935 survey records, however this comparison also shows a decrease in spruce, most likely due to harvesting, and an increase hardwoods species other than beech.

The dominant factor in the changes in vegetation composition has been climate change. Despite over 200 years of timber harvesting in the watershed, which has affected the structure of the forest, the changes in composition due to climate appear to have been much larger.

Suggestions are made for improving the efficiency and completeness of future vegetation reference conditions by better integration with the overall project team.

Introduction

This report provides the deliverables specified by USDA Forest Service Purchase Order #43–1681–9–0053, Specifications for Ecological Vegetation Reference Condition Assessment, Northern Half of the Upper White River Watershed.

According to the Federal Guide (Anonymous, 1995), the purpose of the reference condition, Step 4 of the watershed assessment process, is to describe the known or inferred history of the landscape so that we understand what existed in the past and what changes have occurred that may affect current capabilities. This focuses on ecological changes over time in the vegetation—changes in composition, structure, and function of natural communities over time in this portion of the watershed. The goals are to explain how ecological conditions have changed over time as the result of human influence and natural disturbances, and to develop a reference for comparison with current conditions and with key management plan objectives.

The core questions for the vegetation topic of the reference condition are:

1. What are the broad patterns of vegetation change since glaciation?
2. What is the historic array and landscape pattern of plant communities and seral stages in the watershed (riparian and nonriparian) during the current climatic period, and what processes caused these patterns (e.g. wind, fire)?
3. What is the nature of any fundamental changes to vegetation patterns and structure within the system that are due to natural or human-caused disturbances?

Study area

The Hancock sub-watershed of the upper White River is a roughly rectangular area of land that drains to the confluence of the east-flowing Hancock Branch and the south-flowing White River. The confluence is located in the town of Hancock, VT. The watershed is located principally within the Green Mountain National Forest (GMNF) in the towns of Hancock and Granby. A portion of the southeast corner of the town of Ripton drains into this watershed, as does a portion of Northfield on the eastern side of the White River. With the exception of a few recently acquired tracts along the eastern side of the White River, the National Forest is to the west of the river.

The southern boundary of the watershed runs from the confluence roughly southwest along a long ridgeline to Philadelphia Peak and thence westward through several gaps and peaks to the summit of Worth Mountain. The western boundary of the watershed is defined by the height of land along which the Long Trail runs from Worth Mountain to Little Hans Peak. This is also the boundary between the Middlebury Ranger District and the Rochester Ranger District. The northern boundary runs east through Granville Notch between the headwaters of the White River to the south and the Mad River to the north. The eastern boundary runs north south along a ridge of unnamed peaks. The elevation ranges from 3745 ft. a.s.l. at the peak of Mt. Wilson in the northwest corner to 914 ft. a.s.l. at the confluence. Diane Burbank at the GMNF in Middlebury has created digital maps of the watershed.

The watershed includes four “natural areas” listed by the Vermont Natural Resources Council: Pleiad Lake, Texas Falls, Moss Glen Falls and the Granville Gulf Hemlock-Spruce stand.

Methods

The principal sources of information on the vegetation history of the watershed for this reference condition are research reports and historical documents. Although the literature on ecological processes in New England since the end of the Wisconsin glaciation is extensive, little of it is specific to central Vermont. Searching for and reading relevant research reports represented a significant portion of the time required to complete this study. Although much of this information will simplify the creation of vegetation reference conditions for other watersheds in the Green Mountain National Forest, the articles cited here should be used as a starting point for future literature reviews and not as a comprehensive list of the necessary documents.

I identified the boundaries of the Hancock subwatershed on USGS Topographic maps (Breadloaf, Lincoln, Hancock and Warren quadrangles) using a method provided by Diane Burbank (pers. comm.). I then transferred these boundaries to copies of the equivalent quadrangles from the Green Mountain National Forest Land Status Atlas (USDA Forest Service, undated). The Land Status quadrangles include basic landscape features overlaid with labeled lot and tract boundaries. As the sizes of the tract are large relative to topographic features, and we are primarily interested in simply determining which tracts were within the watershed, it was possible to transfer the watershed boundary visually, rather than using a zoom transfer scope. This allowed me to create a list of tracts, which were within the watershed. I entered these tract numbers into a worksheet using the Microsoft Excel program, along with an indication of whether the tract was fully within the watershed, partially within the watershed, or on the boundary and questionable. I then entered the tract size and conveyance data from the status map tabular record for each tract.

Using the tract list sorted numerically by tract number, I retrieved the full conveyance file for each tract from physical files located at the Forest Headquarters in Rutland, VT. For each tract, I examined two sets of data in the conveyance record. The first item was the tract survey. I used the initial paragraph of the survey regarding tract location to verify if questionable tracts were within the appropriate watershed. I removed from the study list tracts that drained entirely into areas outside of the target watershed. I recorded witness trees for each tract corner within the watershed in a second Excel worksheet, including corner species, diameter and distance from corner or witness corner. The second data source, available for many but not all tracts, was information from Forest Service timber cruises. I entered these estimates of the volume of standing timber by species into a third Excel worksheet. A final data item, present but not recorded, is mention in the survey of features indicative of land use history: stone walls, buildings, wells, roads, etc. Recording this data would have been useful in understanding the human effects on the watershed, but would have more than doubled the required time to gather and record data from the conveyance records.

I used several sources for historical documents on the watershed. Survey plats for the towns in question were available in the Surveying office at the GMNF headquarters in Rutland. Original township boundary surveys were available in the papers of the Surveyors-General, located in the office of the State Archivist, Gregory Sanford, in the Secretary of State's office in Montpelier (Dewart, 1918). Although the original town lotting surveys should have been available in the town clerks' offices, I did not locate the original survey notes containing witness trees.

I located additional historical information at the Vermont Historical Society library in Montpelier, including a copy of a "field book for Hancock of the first survey performed" (Crary, 1787). This field book explains that "extreme inclement weather" destroyed many of the original survey minutes, and the surveyor had to piece together the survey from the remaining notes. Fortunately, the surviving survey does include witness trees for most of the lot corners of Hancock. I entered the witness trees into an Excel worksheet by species for each lot. By examining the Land Status Atlas quadrangles, I assigned each lot to a Forest Service Tract and entered this in the worksheet.

Results

Broad patterns of vegetation change

Although I could locate no paleo-ecological research specific to the Hancock subwatershed, I did find palynological studies for similar areas in New England. The nearest research site was Little Rock Pond in South Wallingford, Vermont (McDonnell, 1989). McDonnell's analysis was made in conjunction with William Patterson of the University of Massachusetts, Amherst, and provides a paleo-environmental reconstruction for a site in central Vermont. As the samples have not been carbon dated, there are only a few points for which we can associate ages. While some aspects of this environment may be specific to Little Rock Pond, the reconstruction provides a general overview of what the broad patterns of vegetation change might have been in the Green Mountains. A portion of the pollen diagram is reproduced in Figures 1 and 2.

Following the retreat of the Wisconsin glacier more than 12,000 years before present, there was a period where the pollen record at this site shows a tundra assemblage consisting primarily of diploxylon pine (jack pine, *Pinus banksiana*), spruce, and non-arboreal pollen (mostly Cyperaceae, with some Gramineae, *Artemisia,* and *Ambrosia*).

Spruce pollen, most likely white spruce (*Picea glauca)* (Patterson, pers. comm.), replaced the tundra assemblage. This mirrors similar time transgressive vegetation changes elsewhere in New England (Davis 1983). As spruce pollen declined, *Ambrosia* pollen reached levels similar to those of the recent settlement period and alder (*Alnus)* reached

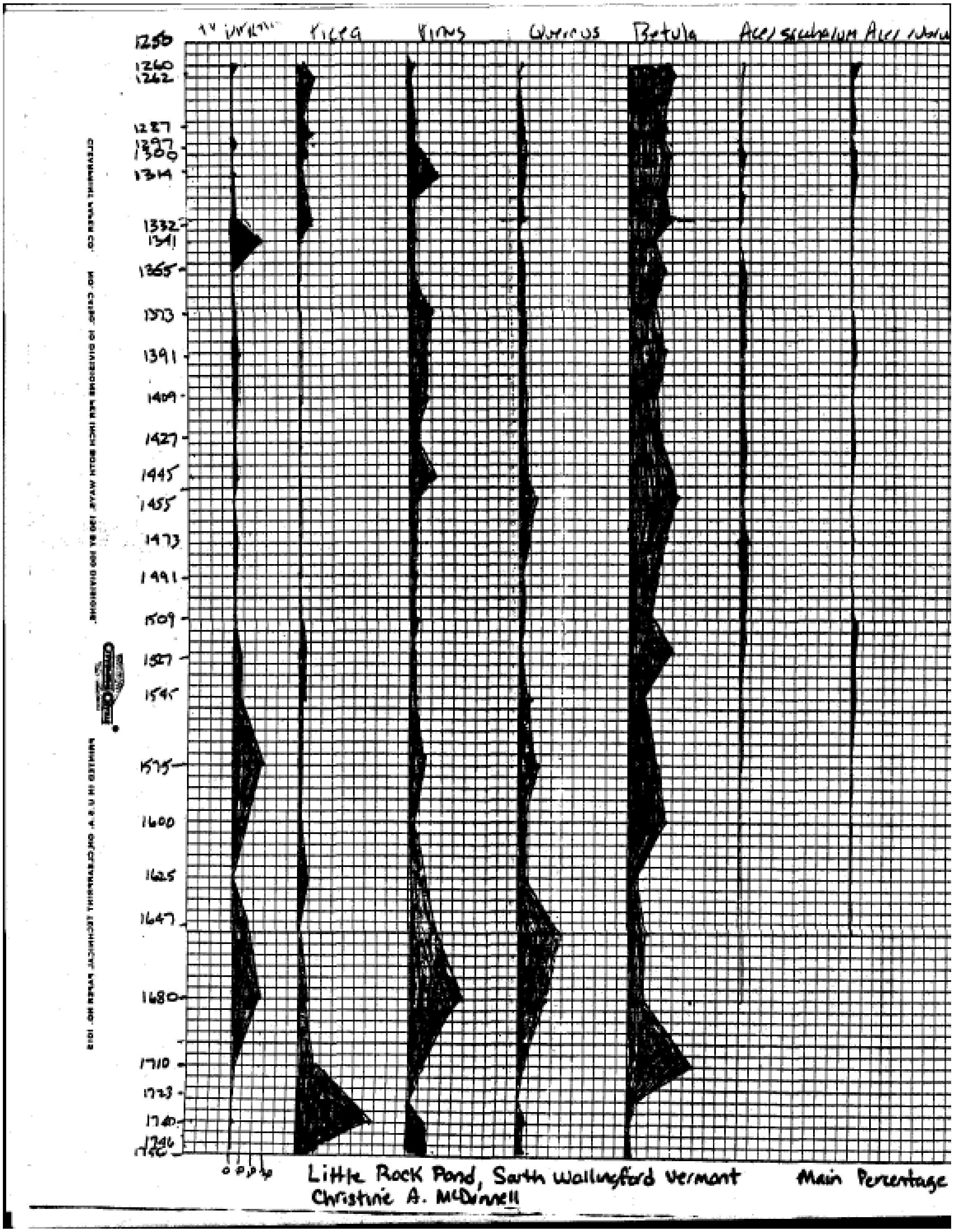

Figure 1. Pollen diagram from McDonnell, 1989.

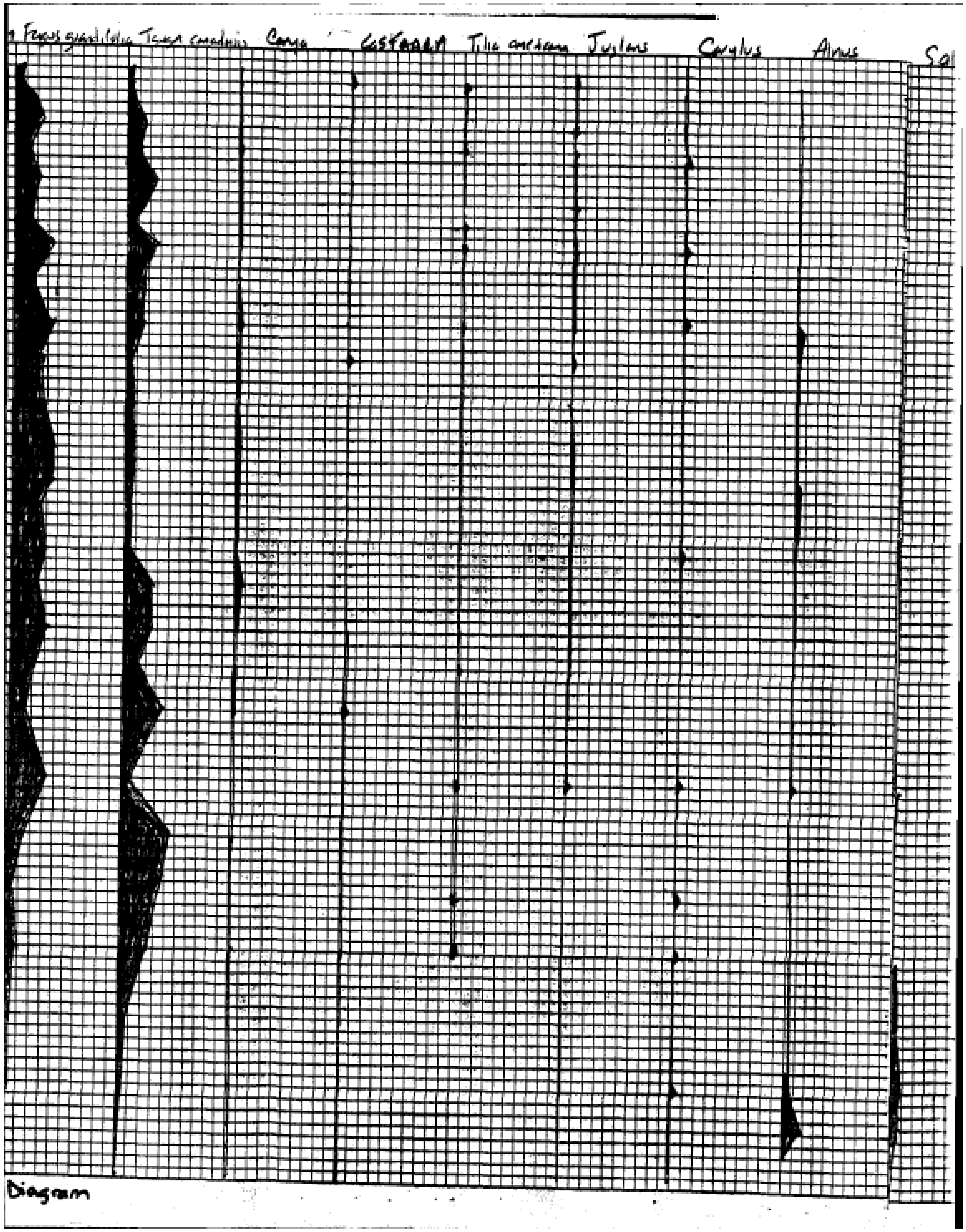

Figure 2. Pollen diagram from McDonnell, 1989.

its post-Wisconsin peak. These changes suggest that climatic warming forced the spruce to move north across the landscape, creating substantial open areas.

These gaps in the environment were filled by birch. *Betula* pollen reached its highest peak since glaciation during this period, but declined and was replaced by pine and oak, resulting in a Pine-Oak-Birch forest. The increase in pine pollen was nearly entirely haploxylon pine, representing an increase in white pine (*Pinus strobus)*. The increase in the haploxylon/diploxylon ratio suggests a warmer, drier climate.

The peak of this ratio and of the overall level of pine pollen coincided with the beginning of an increase in hemlock (*Tsuga canadensis),* birch and beech (*Fagus grandifolia).* The Pine-Oak-Birch forest was replaced by Hemlock-Birch-Beech, with the first maple pollen *(Acer saccharum* and *Acer rubrum)* appearing at this time.

This assemblage went through several shifts in relative species dominance. For example, a second increase in the haploxylon/diploxylon ratio coincided with a temporary decrease in hemlock and increase in beech, possibly indicating the results of another period of climate change. Ultimately, the hemlock sharply declined and did not rebound, resulting in a northern hardwood Beech-Birch-Maple-Hemlock community common today in the Green Mountains. This hemlock decline has been observed elsewhere in New England approximately 5000 years before present (Webb 1982, Allison et al. 1986) and serves to date the emergence of the northern hardwood forest at the Little Rock Pond site in the mid-Holocene epoch.

With the decline of hemlock, oak followed by white pine began to increase again, resulting in a familiar oak and pine component along with the northern hardwood forest. These proportions remained relatively stable until hemlock again began increasing and pine decreasing 2-3,000 years ago. Several fluctuations in pollen levels occurred over the following millennia, but the general assemblage remained stable.

Beginning about 500 to 600 years ago, beech and hemlock levels began a decline that continues to the present. A study in north central Massachusetts (Fuller et al. 1998) found a similar pattern of beech and hemlock decline, and the authors note that the timing of this decline corresponds with the beginning of the Little Ice Age around AD 1450. The Little Rock Pond pollen record shows a concomitant increase in a cold-tolerant genus, spruce, supporting the theory that the beach and hemlock decline beginning in the centuries preceding European settlement was due to a cooler climate.

Vegetation change in the settlement period

Although the conveyance records for many of the tracts in the watershed included volume estimates for major timber species, these timber cruises included insufficient information on non-timber species. Figures 3 and 4 show the percentage occurrence in the survey witness tree data from 1787 and 1935 for the entire watershed.

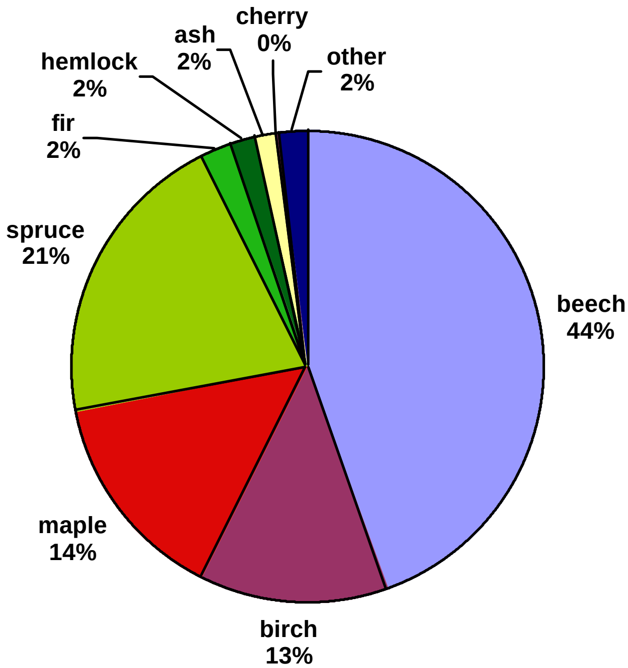

Figure 3. Percentage occurrence by species of survey witness trees, ca. 1787.

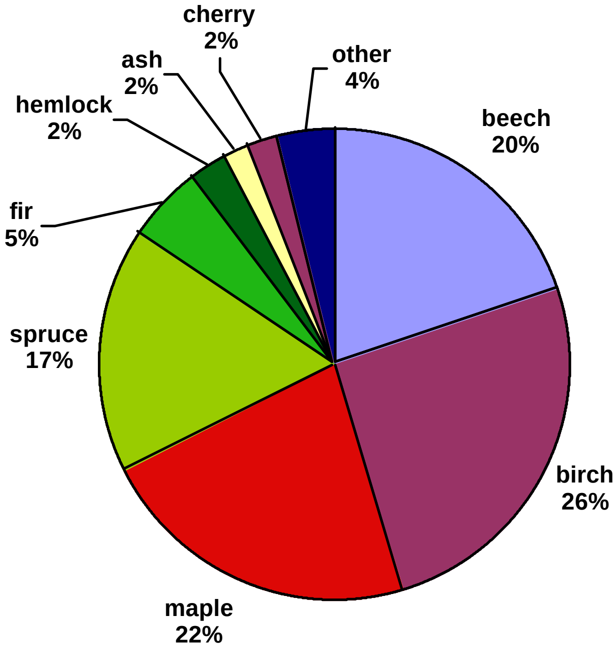

Figure 4. Percentage occurrence by species of survey witness trees, ca. 1935.

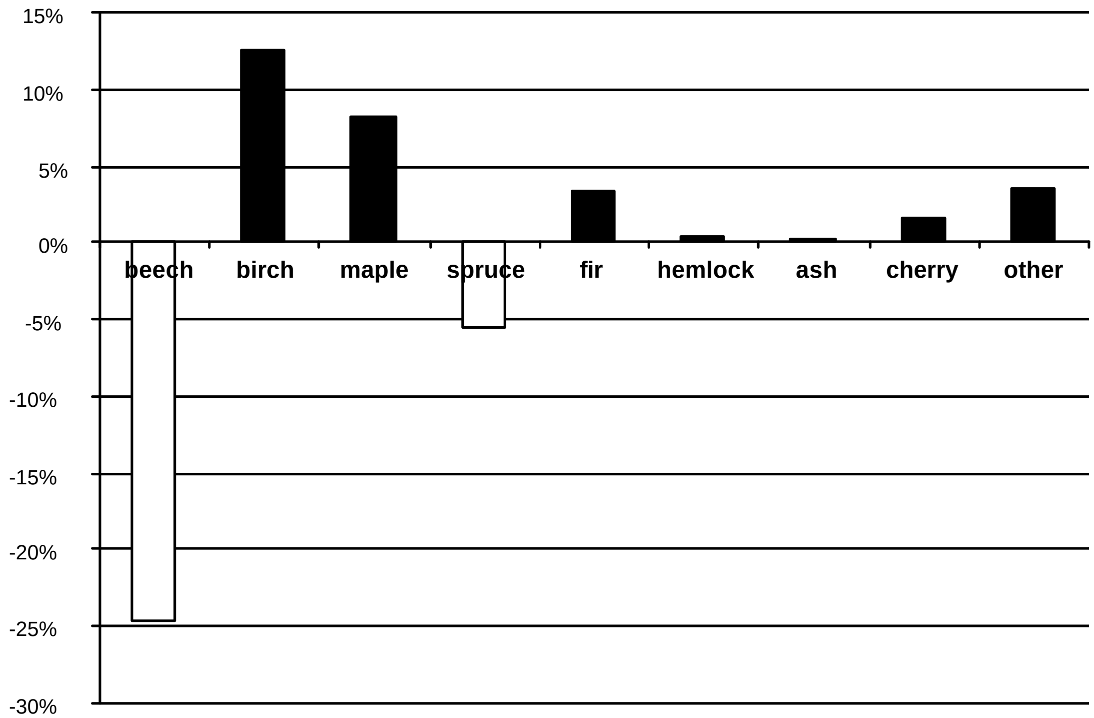

Figure 5. Change in percentage occurrence by species from 1787 to 1935.

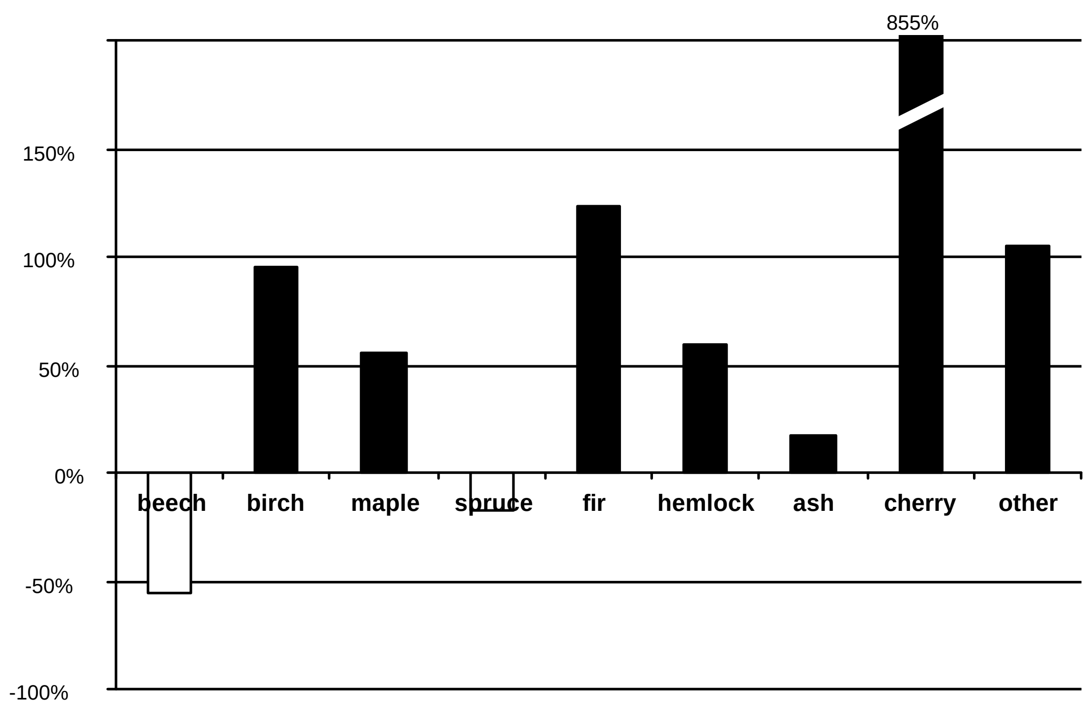

Figure 6. Change in species occurrence 1787 to 1935, relative to 1787 percentage.

Figure 5 shows the change in percent occurrence from 1787 to 1935. Figure 6 shows the same change relative to the 1787 percentage. Note that the figures for cherry in 1787 were derived from a single tree, and the very large apparent increase is probably spurious.

It appears likely that the decline in beech can be attributed to the climate changes discussed above. Although beech has been in decline in recent years due to the beech bark disease, the change from 1787 to 1935 predates the onset of this pathogen. There is no evidence of any cultural history that would result in a decrease in the amount of beech present.

Cluster analysis and ordination of the vegetation in 1935 and the change between 1787 and 1935 by tract were inconclusive, possibly due to the small total number of trees counted for each tract. Figures 7a-c show the change in percentage species occurrence by tract. Once digitized maps of the tract locations are available, these data should be incorporated as a separate GIS layer.

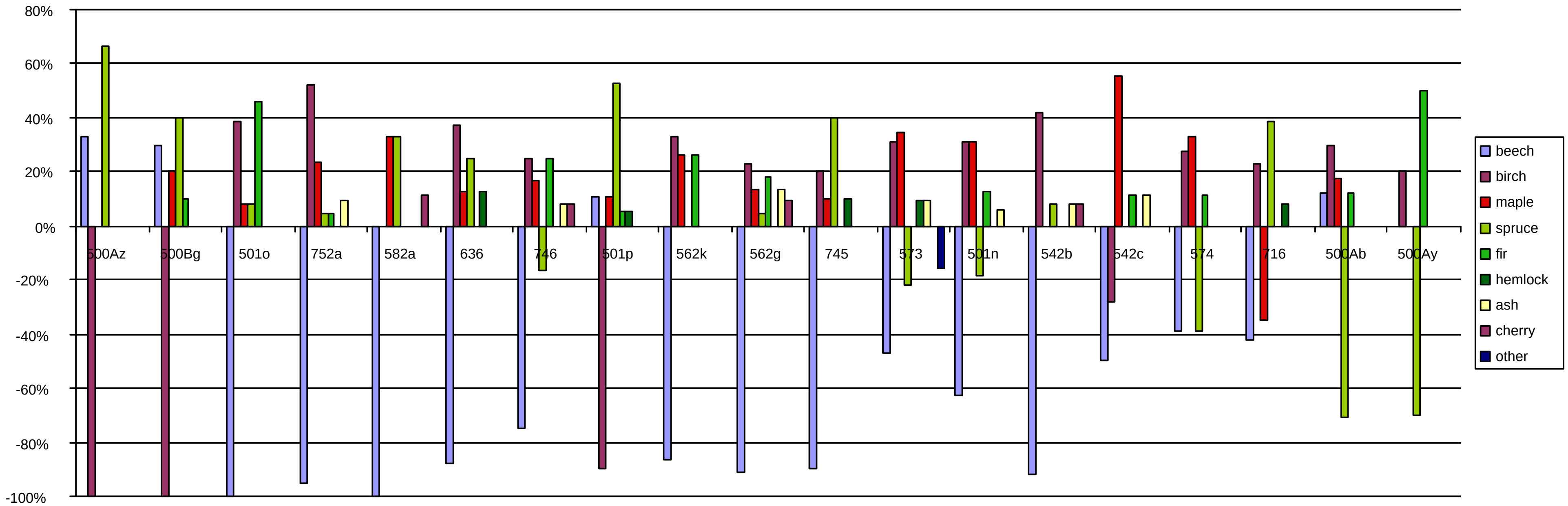

Figure 7a. Changes in species percent occurrence by tract, 1787 to 1935. Large changes.

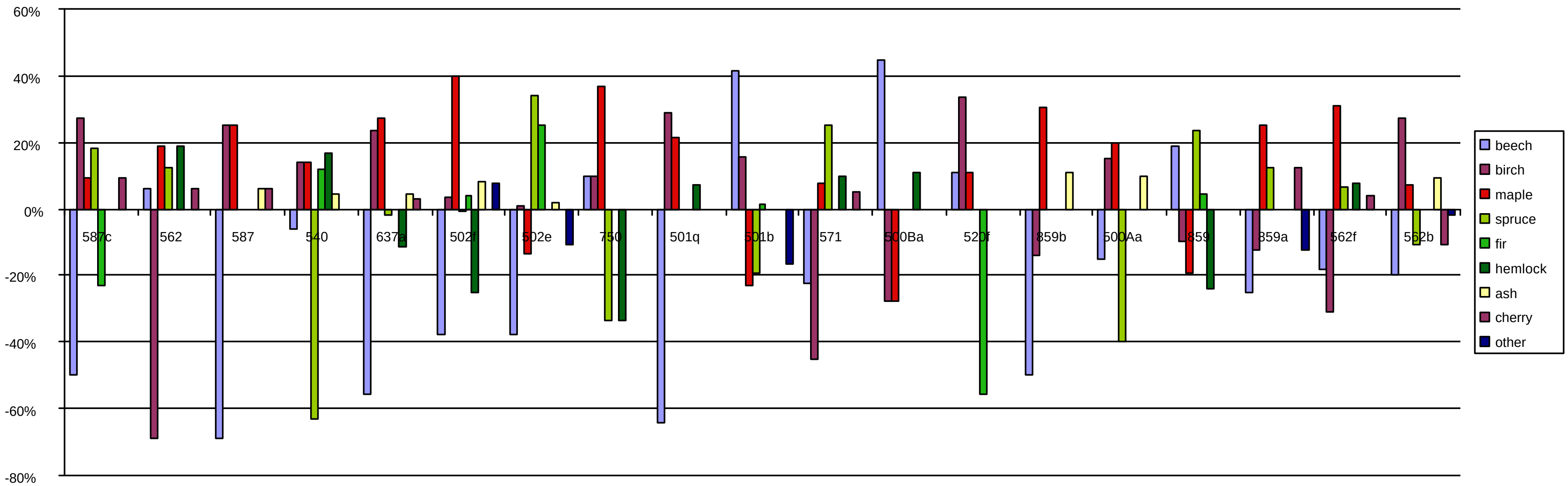

Figure 7b. Changes in species percent occurrence by tract, 1787 to 1935. Moderate changes.

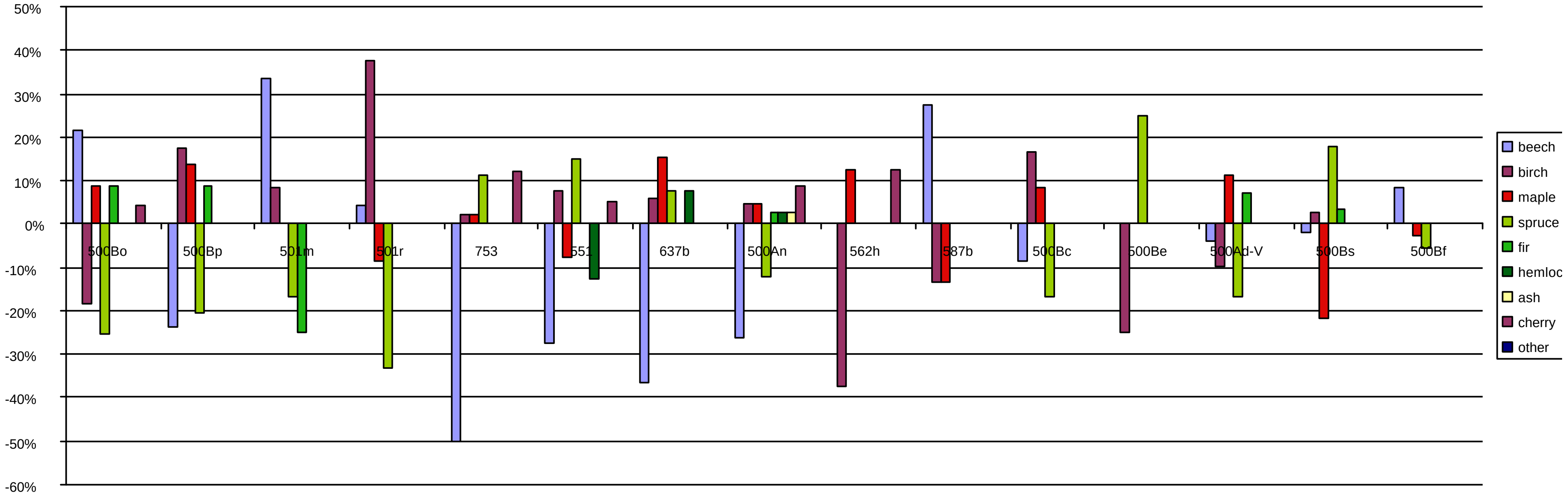

Figure 7c. Changes in species percent occurrence by tract, 1787 to 1935. Small changes.

Survey bias

To analyze whether surveyors had a bias for some tree species over others, I calculated the mean distance for each species or genera (shown in Table 1) and compared them pairwise for all species with more than 1% representation. If surveyors preferred one species over another, they would be likely to select a tree even if it were not the closest tree to the corner. This would result in a larger mean distance. The results showed only a few cases at a 95% confidence level where the confidence intervals did not overlap. 6 species or genera were preferred over cherry (*Prunus serotina)*. Beech, birch and maple were preferred over hemlock. Beech and maple were preferred over spruce. All other pairings of species showed no significant difference in the means of their distances from the survey corners. The only pairs where the bias amounted to more than 5 percent of the mean of either member of the pair were the six pairs involving cherry (average of 24.5%), and beech vs. hemlock (5.5%). This implies that a probable bias in the survey data is an understatement of the amount of cherry present in 1935.

Table 1. Mean distances in chains (20.1m) from survey corners of witness trees in 1935-era surveys.

	ash	beech	birch	cherry	elm	fir	hemlock	maple	poplar	spruce
n	33	341	460	36	24	97	42	415	22	290
Mean	0.35	0.37	0.35	0.22	0.40	0.31	0.28	0.36	0.30	0.31
Confidence Level(95%)	±0.07	±0.02	±0.02	±0.04	±0.15	±0.04	±0.05	±0.02	±0.11	±0.02

Due to the destruction of the original field notes from the town lotting survey, stake to tree distances were not available for the 1787 survey. An earlier study of town lotting surveys in Chittenden County (Siccama, 1971) found no species bias among the surveyors of those townships.

Disturbances

The predominant natural disturbances in the watershed are wind, fire and pathogens. Although major damage from wind is infrequent, central Vermont is subject to occasional catastropic hurricanes (Smith, 1946). Although the hurricane of 1938 caused only minor to moderate damage in central Vermont, the eye of the storm did track nearly across the watershed (Foster, 1988). Estimates for the mean return period for wind disturbance in forests in the Northeast range from 1000 to 2000 years (Whitney, 1994).

The moist climate of the Northeast limits the occurrence of natural fire. Nonetheless, palynogical studies of charcoal in stratified sediments suggest return periods of 800-1400 years (Patterson and Backman, 1988). Unfortunately, charcoal studies have not been completed for the Little Rock Pond samples.

Pathogens have played an important role in the composition of New England forests. These include the hemlock pathogen of 5000 years B.P. (Allison et al., 1986), beech bark disease, spruce budworm, and the 20th century chestnut blight and gypsy moth infestations in southern New England. Although I could find no documents detailing the effects of these specific pathogens in the watershed, it can be safely assumed that these types of pests are a major source of vegetation disturbance in the Hancock sub-watershed.

Prior to settlement by Europeans, the watershed likely had few, if any permanent human residents. No prehistoric Native American sites are known in the immediate area of the watershed (Crock and Petersen, 1994). The first human entrants to the central Vermont region occurred in the Paleoindian period (11,000–9,000 B. P.) following the end of glaciation. Few sites have been found in Vermont that date prior to 6,000–5,000 B. P. and there is no evidence of Native American disturbance in the watershed. Finally, members of the local Woodland period culture (the Western Abenaki) were forced to emigrate to northwestern Vermont and Quebec after the arrival of Europeans (Crock and Petersen, 1994).

Conclusion

The largest changes in vegetation since glaciation have apparently been due to variations in climate and pathogens. The pollen record suggests that the periods of these variations range from several millenia down to several centuries. A gradually changing forest has progressed from a Jack Pine–Tundra assemblage (10,000 years BP), through successive forests dominated by White Spruce, Birch, Pine-Oak-Birch, Hemlock-Birch-Beech, and Beech-Birch-Maple-Hemlock. From the onset of the Little Ice Age (500-600 years B.P) until settlement (ca. 200 years B.P), the composition of the forest was shifting away from a heavy dominance by beech and towards spruce.

The decline in beech has been continuing since settlement, although spruce has also decreased in the settlement period. The largest increase of an individual species since settlement has been in cherry (*Prunus serotina*), as evidenced by a nearly nine-fold increase in cherry among witness trees, despite a surveyor bias against cherry in the 1935 surveys. This species has long-lived seeds that can survive several decades in the forest floor, germinating only when a large gap has been opened to allow sun to enter. The decrease in spruce and increase in cherry reflect over a century of timber harvesting. These compositional changes are much smaller than the climate-induced change in the amount of beech present.

Although one could specify the reference condition of the watershed as the condition of the forest immediately prior to settlement, that beech-dominated Northern Hardwoods-Hemlock association was already being altered by climate changes before the European settlers arrived. Perhaps the best solution is to see the forest condition not as static, but rather as a dynamic pattern, varying with long-term climate change and short-term pathogen outbreaks.

Observations and Recommendations on Process

The analysis of watersheds as described by the federal guide (Anonymous 1995) is an integrated, inter-agency process. As such, it assumes a team approach with each step closely informed by the preceding steps. Members of the team are assumed to be working regularly on the analysis. This process is not well suited for outsourcing to independent contractors, unless the contractors are made an integral part of the team.

For example, the federal guide assumes that the person analyzing the reference condition is fully knowledgeable of the team's results in the first three steps (Step 1: Characterization, Step 2: Identification of issues and key questions, and Step 3: Current condition). While the watershed analysis team made extensive data available to me, including GIS maps, from which one might be able to derive these results, the actual written reports for those earlier steps were not available at the time I began work on Step 4, the Reference condition.

This vegetation reference condition was created in isolation from the remainder of the process. Although I present what I hope is valuable information on the reference condition of the vegetation in the watershed, I would recommend that future work be done by an individual more closely connected to the remainder of the process and team.

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Appendix - Data

See attached Microsoft Excel file.