FOREST MANAGEMENT PLAN

for property known as

The Second College Grant

owned by

Dartmouth College

Dartmouth College Woodlands
P.O. Box 213
Milan, New Hampshire 03588
Date: April 2011

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Acknowledgments

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Second College Grant Management Committee for their understanding that the Grant is indeed a special place, their willingness to be leaders in land management excellence, and for their reviews of drafts of this plan

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I. Introduction

Introduction

The Grant has long exemplified some of the finest forest management in northern New England. Managers at the Grant have striven to protect the rich abundance of native species found within it's borders. All activities are carefully planned and timed to enhance the health and productivity of the resources. The Grant management focuses on maintaining biological diversity, accommodating recreational needs, enhancing wildlife habitat and timber production. The annual timber harvest is carefully calculated to ensure a sustainable supply of timber and other resources.

Timber harvesting has occurred on these lands since 1828, and the college has utilized the services of professional foresters since 1905. The Grant also has an important recreational and educational history. The Dartmouth community has utilized this property for research, student wilderness trips, canoeing, hunting, and other remote recreational activities. Students and volunteers have built ten recreational cabins on the property since the late1940's.

The Grant is comprised of the watersheds of the Dead Diamond and Swift Diamond rivers. The temperate hardwood forest consists of approximately 50 percent hardwood, 20 percent softwood and 30 percent mixed forest. Primary Hardwood species are Hard maple, yellow birch, American beech, red maple, paper birch and aspen. The softwood component is primarily red spruce and balsam fir. The terrain of the region would be considered moderately sloped to steep, with the exception of the river valleys. Mt. Dustin, the Diamond Peaks, and the Dead Diamond Gorge are considered significant physical landmarks for their natural beauty.

The Grant is rich in wildlife, harboring deer, moose, black bear, and numerous smaller animals. One of the largest deer wintering areas in the region is found within the Grant. Osprey feed on the native fish found in the rivers and peregrine falcons have been observed on the cliffs of the Diamond Peaks. Woodcock and ruffed grouse are found in the rich bottom lands and along the upland slopes. The rare pine marten make their home in the high elevation softwood areas.

Dartmouth manages this property with three general objectives in mind: timber investment, education, and recreation. The lands are managed carefully and thoughtfully, with management activities driven by a long term perspective. Advisory committees guide policy development and management guidelines.

Administration of the Second College Grant

Four primary parties are involved in management of the Grant. First, planning and management of forestry operations are vested with the Director of Woodland Operations. Second, development and coordination of recreational activity are vested with the Director of Outdoor Programs. Both of these College officers work with faculty and students on activities of an academic or co-curricular nature. Third, professional review of the planning and execution of logging operations is obtained through certification of the sustainability of these practices by an independent agency (currently employing the standards of the Green Tag Forestry program).

While overall supervision of activities in the Grant is vested with the Vice President for Campus Planning and Facilities, the Second College Grant Management Committee ("the Management Committee") serves in an important advisory capacity to this office and the two program directors. The Committee's primary role is to set policy, review plans and assess accomplishments of goals and objectives. The committee meets at least four times each year, generally after the end of each calendar quarter. All but the early spring meeting are held at the Grant. In addition to long-range planning work, typical meetings involve: updates on current activities from the Director of Woodland Operations and the Director of Outdoor Programs; discussion of forestry practices certification reports; review of budgets, contracts and other operational data; and visitor presentations and site visits within the Grant. Special meetings may also be held.

Finally, there is a Grant Advisory Committee comprised primarily of alumnae along with Director of Outdoor Programs, Director of Woodland Operations, and representatives of Facility Operations and Management. This committee meets once each summer at the Grant. Their primary role is to give advice on recreation management activities from the unique perspective of alumnae and users of the Grant.

While the Grant is first and foremost a private resource of Dartmouth College, the Management Committee considers ways to make the activities carried on their relevant to the surrounding region and reviews conditions under which individuals and organizations outside of the Dartmouth family may be permitted to enter, learn in, and enjoy this very special place.

Special thanks to Edwin L. Johnson '67 for preparing this administrative description for the Second College Grant Web Page.

Advisors for Management of the Second College Grant

Grant Management Committee (as of June 2010)

Vice President - Campus Planning & Facilities	Linda Snyder
Chief Financial Officer - Campus Planning and Facilities	Lisa Celone, Committee Chair
Dean of the College Representative	Harry Kinne
Real Estate representative	Larry Kelly
Director of Outdoor Programs	Daniel M. Nelson`75
Director of Woodland Operations	Kevin S. Evans
Faculty Representative	Matt Ayres, PHD, Professor of Biological Sciences
Faculty Representative	Jon Kull `88, PHD, Professor of Chemistry
Alumni Representative	Joe Bachman '91, Tu '03
Alumni Representative	Chuck Wooster '89
Student Representative	Christopher Rhodes '13
Student Representative	Athena Aicher '11
Ex-officio	Robert Piampiano '67

Grant Advisory Committee (as of June 2010)

Richard Booma '63	Lebanon, NH
Russell Cook '53, Tuck '57	Thetford, VT
Lisa Densmore '83	
Rachel Goldwasser '01	
Earl Jette`55A	Lebanon, NH
Willem Lange '57	E. Montpelier, VT
Lelia Mellen '86	
Jeff Milne	
Jack Noon '68	Warren, NH
Robert Oden	
Tony Owen '71	
Eric Sailer '60 DMS'61	Lyme, NH
Jeff Sassorossi '75	Lebanon, NH
Norman Webber '71	Canastola, NY
Athena Aicher '11	Student Rep.
Chris Rhodes '13	Student Rep.
Daniel M. Nelson`75	Director of Outdoor Programs
Kevin Evans	Director of Woodland Operations

Grant Wildlife Committee (as of June 2010)

Robert Piampiano '67	Management Team- Chair	Yarmouth, ME
Russell Cook '53, Tuck '57	Alumni - Advisory	Thetford, VT
Larry Kelly	Management Team	West Lebanon, NH
Robert Oden	Alumni - Advisory	Hanover, NH
Kevin Evans	Director of Woodlands	Milan, NH
Preston McBride	Student Rep.	Hanover, NH
Marshall Bartlett	Student Rep.	Hanover, NH

Ex Officio – Technical Support

Dan Nelson	Director of Outdoor Programs
Lorraine Turner	Grant Caretaker
Will Staats	New Hampshire Fish and Game
Dianne Timmins	New Hampshire Fish and Game

Management Vision for the Second College Grant

The Second College Grant, given to Dartmouth College by the state of New Hampshire in 1807, is considered important to the College for 1) financial purposes, 2) recreational purposes, and 3) education and research.

Management of the Second College Grant will be a model of environmentally sound private land stewardship, reflective of the ecology, landscape, and culture of the northern forests of New Hampshire and New England. We will manage to:

- Protect the natural qualities and integrity of the land, natural communities, native species, and ecological processes. Use and build upon, rather than work in opposition to, ecological principles and natural tendencies. Manage the land with as little interference as possible with natural ecological functions.

- Emphasize the growth of long-rotation, high quality, solid wood forest products that contribute to the economy of northern New Hampshire.

- Involve concerned and interested employees, alumnae, and students in the management process through the Second College Grant Advisory Committee and the Second College Grant Management team.

- Provide education and research activities

- Provide remote recreation for the Dartmouth community.

This vision statement was revised and aprroved by the Grant Management Team, April 2010.

II. History of the Second College Grant

History of the Second College Grant

A. Vegetative and Geological History

Pre-1807 History

The climax vegetation patterns (or forest associations) existing today on the Second College Grant are part of landscape, soil, and vegetation combinations called Ecological Land Groups (ELG's). The character and distribution of ELG's have been formed through more than 11,000 years of glacial development.

Soil Development

Although the overall topography of the Second College Grant represents much older geologic processes, the soil properties present on the property can be traced directly to glacial movement. The Wisconsin Glacier began advancing about 50,000 years ago and continued to accumulate to an estimated two miles thick over the Grant area. Much like a bulldozer, the advancing glacier scraped, ground, and eroded the previous soils and bedrock into a massive mix of ice, water, and soil and rock debris. More importantly, the glacier acted as a means to deposit material on the land. Glacial deposition took two forms: glacial till and glacial outwash.

Glacial till occurs where debris was deposited at the base of the glacier (basal till) or where debris settled out as the glacier receded (ablation till). Due to the overlying pressure under which it was formed, basal till is typically dense and compact, forming a characteristic layer called a hardpan. Ablation till, on the other hand, precipitated under the force of gravity and generally does not contain a hardpan.

Glacial outwash is material deposited by the meltwaters of the glacier. Rivers and streams flowed on, through, under, and adjacent to the glacial ice as it melted. The water carried, sorted, and deposited vast quantities of gravel and sand in the valleys. These deposits are now composed of multiple layers of gravel and sand which accumulate in places to several feet thick.

After the glaciers receded and the parent material for the soils was distributed, environmental factors (e.g., climate, topography, plant and animal life) acted on these parent materials to form the soils that occur today. The climactic influence relates directly to elevation; higher elevation soils (above approximately 2,300 feet) do not warm above 59 degrees F during the summer and are in the cryic temperature zone. Lower elevation soils are somewhat warmer and are in the frigid temperature zone.

Vegetation

The distribution of exemplary natural communities and rare plants can be traced directly to the last glaciation. Once the glaciers began to recede, native vegetation slowly returned to the landscape through a process known as primary succession. Due to the arctic climate near the glacier's receding front, the first species to colonize the barren earth were hardy, boreal bryophytes (mosses), herbs, and shrubs. Many of these arctic/boreal species are rare today and remain only in higher elevation habitats where harsh winds, cold temperatures, and shallow soils restrict competition from less hardy species.

Soon after this primary succession, cold-hardy spruce forests returned to much of the New England landscape. These spruce-fir forests remain today in higher elevations and lower elevation pockets where frigid, hardpan soils exist. As the landscape continued to warm, pine and then hardwood species returned to occupy suitable lower elevation sites. Thus, the current mosaic of natural communities on the Second College Grant represents both current soil characteristics and over 11,000 years of adaptations to a changing climate.

Post-glacial events can also explain the rarity of some lower elevation species. Evidence of pollen deposition indicates that plants of calcilreous, mineral soils were once more common than they are today. With the warming of the climate and subsequent colonization of numerous southerly species, these "calcicoles" gradually disappeared from the landscape. Rare plants such as broad-lipped twayblade, millet-grass, and marsh horsetail relict are examples of relict calcicoles that remain today in the Second College Grant.

B. Management History since 1807

In 1807, the state of New Hampshire granted Dartmouth College a 26,800 acre tract of land. This land, known as the Second College Grant, is located in northeastern Coos County; the eastern side borders Maine and the remaining sides border large timber tracts. When New Hampshire granted the land to Dartmouth in 1807, the land, considered remote, had not even been surveyed for the Map of New Hampshire (Figure 1: Old Map 1812). Today, as in 1807, almost all of the Grant is heavily wooded. Two rivers run through the Grant, the Dead Diamond and the Swift Diamond, both of which run into the Magalloway (Figure 2: Map of the Swift and Dead River Watershed). These rivers provided an ideal way to transport logs in the early days, and were the source of plentiful amounts of fish. In his article "Exploring the Magalloway", in the November 1864 issue of Harper's, Francis Parkman described the Magalloway, stating that "the stream, tumbling over ledges, whirling in pebbly basins, or lurking, sullen and dark, under the brows of projecting rocks, was eminently suggestive of trout" (Parkman 738). Later, Arthur H. Lord, in his diary kept during two summers of work at the Second College Grant in 1908 and 1909, mentioned Four Mile Brook, stating that he "began fishing, brook full of them, biting every minute, great sport. After 3 hours we had enough, even though we had not finished half the brook…We found we had over 400 trout in all" (Lord Diary Jun 28). Thus, from its early days the Grant was both a source of money as well as recreation.

The Second College Grant is unique in its status as the only land grant given to Dartmouth by the state of New Hampshire that "remains essentially intact and unsettled" (Appleton Intro). The state of New Hampshire gave the land to Dartmouth because it felt the College would bring literature to the state of New Hampshire; the agreement made when New Hampshire gave the College the land was that "the incomes of said land shall be applied wholly and exclusively to assist the education of the youths who shall be indigent and to alleviate the expenses of the members of families in this State" (Monahan 3). This Act was amended twice: once in 1846 to state that the Trustees could sell out, and again in 1919 to state that once the money generated by the Grant had covered its original intent, the remaining money could be used for general expenses of the College (Appleton 8).

Unlike Dartmouth's other land grants, all of which were eventually sold off, the Second College Grant has remained in the possession of the College. In 1828 the College divided the land into lots but it was unable to lease most of them because prospective farmers did not like the rugged terrain and remote location of the Grant (ES 50 Plan 1). Only three lots were leased; Lot #2 to Moses Mason in 1828 for 999 years, Lot #3 to David Sawyer in 1829 for 999 years, and Lot #4 to Peter Bennett in 1882 for 999 years (Appendix 1: Second College Grant Title). Because the College could not gather significant income through leasing the land, other means had to be found.

Although as early as 1840 the College made money from small scale cutting of timber at the Grant, it was not until 1888 that the first major cutting occurred. The contractor for this cutting was the Connecticut Valley Operator George Van Dyke. In 1893, Van Dyke assigned his lease to Androscoggin River Supply Co., which was later combined with the Rumford Falls Mills. In June of 1898, Rumford Falls told the College that there would be no cutting at the Grant the following year. It was at this time that the College became entangled in a series of legal battles which had plagued the other land grants as well. That next year, the winter of 1899, 13 operators sneaked into the Grant and cut and landed 11,562,000 feet of timber (Figure 3: Map of names, locations, and amount of secret cutting). International Paper Company was one of these covert operators, and Surveyor Ray T. Gile later went out to the Grant to check on the location and amount of the secret cutting done by the Paper Company. Gile discovered areas that should only have been cut once were recut, thus proving someone had wronged the College. In the end, the International Paper Case was settled for $62,500 (Appleton 23-24).

Around 1900 the Grant started to become a significant source of income for the College and in 1905 Dartmouth hired its first forester, Phillip Ayres, who worked at the Grant on a part-time basis (ES 50 2). During Ayres' time, the Peak's Camp cabin was built (1908) at what is now the location of the Management Center. Ayres' big project was a farm located in the Upper College just above Merrill Brook, but in 1911, after Ayres had spent $7,900 above what he made from stumpage receipts and ended his term, the farm was no longer in use and the area where it stood is now covered with trees (Appleton 27).

In 1918 and 1919, the Grant was plagued by the spruce budworm. Epidemics of spruce budworm can destroy timber resources because the budworm either kills the tree through repeated defoliation or makes the tree weak and vulnerable to other pests such as the bark beetle (Appleton 29). The Spruce Budworm epidemic of 1918-1919 prompted major cutting operations at the Grant in order to salvage merchantable timber (Monahan 4). Cutting began in 1921 and lasted until 1930 bringing in considerable profit for the College since prices were at a high in 1920 (Appleton 30).

In 1947, the College President, John Dickey, appointed Robert Monahan as the second College Forester (Figure 4: 1958 Map of Grant). Dickey's main contribution to the Grant was his encouragement of a multiple-use philosophy (ES 50 20). Monahan worked to make this multiple-use philosophy a success; three additional cabins were built during his time, as well as the Management Center, which began construction in 1951 (ES 50 2). Also, hiking and fishing at the Grant became more popular, especially since new logging roads made areas of the Grant

more accessible. In addition to expanding the multiple-use philosophy, Monahan "helped develop markets for old growth hardwoods, and during his tenure, millions of board-feet of yellow birch and maple were harvested. But while hauling timber out of the Grant on an improved road system was a lucrative practice in the short term, selective cutting of only the top-grade hardwoods left the Grant lacking saleable high-quality hardwood" (ES 50 2, 2nd ref Dead and Swift rivers: Watershed Resource Assessment 1989).

In 1967, a committee of three professional foresters appointed by the Trustees were to devise a new timber management program. The committee recommended that the firm Prentiss & Carlisle should undertake a long-range management study of the Grant; the Seven Islands Land Company of Bangor, Maine was then contracted to carry out the management of the forests. Seven Islands was told to develop a plan which would provide income for the College, increase timber growth and quality, and protect and provide for other aesthetic uses of the Grant (Appendix 2: Ten-Twenty Year Plan). Seven Islands determined and implemented an allowable harvest amount of 4000 cords/year (10-20 Yr Plan 5). Another positive move during this time was the adoption of a deeryard management plan in 1973. This acknowledged the importance of wildlife in the Grant, and biologists supervised harvesting at the Grant in order to ensure that deer habitat was being preserved and maximized (ES 50 3). Also at this time, athletic teams utilized the Grant for pre-season training, expanding the recreational use of the Grant. In 1978, Seven Island's Ten-Twenty Year plan was curtailed because evidence of an increase in spruce budworm prompted a moritorim on harvesting while a plan was developed in response to the epidemic. Implementation of salvage operations began along the northern border of the Grant, and continued until 1986 (Figure 5: Map of Spruce Budworm Affected Area (1981). Salvage harvests from 1980 to 1986 ranged from 1500 cords to 7200 cords.

In 1987, the College returned to having a College Forester on staff and Mr Edward G. Witt was hired. Mr. Witt continued the implementation of Seven Islands Land Company's management plan. A multiple-use management philosophy was emphasized during this period, and the silvicultural goal to "improve the quality of the residual forest by cutting as much low-quality timber as possible" (Bryant letter) was continued. The plan called for harvesting 10,000 cords of wood per year, and an approximate average of 8000 cords per year have been cut since that time. Cutting from 1987-1992 occurred mainly south of the Swift Diamond River, Alder Brook, Johnson Brook, and in the Four Mile Brook Valley (Figure 15: Cut History Map).

The College's most recent Woodland's Manager, Mr. Kevin Evans, was hired in 1993. Mr. Evans followed the same management plan adopted and implemented by Ed Witt. In 1993, the College entered a formal agreement with New Hampshire Fish and Game to protect and enhance wildlife habitat. Also in 1993 the College gained stewardship recognition for its commitment to long term quality land management from the State of New Hampshire.

In 1995, through the vision and generosity of a few alumnae, the College undertook a monumental project of a complex inventory of its natural resources. By 1999 the inventory was complete and the College now enjoys the results of this investment

- a geographic information system (GIS) to manage spatial data
- a permanent sample plot system to provide continuous inventories of wildlife populations and timber growth
- an updated timber inventory to establish harvest plans
- a system of annual wildlife population surveys

These tools will allow managers to continue to monitor wildlife, enhance and manipulate different habitats, to continue extracting timber in an ecologically sound manner, and to then teach other landowners of successful techniques.

Balancing land management with increased recreational demands will continue to be the challenge for Mr. Evans and the College. Concern of the viability of the northern forest region and the development of the Lake Umbagog Wildlife Refuge will make the area a popular place for summer recreation and use of the Grant will likely increase. Good management of this property will continue to provide scholarships for students and financial support for the College through logging operations, as well as providing educational and recreational opportunities for students, alumnae, and the community.

Special thanks to Carol Gilchrist '95 for researching and writing this chapter.

III. Infrastructure

Infrastructure

To manage 27,000 acres of land requires development and maintenance of a road system and regular maintenance of exterior boundaries. There are also recreational features, trails and special places that need to be cared for. This section briefly presents an inventory of roads, bridges, trails, and boundary lines; it describes each and lists expected maintenance needs.

A. Bridges and Culverts at the Second College Grant

Bridges are used for water crossings where culverts cannot be used or when a broad, low span is needed. Bridge locations at the Grant are shown in Figure 6 and general bridge inventory data is presented in Table 2. Though amount of traffic on these bridges is light, the truck weights for timber extraction require good structural bridges.

When building bridges the applicable state wetland and county zoning laws shall be complied with. Bridges should be built to handle a 25 year frequency storm. The bridges should also be long enough to allow for minimal bank disturbance, and the bank should not be excavated below normal high water mark if possible. Steel stringers shall be used with a 6 by 6 inch decking on bridge spans less than 40 feet, and 8 by 8 inch decking used on bridges over 40 feet to support anticipated loads. Running planks shall consist of 3 inch hemlock placed with a distance of 3 feet between. Spacing between decking should be 2 inches to be sure water and snow do not accumulate on the deck and to be sure the wood is able to dry out. Bumper guards on the bridge shall be constructed along the sides of the bridge and shall be 8 inches high.

Bridge maintenance should take into account the life expectancy of the material used. Table 1 describes the appropriate inspection and replacement schedule for various materials. Bridges should be inspected for structural problems, including an examination of the concrete for any cracks, or other indications of undermining. These periodic inspections should be done by a licensed engineer, however yearly cursory inspections should be done by the Woodland's Manager. Specific inspection schedules shall be kept on the GIS data base and updated annually. (See Table 3)

Table 1. Bridge Maintenance Schedule

	Small bridges		Large bridges	
	Inspection	**Replacement**	**Inspection**	**Replacement**
Concrete Abutments	5 years	30 years	5 years	70-75 years
Wood Abutments	5 years	15-20 years	5 years	12-15 years
Decking	2 years	8-10 years	2 years	10-15 years
Running Plank	Annually	5-8 years	Annually	5-8 years

Culverts that are frequently washed-out should be replaced with larger sized culverts or if the size of the stream or brook warrants, stone fords and or bridges should be installed. Culverts which are in streams or brooks that do not allow for fish passage, known as "hanging culverts", should be removed and another means of crossing the stream should be found.

An inventory of all culverts on the Grant was completed in 2007 and can be seen in Figure 7. A list is seen in Table 4. For each of the 610 culverts, a GPS location was recorded, pictures of the inlet and outlet were taken and an assessment of condition and needs was completed. An interactive GIS layer was created showing the culverts location, a data base describing the culvert and a corresponding set of pictures.

B. Roads at the Second College Grant:

There are approximately 60 miles of road on the Second College Grant; 35 miles of all season gravel road and 28 miles of winter access road. (see Figure 8) The roads are built and maintained for the dual purpose of extraction of wood products and recreational use. The cost of road maintenance is covered by the Grant's timber management budget. Annual maintenance includes:

- road grading
- rock raking
- road side brushing
- mowing of winter roads
- culvert repair and replacement
- maintenance of ditches to ensure proper water drainage
- spot graveling and repairs

The College's approach to road design and maintenance is based upon a desire to ensure safe driving conditions, to provide visitors with an opportunity to experience the Grant's beauty, and to not disrupt wildlife travel corridors. Thus road widths are kept to a minimum, typically twenty feet, and road side brushing is kept to a minimum as well.

Dartmouth College has always controlled access to the Second College Grant with gates at the entrances. Members of the Dartmouth community who use the cabins are given keys for their scheduled visits; these are administered by the Outdoor Programs Office as part of the cabin rental program. Other keys, including single day use keys, are administered by the College Forester in the Woodlands office. Specific policies regarding keys to Grant gates are presented in Appendix 3. (look at master plan for copies of policies)

In order to retain the sense of remoteness at the Grant, future road development plans are few. Some spur roads and log landings need to be built in the 4-mile brook drainage. All secondary haul roads will be gated to all vehicular traffic. Roads and Gate policies can be found in the Appendix 3 and 4. Specific road mileages for roads in figure 8 are presented in Table 4. All road signs will be brown background with yellow lettering.

C. Trails at the Second College Grant

The Second College Grant is seen as a back country recreation area. There are very few organized trails and members of the Dartmouth community are encouraged to explore the forests and skid roads. The road system at the Grant is also very scenic and offers visitors easy routes for walking and biking. People looking to explore the trails and the road systems of the Grant are encouraged to get a recreation map from the outdoor programs office which depicts roads, trails, cabins, and points of interest. Other helpful references include the Dartmouth Outing Guide and the Second College Grant web site. Trails are described in Table 6 below and locations are shown in Figure 9.

TABLE 6. TRAILS

NAME	LENGTH IN MILES
Alice Ledge Trail	0.06
Blueberry Field Trail	0.02
Brungot Camp Trail	1.75
Diamond Peaks Trail	1.59
Dike Site Trail	0.93
East Branch Trail	0.48
Finnson's Cliff Trail	1.17
Forks of the Diamond Trail	0.29
Halfmoon Beach Trail	0.02
Hand on the Rock Trail	0.22
Hell Gate Gorge Trail	0.12
Hell Gate Pond Trail	0.15
Kendall Pond Trail	0.31
Lamb Valley Pond Trail	1.50
Linda's Ledge Trail	1.09
Old Loomis Valley Rd	0.40
Rands Rock Trail	1.08
Sam's Lookout Trail	0.07
Sanderson Brook Trail	1.40
Slewgundy Trail	0.03
Stoddard Cabin Rd	0.04
Swift Diamond Trail	0.59

Additionally visitors to the Grant can enjoy these special places or points of interest:

- Sam's Lookout, on the Swift Diamond Road
- Monahan's Bathtub, on the Dead Diamond Road
- Diamond Gorge, on the Dead Diamond Road
- Hell Gate Gorge, on the Dead Diamond Road
- Slewgundy, on Dead Diamond Road
- Sid Haywood Ledge on Dead Diamond Road
- Ellingwood Falls on Swift Diamond Road
- Halfmoon Beach on Dead Diamond Road
- Blueberry Field on Swift Diamond

D. Boundary Lines at the Second College Grant

Grant boundaries are shown in Figure 10.

Boundary lines and markers at the Second College Grant, including the additional parcel at Hellgate, should be maintained on a 7-10 year basis based upon a maintenance schedule developed by the College Forester. Maintenance shall include brushing, re-blazing and painting:

- blazes shall be painted blue
- all boundary posts shall be clearly marked and witnessed
- boundary lines which cross major roadways shall also be marked with a line post.
- boundary lines shall be marked or blazed at approximately 10 foot intervals.

The New Hampshire state plane co-ordinate system in effect at the time the survey is performed should be utilized in any survey of boundaries or points in the Grant performed on or after July 1, 2010. (The current system is the "New Hampshire Coordinate System of 1983") Unless a higher standard for a particular project, any such survey should meet minimum horizontal and vertical control accuracy standards for Second Order Class II surveys as defined by the Federal Geodetic Control Subcommittee (FGCC) or its successor, with any positions obtained by GPS relative positioning techniques also meeting order 2 Class II standards as set by the FGCC.

Within the next 10 years, the state plane coordinates of the four corner boundary markers, and of boundary markers at the mid-point of each boundary line, plus the corner markers of the Hellgate parcel, as well as the latitude and longitude of such points, should be determined.

Any remarking of the easterly boundary line of the Grant should be done in consultation with the Commissioner of the New Hampshire Department of Transportation or his designated representative as required by law.

Where ever possible partnerships with abutters should be established to share the cost of boundary maintenance. Specific boundary data is presented below.

(Description of each boundary follows)

North Boundary:

length: 5 miles

owners: Bayroot Corporation (Wagner Forest Management LTD)

last maintenance: 2004, 2009 (east from Dead Diamond Road)

notes: Boundary between Second College Grant and Atkinson and Gilmanton Grant will need some work in 2013-2015

South Boundary:

length: 6.5 miles

owners: Plum Creek, State of New Hampshire, 2 small non-industrial private landowners

last maintenance: brushed and blazed in 1999, Painted 2000

notes: Blazes are fading and scrubs and blowdowns are numerous, hard to see down line. Heavy timber cutting by Plum Creek has disrupted boundary evidence in many places.

East Boundary:

length: 8 miles

owners: Seven Island Land Company, Bayroot Corporation, small non-industrial private lands

last maintenance: State of Maine and NH perambulation took place in 2005.

notes: This line needs inspection.

West Boundary:

length: 9 miles

owners: Bayroot Corporation

last maintenance: South half: 1990
Greenough Pond Road south completed 2003
North half: A&G Line north completed 2004

notes: The boundary in the 4-mile brook area needs some work, specifically from Rouleau's road towards the height of land with Mt. Tucker.

IV. Resource Management
A. Timber

Resource Management

A. Timber:

The Second College Grant is a very representative parcel of land in New Hampshire's Northern Forest. It has variable terrain, marked by two river valleys and a few small mountains (elevations up to 2800 feet); the soils are typically well drained on hillsides, wet in the valleys, very stony, and best suited for growing trees, not cultivating crops. The water resources are considered clean and undisturbed by human impact. The tree species found at the Grant are also typical for the region and are the result of the terrain, climate, soils, and harvest history.

There are three main forest cover types found on the Grant:

- Hardwood forest (stands made up of >75 percent hardwood species)
- Mixed wood forest (combination of softwood and hardwood)
- Softwood (>75 percent softwood species)

In the forest the main hardwood species found in this area are hard maple, yellow birch, red maple, American beech, white birch, and aspen. The softwood stands consist of balsam fir, red spruce, and white spruce, with a smaller percent of stands made up of black spruce, larch and white pine. In the 1985 timber inventory hardwood forest made up 53 percent of the forest, mixed wood covered 32 percent of the area, and softwood comprised the remaining 14 percent. By 1999 the hardwood forest made up 55 percent of the forest, mixed wood covered 30 percent, and softwood still comprised 14 percent. Additionally about 1% of the total land area is considered open, these are fields, old landing areas, grassy winter roads, and the airfield. Other sites which are not forested include cabin locations, roadways, and wetlands. This data is presented in Table 7 (1985) and Table 8 (1999).

The Grant property has been divided into 11 management compartments based on topography and harvest operability. These compartments range in size from 800 to 3600 acres as follows:

1. Four Mile Brook - 2996 acres
2. Lamb Valley - 3586 acres
3. Larry Brook - 1662 acres
4. Mount Dustin - 2740 acres
5. Hell Gate - 820 acres
6. Dike Site - 2444 acres
7. Loomis Brook - 2152 acres
8. Windey Ridge - 1696 acres
9. Alder Brook - 3588 acres
10. Sanderson Brook - 1368 acres
11. Halfmoon Mountain - 3598 acres

The delineation of these management units can be seen in Figure 11.

1. Soils

A full topographical map of the Grant region can be seen in Figure: 12. This is from a U.S.G.S. Digital Elevation Model and show the elevations as they relate to mean sea level. Contour lines represent steep land measured in intervals of twenty (20) feet. On a topographical map, the closer the contour lines are together, the steeper is the land. Given the large area covered by the Grant the terrain is quite variable and ranges from level (in the flat river valleys) to moderately sloped (on small hillsides) to steep (on the mountains and gorges). The elevations at the Grant range from about 1300 feet above sea level to 2800 feet. The lower elevations are located along the Dead Diamond and Swift Diamond Rivers. The highest elevations occur on Chase Mountain and Mount Tucker.

In 1997 the U.S. Department of Agriculture's Natural Resource Conservation Service (N.R.C.S.) completed the mapping of the soils at the Second College Grant. The Grant was one of the last areas of the State to be mapped. The soil types were mapped in five acre units, considered Order II mapping. The types have numerical references. The mapping also includes a topographical reference, each soil type includes a slope reference, depicted by letters. There are five possible slopes, with A meaning a level piece of ground, and E referring to the steepest areas with a slope over 25%; this means that the ground changes in a vertical direction 25 feet for every 100 feet of horizontal distance. In all, there are many, many types of soils found on the Second College Grant. The soil maps can be found in the Appendix 5.

A more useful management tool is a combining of soil types into "Important Forest Soil Groups." Especially in managing a property of this size, soils grouped together by common characteristics such as drainage patterns, stoniness, and expected successional trends is much more valuable. Thus, the NRCS has developed six "Important Forest Soil Groups" for use in this region:

- *Group IA* - deeper, loamy textured, moderately well and well-drained soils
- *Group IB* - sandy or loamy over sandy textures, and slightly less fertile than group IA
- *Group IC* - outwash sands and gravel
- *Group IIA* - Same characteristics as group IA and IB but have been separated due to physical limitations such as steepness, bedrock outcrops, and surface boulders
- *Group IIB* - These soils are poorly drained.
- *Group NC* - These soils have limited potential for commercial production of forest products.

Soils are important in managing timber from two standpoints: First, some soils are simply more fertile and therefore have better productivity than others; and Second, certain soil types offer management limitations that must be considered. Productivity standards define which species will compete best on any given soil type. Therefore, when developing silvicultural prescriptions for specific stands the soil type becomes the basis for knowing which species to aim towards. Limitations are typically defined by a soil's characteristics such as wetness; an area with wet

soils should be harvested in the winter, on frozen ground, to avoid damage to the ground. Conversely, drier soils, perhaps found on higher ground, can be safely harvested in the summer without negative disturbances. These considerations are key in defining management and silvicultural decisions made on the Grant property. Basic productivity and limitations for the Important Forest Soil Groups are as follows:

A map of the important forest soils of the Second College Grant can be seen in Figure 13.

Group IA consists of the deeper, loamy, moderately well drained and well drained soils. Generally, these soils are more fertile and have the most favorable soil moisture relationships. Successional trends are toward climax stands of shade tolerant hardwoods, such as sugar maple and beech. Early successional stands frequently contain a variety of hardwoods such as sugar maple, beech, red maple, yellow, gray, and white birch, aspen, and white ash, in varying combinations with red and white spruce, balsam fir, hemlock, and white pine. The soils in this group are well suited for growing high quality hardwood veneer and sawtimber, especially, sugar maple, white ash, and yellow birch. Softwoods are usually less abundant and are best managed as a minor component of predominantly hardwood stands. Hardwood competition is severe on these soils. The dryness of these soils make summer harvesting possible.

Group IB generally consists of soils that are moderately well drained and well drained, sandy or loamy over sandy, and slightly less fertile than those in group 1A. Soil moisture is adequate for good tree growth, but may not be quite as abundant as in group 1A. Successional trends and the trees common in early successional stands are similar to those in group IA. However, beech is usually more abundant on group IB and is the dominant species in climax stands. Group IB soils are well suited for growing less nutrient and moisture demanding hardwoods such as white birch. Softwoods generally are scarce to moderately abundant and managed in groups or as part of a mixed stand. Hardwood competition is moderate to severe on these soils. The dryness of these soils make summer harvesting possible.

Group IC soils are derived from glacial outwash sand and gravel. The soils are coarse textured and are somewhat excessively drained to excessively drained and moderately well drained. Soil moisture and fertility are adequate for good softwood growth but are limiting for hardwoods. Successional trends on these soils are toward stands of shade-tolerant softwoods, such as red spruce and hemlock. White pine, red maple, aspen, gray birch, and paper birch are common in early successional stands. These soils are well suited for high quality softwood sawtimber,

especially white pine, in nearly pure stands. Less site-demanding hardwoods such as white birch have fair to good growth on sites where soil moisture is more abundant. Hardwood competition is moderate to slight. With modest levels of management, white pine can be maintained and reproduced. The dryness of these soils make summer harvesting possible.

Group IIA consists of diverse soils and includes many of the soils that are in groups IA and IB. The soils in IIA, however, have limitations such as steep slopes, bedrock outcrops, erodibility, surface boulders, and extreme stoniness. Productivity of these soils isn't greatly affected by those limitations, but management activities such as tree planting, thinning, and harvesting are more difficult and more costly. The limitation of slope, and rockiness make winter harvesting preferred.

Group IIB soils are poorly drained. The seasonal high water table is generally at a depth of 12 inches or less. Productivity is lower than in IA, IB, or IC. Fertility is adequate for softwoods but is a limitation for hardwoods. Successional trends are toward climax stands of shade-tolerant softwoods, such as red spruce and hemlock. Balsam fir is a persistent component in nearly all stands. Early successional stands frequently contain a variety of hardwoods such as red maple, yellow, gray, and paper birch, aspen, and white and black ash in varying mixtures with red spruce, hemlock, balsam fir, and white pine. These soils are well suited for spruce and balsam fir pulpwood and sawtimber. Advanced regeneration is usually adequate to fully stock a stand. Hardwood competition isn't usually a major limitation. Winter harvesting is a necessity.

Not Rated Several mapping units in New Hampshire are either so variable or have such a limited potential for commercial production of forest products that they haven't been placed in a group. Examples are very poorly drained soils and soils at high elevations.

2. Timber inventory

Timber inventories have been conducted on the Grant since 1947. These inventories give land managers the data needed to make sound silvicultural prescriptions, to estimate growth trends, and to ensure a sustainable yield of timber. Inventories should be conducted at regular time intervals (usually ten years). The most recent cruise took place in 1999; results presented in Table 9. Since this inventory is now over 10 years old, a new inventory should be completed in the next 2-3 years. A policy of cruising one watershed per year should be adopted to keep the information current and spread the cost out. The cruise if done on an annual basis the cruise may also be able to be accomplished by existing staff.

Over time, and as forest science has changed, inventories have often contained different data which makes comparisons and analysis of potential trends difficult. The inventory designed for use in 1998-99 was especially developed to avoid this problem in the future. An inventory manual was created, and can be seen in Appendix: 6. Inventories conducted on the Grant will include collection of the following data:

- Land use class
- Percent slope
- Aspect
- Water class
- Terrain position
- Stand origin
- Stand size
- Stand history
- Stand age
- Silvicultural treatment needed
- Forest type
- Seedling and saplings per acre
- Understory vegetation
- Dead tree tally
- Cavity tree
- Live tree data
- Product potential
- Growth data
- Special information (ex. 1998 ice storm damage)

This forest data, collected via a sampling method, is necessary to calculate or estimate these stand parameters:

- stocking - an indication of the number of trees in a stand as compared to the desirable number for best growth and management
- density - a quantitative measure of tree stocking usually expressed in two common terms: *Trees per acre* and *Basal area per acre*
- crown closure - a description of how well the crowns of the largest trees in a stand are grown together, or put more simply how thick are the crowns of the trees and therefore how much sunlight is reaching the forest floor
- mean stand diameter - an average of the estimated diameters of all trees in the stand, expressed in inches; it estimates the "average size" of trees in the stand
- timber volumes - estimates of volumes of timber on the stand, expressed in the terms of *pulp (cords)* and *sawlogs (board feet)*
- regeneration - a measure of how well the stand is supporting young trees and other descriptive criteria such as

- quality of the site for growing specific species
- potential value of the timber in the future
- disease evidence indicating forest health
- important wildlife habitat information
- ice damage severity

Other inventory tools used by Grant managers include aerial photography and Global Positioning Systems (GPS). Foresters extract a great deal of information from aerial photographs including forest cover types, terrain, general stand density estimates, and tree heights. They are also utilized to plan an inventory; to pin point specific plot locations and exact cruise line locations. Photography can be especially useful to gather information in difficult terrain such as the Diamond Peaks and Diamond Gorge areas. Historically, foresters conducting cruises would note locations of trail, brooks, roads, or other things as they walked through the forest. Today's GPS technology allows these to be located exactly and this data can be put into the GIS maps.

Aerial photographs are taken every five years of the entire Grant property. Good management recommends the Woodland's Manager practice these three parameters:

- photography should be taken during peak foliage (gives best detail on tree species)
- true color photographs
- 1:15840 scale

The window of opportunity for peak foliage is about one week; thus occasionally bad weather conditions will not be conducive for good quality photography. The last photography was done in 2006. The College also has photographs from 1967, 1970, 1985, 1989, 1995, and 2000. This collection allows for good comparisons on cover types and forest growth on the property.

One limitation of timber inventories as described above is that one cannot calculate growth trends since plots placed at random locations cannot be duplicated. Instead foresters rely on a system called Continuous Forest Inventory (CFI) which is permanent inventory plots measured at regular intervals, with same plot measurements growth trends can be assessed over time. In 1998 one hundred fifty permanent plots were established on the Second College Grant. (See Figure 14.) These plots are 1/10 acre in size and the center point of the plot is exactly marked and recorded so that it can be located again. The trees on these plots are measured and a number is assigned to each so they can be measured at five year intervals. Accretion, mortality and in-growth can then be calculated to insure cutting is not exceeding growth. In 2003- 4 the first re-measurement of these permanent plots was completed.

Inventory data is very important to the forester when trying to prescribe silvicultural treatments. Basal area per acre and trees per acre are important density measurements to decide if the particular stand needs treatment. Hardwood stands with basal area of 120-140 range should be treated. Untreated softwood stands and mixed wood stands typically have basal areas of 140 to 200 square feet. Optimal basal area for hardwood stands is 75 to 85 square feet while that for mixed wood stands is 110 to 120 square feet.

3. Timber management

The Grant has long exemplified some of the finest forest management in northern New England. Managers of the Grant have striven to protect the rich abundance of species, scenic beauty, and diverse habitats found within its borders. Timber harvests are carefully planned and timed to improve the health and productivity of the forest resource and to enhance wildlife habitats. The Grant's location in the heart of the northern forest and its tightly controlled access is ideal for the development of model land management practices. Some consider the Grant as "an island in a sea of industrial forests."

Dartmouth College enjoys a reputation for its exemplary program of sustainable forest management at the Second College Grant. It has been recognized with the following awards:

- *1993 "Stewardship Forest"* by the State of New Hampshire Division of Forests and Lands and University of New Hampshire Cooperative Extension
- *1995 "Wildlife Stewardship Award"* by the State of New Hampshire Fish and Game Department and University of New Hampshire Cooperative Extension
- *1997 "Tree Farm of the Year Award"* by Coos County Tree Farm Committee.
- *2001 "Cooperator of the Year"* by Coos County Conservation District
- *2008 "Cooperative Conservation Award"* by U.S. Department of Interior

These awards were granted for Dartmouth's high quality land management practices, commitment to sustaining and enhancing wildlife habitat, and efforts in water quality protection within its timber harvesting practices.

Additionally, in 1999, Dartmouth became the first forest in the northeast to be certified under the National Forestry Association's Green Tag Forestry program. This will be discussed in detail later.

Timber management at the Grant focuses on improving the overall quality of the timber resource, enhancing wildlife habitat, accommodating recreational needs, and maintaining biological diversity. While financial return is the overall purpose of the timber management program, immediate income is not a consideration in harvest planning or silvicultural treatment recommendations.

Balancing a timber management program with an established recreation culture at the Grant continues to be a challenge in Dartmouth's commitment to multiple use management at the Grant. In the 1980's most of the timber harvesting took place in remote sections, far from the cabins and popular recreational sites. In the 1990's, however, the harvests have been performed in close proximity to these areas. The challenge is two-fold; how to ensure minimal disturbance to visitor's experience; and how to best utilize the opportunity to educate visitors about good quality timber management and harvesting. The following practices are incorporated to meet this challenge

- Log yards are built off the main roadways when possible
- Log yards are cleaned up, seeded, and mowed following harvest
- "No cut" buffers are maintained around cabins

Additionally, and perhaps most important, the College Forester is always available to talk to visitors about management policies and practices.

The primary timber management goal on the Grant is to grow long rotation solid wood products. Past cutting histories have resulted in high pulpwood volumes at the Grant. Today's management practices will be designed to reduce this pulpwood volume, thereby increasing sawlog percentages for future harvests. Today's silvicultural treatments are aimed for reducing stand densities to optimal growing levels, decreasing pulpwood percentages, and removing diseased trees. Consequently harvests typically remove less than one-third of the trees in a given stand, thereby setting the stage for another improvement cut in the short time span of 15-20 years. In the past, products and markets defined the cut, and harvests were often so heavy that subsequent treatments could only be done every 50-70 years.

a. General stand prescriptions

Hardwood stands: The northern hardwood stands on the Grant generally have two age classes with variable sizes and a mixture of quality. This is a result of previous high grade logging operations and varying soil moisture conditions. Most of these stands have been logged at least twice in the past fifty years; the first removal of high quality yellow birch veneer during the 1940's and the second removing of all veneer and sawlogs in the 1950's. These stands should be managed for hardwood sawlog production on a 120 year rotation, 15-20 year cutting cycle, and an uneven aged system. Targeted residual basal areas after treatment should be in the 75-85 square foot range. Special attention should be given to developing tree species diversity, enhancement of wildlife habitats including maintenance and development of wildlife den trees, sustained mast production and softwood retention for perching. Small patch cuts should be utilized to encourage the regeneration of intolerant species to balance the tolerant species already established and maintained through selection cuts.

Softwood stands: These stands are found on the lower slopes along the Dead and Swift Diamond Rivers. They occur in very shallow and poorly drained soils. These stands were clearcut in the late 1920's for spruce budworm damage and then regenerated back to balsam fir. The stands that survived the 1980's outbreak of the budworm are over-mature and in need of some treatment. These areas need to be protected from future budworm outbreaks. To reduce their vulnerability the softwood stands should be managed on an even aged basis for balsam fir and red spruce sawlogs and the rotation length should be approximately 75 years. This will create stands of softwood with a good diversity of ages and sizes. If adequate regeneration is present in the understory, clearcutting should be carefully considered as a treatment option. In order to limit soil scarification, and therefore ensure softwood regeneration, these should be planned for the winter season. If possible clearcut sizes should not exceed 10 acres. Shelterwood systems should be considered if adequate regeneration is not present.

Mixed wood stands: The mixed forests of the Grant are found on the mid to upper slopes of the mountains or in shallow, rocky lowland areas. The soil type in these areas greatly influences the condition and quality of the tree species found. On the mid and upper slopes, generally drier soils, red spruce makes up a larger portion of the softwood component than the Balsam fir; the

opposite is true for wetter soil types. Yellow birch does better on the drier hillsides, and red maple is a larger component on the lower wetter sites. Unevenaged management is the recommendation for these stands; managers should aim for both softwood and hardwood sawlogs. The rotation age is 120 years, with expected treatment every 15-20 years. Patch cuts and selection cutting are the most appropriate treatment options for these areas, specific site conditions need to be considered. Residual basal areas should be close to 100 square feet.

b. General management guidelines

In addition to these silvicultural guidelines above, these general guidelines for management are also applied to all management activities within the Second College Grant:

- All management activities should follow guidelines specified in Good Forestry in the Granite State: Recommended Voluntary forest Management Practices for New Hampshire (NHDRED 1997) and Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire (Cullen 1996).

- The underlying objective is to grow and harvest timber on a sustainable basis, emphasizing long rotation, solid wood products.

- Silvicultural techniques applied should be based upon the principles of ecosystem management.

- Forest management decisions and appropriate management plan adjustments should be made upon consistent collection and analysis of growth data.

- Biologists with the New Hampshire Fish and Game Department should be consulted during planning stages for all management activities.

- Clearcuts should be limited to 10 acres when possible.

- Insecticide use on the Grant will be evaluated on an individual case basis. The use of insecticides will be reviewed by the Management Committee in consultation with State Biologist, and other resource professionals.

- No herbicides should be used.

- The transportation system should be designed and maintained to minimize the impacts to wildlife and aquatic habitat and its movement between habitats.

Cooperative agreements with, New Hampshire Fish and Game, Audubon Society, The Nature Conservancy and New Hampshire Division of Forest and Lands shall be maintained for the management of special areas within the Grant.

c. Certification

In 1998 the College sought third party certification of its forest management program to ensure that it was indeed being done to top standards. In 1999 the Management Team chose the Green Tag Forestry program of the National Woodland Owners Association for certification of the Second College Grant property.

The certification process for the Green Tag forestry program consisted of three visits by the inspection agency;

- to the office to look at plans and records,
- to participate in a quarterly Grant management meeting of College officials, and
- to the property to see harvests, roads, and projects sites.

The expected outcome was a report and a decision on whether the property met the required criteria for being certified. The college forester also wanted tangible suggestions for improvements and so designed a complimentary review process by respected experts in a variety of management areas. Upon completion of this inspection, in September 1999 Dartmouth's Second College Grant property became the first forest in the northeast to be certified under the National Forestry Association's Green Tag Forestry program.

In the summer of 2004 the College underwent a 5-year review. For three days the College hosted a site visit by the certification inspection agency. Carl Henderson, Operations Forester, with James W. Sewall Company of Old Town, Maine, conducted a one-day office visit, talked with employees and consultants, and reviewed other documentation. Additionally he spent two days at the quarterly meeting of the Management Committee where he interacted with the Management team, logging contractor and visited summer and winter harvest operation sites.

The College received confirmation in the fall of 2004 that our management continues to be sustainable and appropriate for certification. The college will continue having re-inspections on a yearly basis and a full audit every 5 years. The College still remains in the American Tree Farm System and will be green certified thru 2012.

4. Timber harvesting

a. general/history

The annual timber harvest is carefully calculated to ensure a sustainable supply of timber while considering the values of other resources. Cutting practices are designed to diversify forest age classes, to improve stand structure, and maintain or increase species diversity. Before each harvest the College Forester consults with a wildlife biologist to ensure the harvest will have the most benefit and least impact to the ecosystem.

Timber harvesting has occurred on the property since 1828. Records of cut histories, income produced, and average cords cut can be seen in Table 10 and 11. Since 1985 the College has harvested an averaged of 7,047 cords of wood annually. The goal outlined in the 1985 plan was to harvest 200,000 cords to reduce the overstocking of low value hardwood pulp, which had grown exponentially, to take advantage of available wood markets (see Table 12). In 1987 the College Forester implemented that goal by harvesting an average of 10,000 cords annually for a period of ten years with a plan to scale back to 6000 - 8000 cords per year afterwards. In 1998 the harvest was scaled back to 7000-8000 cords. A cut history map of harvest areas since 1980 is in Figure 15 and a longer historical presentation of volumes harvested is presented in Figure 16.

The 1998 to 2003 growth data collected as part of the CFI program was calculated by James Sewall Company. Based upon this data plus the amount of operable acres, land use designations (natural area, zoning districts, etc.), and discussions by the Management Team, the newly calculated sustainable level of harvest is now 7,800 cords annually. Growth data show

Gross growth is .495 cords per acre per year
Net growth is .119 cords per acre per year
Removal is .317 cords per acre per year
Mortality is .376, cords per acre per year (with Balsam fir making up over 40% of total)

These numbers are based upon only 5 years of measured growth and therefore need to be applied with caution; more time is needed to fully evaluate growth and mortality. As current cutting practices continue, the in-growth of regeneration from budwormed spruce and fir (1980's) should offset the high mortality in mature fir areas. (See Appendix 7 for actual data)

Today's harvest plans are developed by the College Forester who considers the following:

- location
- ease of access
- cost of access
- stand conditions
- silvicultural treatments needed
- existing and potential wildlife habitats
- zoning laws
- harvesting laws
- proximity to cabins
- aesthetics
- markets
- impacts to recreational use

Of these silvicultural treatments is the highest priority as the College is committed to improving the health and productivity of the forest itself.

The forester also has these laws, guidelines, and resources to utilize and consider in the development of harvest plans:

- Fish & Game wildlife plan
- Forestry laws enforced by the State of New Hampshire
- Coos County Zoning Ordinance for the Unincorporated Places
- New Hampshire Wetlands Laws
- Recommended Voluntary Forest Management Practices for New Hampshire
- Memorandum of Understanding between Dartmouth College & NH Fish & Game Dept.
- Best Management Practices for Erosion Control on Timber Harvesting Operations in NH

b. future harvest plan

The following is a tentative cutting plan for the next five years (2010 – 2015). Flexibility is a critical component in these plans as weather, labor markets, and natural disturbances can affect them. (See Figure 17)

As we enter the second 20 year cutting cycle and leave the improvement cutting stage the following factors will need to be considered in any harvest layout.

- Advancements in technology and best equipment to be used to accomplish these harvest
- Advanced regeneration to be saved and protected
- Best method of harvest for larger wood which needs more care to remove

Year/Season	***Location***
2010/Summer	4-Mile Brook Area
2011/Winter	South of Swift Diamond (Mt. Dustin), Alder Brook
2011/Summer	4-Mile Brook Area
2012/Winter	Greenough Pond Road, 4 mile Brook
2012/Summer	Loomis Valley Road

2013/Winter	4-Mile Brook Area, Johnson Brook Area
2013/Summer	Loomis Valley Road
2014/Winter	Windey Ridge Road, Dike Site
2014/Summer	Loomis Valley Road (black and round Mt.)
2015/Winter	Dike Site, Loomis Valley Road

- By 2015 a new five year plan should be in place

In the long term these areas are targeted for treatment:

2016-2020	Dead Diamond River and finish Loomis Valley
2021-2025	Lamb Valley

IV. Resource Management
B. Wildlife

B. Wildlife

Wildlife management

History:

The College has always had a working relationship with New Hampshire Fish and Game.

- Grouse and deer surveys have been completed since the 1940's.
- The historic Fish and Game cabin, now know as Pete Blodgett cabin, was probably built in the 1920's to provide remote shelter for wardens.
- Today biologists with the department assist the College in riparian and deer yard management.

The relationship continues to be one of technical assistance which comes in many forms, including harvest layout help in critical habitats, completion of woodcock and grouse population surveys, planning and layout of permanent openings and finally meetings with management team and alumni on various issues.

The Grant continues to be a land base where wildlife is an important link to having a healthy and balanced forest. It is an important place where students can come and do research on a variety of wildlife species. Projects in the past have included pine marten research, woodcock survival studies, and deer feeding research.

Dartmouth College is in a unique position to continue to be a leader in incorporating wildlife management goals into its land management policies and practices for the following reasons:

A commitment to top quality multiple use management

An interest in education and research opportunities

Controlled access to the property

One of the largest deer wintering areas in the region is found within the Grant

Osprey and their access to native trout in the Dead and Swift Diamond Rivers

Peregrine falcons have nested on the Diamond Peaks (and may come again)

The state endangered pine marten make their home among the mountains and along riparian areas

The Grant's location in the northern forest ecosystem

The unique, and large, landscape of the Grant, amid a region of homogenous industrial forests offers wildlife a variety of habitats. The river valleys, (both sharp and deep in the gorges and smooth and shallow in other areas), the mix of forest cover types, the mountains, the controlled access which minimizes human-wildlife interactions, and the College's long term ownership and management perspective all result in a property which embodies a rich representation of species native to the region.

In 1998 a complete map of the Grant depicting various habitats was completed. This differs from typical land type or forest cover type maps in that it does not consider tree or stand parameters. Instead, the delineations are based upon common patterns of characteristics important to wildlife use; for instance linking ridge top softwood stands with other softwood corridors to provide continuous shelter and safe movement opportunities for a given species. The original map can be seen in Figure 18A. Subsequent maps 18B and 18C show changes in habitats between 1995 and 2000, and actual habitat work completed since 2001 respectively.

In 1994 the College signed an Agreement with the Fish and Game Department to voluntarily implement a Forest/Wildlife Management Plan. The primary recommendation of the plan regarding habitat is to create, and maintain, a certain percentage of the forest in some regenerative or open state; specifically to have 3-5 percent of the Grant land area in an early regenerative state at any one given time, preferably including two percent in permanent openings. The complete Plan is presented in Appendix 8.

Historically, the management of the Grant has utilized commercial timber harvesting to achieve goals for enhancing wildlife habitat. The practices have aimed to improve forest structure including a diversity of age classes (meaning having trees of all sizes and ages). Ensuring multiple age classes in trees and shrubs provides a variety of habitat types for a multitude of wildlife species. Today this approach is still the backbone of wildlife management efforts of the College. However, with a new emphasis on ecosystem based management and the importance of maintaining biological diversity, the College has since enlarged its vision of wildlife management to include non-timber management activities especially designed to enhance wildlife habitats. In 1995, through the commitment and vision of the College's management team and the generous financial support of alumnae, the Woodland's office embarked on an ambitious project to increase research opportunities at the Grant; to gather base-line data on wildlife populations, and to monitor population trends. In this way, impacts (both positive and negative) of various timber management activities can be tested, analyzed, and revised in a true scientific fashion.

The complete forest inventory completed in 1999 had a significant habitat data component. From this data the 1995 habitat map was updated and revised to reflect new findings. Also, figures to address "Dead and down woody debris" and "Cavity trees" were calculated. Results show that the Grant property maintains a supply of dead and down wood debris covering approximately seven percent of the ground. This debris is very important habitat for small mammals, amphibians, and reptiles. Additionally, there are about 30 cavity trees found per acre throughout the property; these are used by both birds and many mammals. Both of these figures represent healthy stocking and exceed the recommendations put forth by the State of New Hampshire.

Since 1995 new wildlife habitat improvement activities include releasing old apple trees from overtopping hardwoods, increasing the amount of fields and open spaces mowed and maintained, and establishing a blueberry management area. The specific treatments completed since 2001, and the acreages covered, are presented here and in Map 18C:

Alder regeneration	12.2 acres
Apple Tree release	0.3
Aspen regeneration	0.7
Blueberry management	14.2
Open field	16.5 acres
Roosting fields	29.4
Maintaining open landing areas	62.4
Gravel pit area	9.5

These areas are being maintained in an open state with the following schedule:

- Roadsides are mowed every 3 years
- Landing areas are mowed every 6 years
- Roosting fields are mowed every 3 years
- Alder regeneration is cut every 20-25 years

Through a Wildlife Habitat Improvement Program (WHIP) grant from the U.S.D.A. Natural Resource Conservation Service, we will continue to mow alder habitats, create permanent openings, and regenerate aspen. We will still continue to mow and maintain logging yards, roosting fields and apple tree release areas. It is also time to do an updated forest/wildlife inventory. As new aerial photography is completed we should continue to note changes in habitats over time. It is also time to find new funds to re-visit wildlife monitoring completed between 1995 and 2005 to record significant changes.

2. Wildlife monitoring

One component of the wildlife plan is long term monitoring. The goal of wildlife monitoring is to collect population information to see how management (or lack of management) of specific habitats is affecting wildlife populations over time. The College's commitment to this component of land management will have future value for both Grant managers and other nearby landowners as well. Specific wildlife monitoring practices are presented below and the associated maps are presented in the Appendix 9.

Approaches:

1) Woodcock singing ground surveys
    - Background:
        - These surveys are conducted in order to look at woodcock populations on the Grant and to determine how these populations fluctuate from year to year. Location and types of areas used for singing grounds will be examined in order to understand habitat requirements and other uses.

- Methodology:
  - Five woodcock routes have been established throughout the College Grant. These include 1) the Dead Diamond road, 2) Alder Brook and Four-Mile Brook, 3) south of the Swift, the Swift Diamond road, and the Greenough Pond road, 4) the Stoddard cabin road, and 5) the Miller Quinn Memorial Landing Strip, the Dike Site, and Sanderson Brook. These surveys are conducted in the spring just after sunset, and stops are made on the designated route at 0.4 mile intervals. The observer listens for exactly two minutes at each stop and records the number of woodcock heard peenting, as well as other information including a description of the courting area. Survey protocol is consistent with the U.S. Fish & Wildlife Services North American Woodcock Singing Ground Survey.
- Results to date:

Year	*Woodcock peenting*
1997	24
1998	27
1999	35
2000	42
2001	27
2002	20
2003	35
2004	29
2005	23
2006	24
2007	21
2008	19
2009	10
2010	

The data shows bird movement between singing grounds. After the routes were established, new openings were created (not necessarily near route stops). This resulted in the birds going to the new openings, and therefore unable to be heard at the stops on the established routes. This is especially evident in the data between 2000 and 2001, a time when new appropriate habitats were being purposefully created.

2) Grouse drumming surveys
   - Background:
     - As with the woodcock singing ground surveys, these surveys are used to assess the current grouse populations on the Grant, and to track population changes over time.
   - Methodology:
     - The same routes used in the woodcock singing ground surveys are used for the grouse drumming surveys. These surveys are conducted in the same way, except that stops are made at 0.8 mile intervals on any given route, the surveys begin at sunrise, and the observer listens for exactly four minutes at each stop. The

number of grouse heard drummingis recorded, as well as other information including a description of the drumming area.

- Results to date:

Year	*Grouse heard drumming*
1997	16
1998	8
1999	15
2000	12
2001	0
2002	No survey
2003	39
2004	7
2005	23
2006	No Survey
2007	13
2008	20
2009	25
2010	

We believe that weather is a large factor in these results. These findings, along with the hunter success surveys, seem to follow the expected 5-7 year population cycles of grouse.

3) Breeding bird surveys
   - Background:

     - Ten permanent plot lines have been established throughout the Grant in order to provide an effective way to conduct wildlife monitoring. These lines, consisting of 15 points per line, are focused mainly along riparian areas - nine of them in managed forest and one in an unmanaged natural area. Each point is GPS referenced and forestry data has been taken - including stand information, understory/regeneration information, and tree level data. It is along these lines and at these points that the breeding bird surveys (and track surveys) are conducted. From these surveys, we will be able to monitor birds, mammals, and forest types through time.

   - Methodology:

     - Point count surveys will be conducted on each transect line during late May through early July. These surveys begin at sunrise (5:00 am) and are to be completed within 4½ hours, but only on calm days with no precipitation. These surveys last for ten minutes at each stop, and data are recorded in segments of the first three, middle two, and final five minutes of the survey. All individuals detected at a point will be tallied, noting any additional species detected between points.

4) Hunter surveys
   - Background:

- Wildlife information provided by hunters can be a valuable tool when trying to gather additional information about wildlife populations, mortality, and habitat use. Other information, such as time spent hunting versus kill numbers, is also important when evaluating wildlife populations and changes through time.

- Methodology:

  - Surveys are placed in conspicuous boxes at main entrances to the Grant and in cabins at the beginning of the fall season. The Dartmouth Grant Hunter Survey focuses primarily on woodcock and grouse hunting, and requests information such as hours hunted per day, number of grouse/woodcock taken per day, general area hunted, number of grouse/woodcock flushed per hour, and number of grouse/woodcock shot and not retrieved. After five years of data collection, we suspended the program because the hunters were not serious in their answers and the data was not useful.

- Results to date:

Grouse 1997 to 2001

Year	Hours hunted per bird shot	Number of birds shot
1997	13	94
1998	13	68
1999	16	62
2000	8	27
2001	4	61

Woodcock 1997 to 2001

Year	Hours hunted per bird shot	Number of birds shot
1997	103	12
1998	101	9
1999	202	5
2000	220	1
2001	8	31

Some Angler surveys have also been completed by fishermen at the Grant, though we find the participation rate low. Results from those that take the time to answer the questions indicate that

- Most who respond are fly fishermen
- Most are traveling 100-200 miles to fish here
- Most are not keeping the fish (95% catch and release)
- Dead Diamond and the Little Dead are the areas fished most

These surveys could be improved to get better participation and understanding of level of participation, but it would take a lot of time.

5) Track surveys

- Background:

- These surveys were used to look at animal activity in the winter throughout different areas and habitats throughout the Grant.

- Methodology:
  - Track surveys were conducted along the same permanent plot lines described in the breeding bird survey section. These lines were broken into four quarter sections between plot centers, and a 12 foot wide corridor (6 feet on each side of the center line between plots) were used to count tracks. Observers monitored transect lines between December and March, one to four days after a snowfall. Only tracks observed within the 12 foot wide corridor were counted. (See Dartmouth College Grant Mammal Track Survey).
- Results to date:
  These have not been done regularly; the New Hampshire Fish and Game regional biologist goes out occasionally in the winter. He looked specifically for unusual sightings, such as lynx or wolf, but has not recorded any interesting sitings. He has seen numerous tracks of the American marten.

Important wildlife considerations continue to be incorporated in the development of harvest plans. These include some of the same goals discussed in the timber management section such as diversifying tree species, and age & size classes. Other considerations in forest management planning are specific to particular wildlife needs or issues.

3. Wildlife considerations

a. Overstory inclusions (DeGraaf et al. 1992, NHDRED 1997)
Overstory inclusions are small patches of forest cover that are distinct from the surrounding forest, but are too small to be treated as a separate stand. Examples include patches of softwood cover in hardwood stands, and/or patches of hardwood in softwood stands. Such inclusions increase the habitat diversity in an area, and provide feeding, nesting, and shelter opportunities that may not be available in stands of a single type. For example, coniferous overstory inclusions of spruce and fir can provide feeding, nesting, and winter shelter opportunities in deciduous stands that pure hardwood stands cannot provide. Likewise, deciduous overstory inclusions of beech and other hardwoods can provide mast and other foraging and nesting sites that pure coniferous stands cannot provide.

Overstory inclusions may result from either small-scale site differences, or variations in the past disturbance history of the stand. They can vary significantly in size, from a group of stems to an acre or more. It has been shown that wildlife use of overstory inclusions increases with the tree size class - meaning more species use the saw-timber size class than the regeneration size class. While larger inclusions may more significantly diversify available habitat, smaller inclusions are also very important. The value of a small inclusion increases proportionately to how different it is from the surrounding forest. Even a single hardwood tree in a pure softwood stand can greatly increase the variety of habitats. Over a quarter of New England's bird species and a lesser number of mammals use overstory inclusions in one way or another. Therefore, the objective for forest management should be to maintain and regenerate inclusions of softwood cover in predominantly hardwood stands and inclusions of hardwood cover in predominantly softwood stands.

b. Permanent forest openings (Oliveri 1988, NHDRED 1997)
Permanent forest openings are areas that are usually less than 10% stocked with trees and are dominated by grasses, forbs, brambles, and fruiting shrubs. Although these areas represent only a small portion of New Hampshire's landscape, they may contribute a disproportionately high share of wildlife habitat to the overall forest environment. These areas provide necessary habitat for about 22% of New England's wildlife species, and are seasonally important habitat to nearly 70% of species. They are valuable to wildlife because with more light reaching the forest floor, the number of plant species available increases, thus diversifying the forest structure and providing seasonally important foods. Habitat components for many woodland species are also made available, and new habitats for open and edge-adapted species are provided. The value of these openings depends largely on the surrounding landscape. For example, such openings will be more beneficial in large expanses of continuous forest than in areas containing a mixture of forest and non-forested habitats.

Prior to European settlement, these non-forested habitats were found mostly in wet areas and in areas cleared by Native Americans. With the expansion of agriculture through the 1800's, these habitats increased greatly. However, for the last 150 years this type of habitat has been declining. Cropland and pasture constitute only a small percentage of New Hampshire land today. It has thus been suggested that 3-5% of forest land should be maintained in permanent forest openings to maintain this habitat. Topography, aspect, size of the opening, and distance to other openings will influence the use of new openings by wildlife and should be considered when planning cutting operations. The primary sources of permanent forest openings in a managed forest are remnant meadows and pastures, as well as log landings created during harvesting operations which are maintained afterward. In general, an opening of moderate size with a southern exposure will be most useful, especially when other openings are not already available within an otherwise mature forest. Overall, the objective in forest management should be to create or permanently maintain openings dominated by grasses, forbs, or shrubs within forest-dominated upland landscapes.

c. Beaver-created openings (Diefenbach et al. 1988, NHDRED 1997)
Beaver are renowned for their manipulation of water, and the ecological changes associated with it. The activities of beaver in a forested landscape create a series of habitats - from newly flooded areas, to stagnant ponds, to open meadows. Initially, nutrients are released from the soil into the water, supporting a wide variety of plant and animal communities. Nutrients then accumulate in the bottom organic matter as flowages stagnate. When beaver eventually abandon these flowages and water levels drop, the organic matter decomposes, allowing grasses and forbs to colonize the area. In time, shrubs and trees reoccupy these beaver meadows and the cycle continues.

Each of these successional stages provide habitat for a variety of wildlife species. Frogs, turtles, otter, mink, and other species thrive in the open water stage of beaver-created openings. Species such as wood ducks, black ducks, and other waterfowl depend on beaver flowages for feeding, nesting, and brood-rearing habitat, as well as refuges during the autumn migration. Hooded mergansers, common goldeneyes, tree swallows, woodpeckers, and other cavity-nesters use the dead and dying trees created when the flooding occurs. Birds like swallows and flycatchers are

attracted to these areas because of the abundant insect populations and perch sites. The diverse vegetation of the wetland edge attracts species such as yellow warblers and common yellowthroats. Herons, eagles and ospreys also use these habitats for feeding and nesting. Because of the early "green-up" along these wetland edges and at beaver meadows, species such as moose, deer, and bear are attracted to these areas as well.

Besides benefiting wildlife, beaver flowages also influence water quality. Their dams reduce erosion by trapping sediments, thereby recycling nutrients that would have been washed further downstream. Wetlands created by beavers can also slow spring run-off, decrease downstream flooding, and help in groundwater discharge. Therefore, beaver and their habitat should be recognized as essential components of a forest management plan. Objectives would include maintaining hardwoods, especially aspen, along drainways in places where beaver dam-building activity and subsequent wetland openings are desired, and where water levels can be controlled so that transportation corridor and personal property damage is minimal.

d. Deer wintering areas (Wiley 1988, NHDRED 1997)

In New Hampshire, white-tailed deer live near the northern-most edge of their geographical range in the northeast. Because of the severe winter conditions experienced in this area, deer require special habitats called deer wintering areas, or deer yards, to help them survive. These areas are typically lowland softwood stands, usually associated with waterways and riparian habitat. Compared to more open areas, these softwood stands provide shelter from harsh winter weather by reducing snow accumulation and wind speeds, allowing for overhead thermal cover, and increasing nighttime temperatures and relative humidity. Because of the young hardwoods growing intermixed with the softwood, they also allow access to food supplies as well as escape from predators. These factors all serve to reduce heat loss and energy demands placed on the deer in winter when food availability and quality is reduced. Yard size varies from small yards of only a few dozen acres to thousands of acres, and the number of deer present in the yard varies with size. Overall, deer wintering areas compromise 3% of the land base in New Hampshire.

Two basic habitat elements need to be present in order for an area to be classified as a deer wintering area. These are: 1) a core area identified by concentrations of dense softwoods, and 2) mixed hardwoods and softwoods adjacent to or within the core area which provide accessible forage. The severity of the winter often determines whether a certain area is used as a wintering area in a given year. In mild winters, deer often use habitats further away from the core of dense softwood which may be used during severe winters. Proper management planning for deer wintering areas should provide at least 50% of the entire area in functional shelter at all times - meaning softwood cover at least 35 feet tall with crown closures averaging 65 to 70%. The remainder of the wintering area should be in younger age classes that will provide hardwood browse, and softwood regeneration that will provide shelter in the future. Also, because not all available browse is good quality for deer in winter, preferred foods such as red/sugar/mountain and striped maple, hobblebush, and birch should be retained and cultivated whenever possible. In order to allow for deer mobility and access throughout the wintering area, it has been suggested to manage unbroken, dense lanes of softwood cover at least 200 feet wide as sheltered travel corridors, utilizing existing networks of softwood riparian habitat wherever possible.

Besides benefiting deer, managing existing deer wintering areas will ensure a continued yield of forest products and abundant regeneration. Also, diversifying the age and size classes of softwoods will provide quality habitat for a large variety of wildlife species. Therefore, a forest management objective should be to manage existing and potential deer wintering areas to provide shelter, travel lanes to access food, escape from predators, and access to preferred browse.

e. Mast (Oliveri 1988, NHDRED 1997)
"Mast" is the nuts, seeds, and fruits of woody plants that provide food for wildlife, and are broken down into two categories. "Hard mast" refers to nuts and seeds, while "soft mast" refers to fruits and berries. Mast is a very nutritious food, containing high levels of fat and protein. This is important in contributing to fat stores critical for migration in species like the wood duck, or hibernation in species such as bears and raccoons. It is also important to the survival of newly fledged young such as cedar waxwings and robins. Birds and mammals depend heavily on mast during peak production periods either in late summer, early fall, or during the winter when sources may still be available on trees and shrubs, on the ground, or stored in caches.

While many trees and shrubs are mast producers, some are more important than others in terms of wildlife value and merit special attention. In terms of hard mast, beech trees provide an especially important autumn food for black bears in New England. Often these trees will be scarred with claw marks on the trunk or there will be clumps of broken branches in the crown where they sat and consumed beech nuts. Beech nuts are also important to a number of other wildlife species including raccoons, red squirrels, white-tailed deer, ruffed grouse, spruce grouse, wild turkey, and rose-breasted grosbeak. Birches are also important mast producers because of their abundance and the fact that they retain much of their seed crop above the snow through the winter. Many small birds and mammals rely on birch seeds, including redpolls and pine siskins. Softwood trees including white and red pine, white/red and black spruce, hemlock, tamarack, and balsam fir are important seed sources for wildlife, especially because of its availability in winter. Many birds and small mammals, including mourning doves, chickadees, crossbills, finches, grosbeaks, pine warblers, nuthatches, mice, voles, and red squirrels make use of softwood mast.

As with hard mast, there are a number of important soft mast species that are beneficial to wildlife. Red, pin, and choke cherry provide abundant fruit that are eaten by many birds and mammals. Wild apple trees are also extremely valuable as wildlife food. Wild apples are eaten by a wide variety of wildlife species, including deer, bear, fisher, grouse, and various song birds. Many shrubs also produce valuable food for wildlife, including alder, mountain ash, beaked hazelnut, dogwood, blueberry, raspberry, viburnums, and elderberry. Because all of these sources of mast are critical to wildlife survival, it is important to manage mast producing trees for a continuous source of wildlife food and quality seed for regeneration.

f. Cavity trees, dens, and snags (Elliott 1988, NHDRED 1997)
Snags (dead or partially dead standing trees) and den trees (live trees with existing cavities) are essential to the well being of many kinds of wildlife. Collectively, the term "wildlife tree" includes both snag and den trees. Snag trees can either be classified as hard snags which often have some limbs remaining and fairly sound sapwood, or soft snags which usually have no limbs

and are in the advanced stages of decay. Ten species of New Hampshire's forest birds excavate cavities for nesting and roosting, while another 15 birds and 18 mammals use natural or excavated cavities in forested habitats for nesting, roosting, or denning. These species require a wide range of cavity-tree size classes in order to provide suitable shelter. Bats and brown creepers also use the spaces beneath the loose bark of dead or dying trees as resting sites.

Many of the species that use wildlife trees, especially cavity-nesting birds, are insectivorous. They help to decrease populations of insects that attack trees, buffer epidemic outbreaks, and increase the effectiveness of insects that parasitize those insects attacking the trees by chipping the bark off of infested trees. One benefit of this biological control is reduced economic loss to damaged trees. However, regardless of their role in insect control, these birds (and all other species that use wildlife trees) are part of the forest community, a fact that seems reason enough to justify preservation of suitable habitat.

The use of a wildlife tree by a certain species depends both on the characteristics of the tree (live/dead, DBH, height, type of decay), and of the surrounding vegetation (species composition, age, stand size). Larger trees with cavities are more valuable since they are known to accommodate more species - including providing resting sites for pine marten and fisher, as well as a place for them to raise their young. Also, the presence of heart-rot allows for easier excavation, and sound sapwood provides insulation from temperature extremes and protection from predators. Snags and wolf trees that do not currently have cavities are also very important components of the habitat. They provide foraging sites and perches for insectivorous birds, kingfishers, and raptors. They also provide singing perches for many species of songbirds, and nest sites for species like great blue herons and ospreys. Therefore, a forest management objective would be to retain snags and den trees (a minimum of six per acre - one exceeding 18 inches DBH and three exceeding 12 inches DBH) in order to help maintain populations of cavity-nesting wildlife.

g. Dead and down woody debris (Elliott 1988, DeGraaf et al. 1992, NHDRED 1997)
Dead and down woody debris (also referred to as coarse woody debris) are dead trees or portions of trees lying on the forest floor, including logs, stumps, limbs, upturned tree roots, and slash. Such material may play several roles in forest ecology including providing a base for the growth of new trees ("nurse logs"), harboring fungi that aid in nutrient retention and cycling, and providing habitat for wildlife. Dead and downed material is used as habitat by over 30% of the region's mammal species (mostly rodents, shrews, and carnivores), 45% of amphibians (primarily salamanders) and 50% of reptiles (mostly turtles and snakes). It is used as feeding sites by rodents, shrews, black bears, and woodpeckers, and provides shelter for many species of small mammals. Seventeen species of New Hampshire mammals also den in or around downed logs. Moist micro-habitats are created when downed logs cause the formation of pools and riffles in streams which provide important fish habitat, as well as basking and nesting locations for turtles, waterfowl, mink, and otter. Ground-nesting birds (including juncos and winter wrens) also nest within upturned tree roots. Dead and downed material provides habitat for lower organisms which contributes to the food chain - including insects and other invertebrates, mosses, fungi, and lichens. It is also used as lookout sites, preening and drumming sites, and natural bridges across streams.

In general, larger (18+ inches) hollow or rotten logs and stumps have the highest value for wildlife. Softwood stands also seem to contain more and longer-lasting woody debris than hardwood stands. However, the amount of dead and down material is low in many of New Hampshire's forests. It has been viewed as fuels that create fire hazards, as potential wood products that should be salvaged, and as physical barriers to forest operations and regeneration. As forests are maturing though, the supply of dead and down material is naturally increasing due to the older trees dying and falling over. Factors that could reduce the supply of such material includes greater utilization of cull material through chipping or whole tree harvesting, increasing the intensity of forest management, and the shortening of rotation lengths. Therefore, it is important to manage for dead and down woody debris in forests by retaining material that currently exists and allowing its accumulation where it is currently missing.

h. Vernal pools (NHDRED 1997)
Vernal pools are small depressions in the ground that fill with water during the melting of snow in the spring, or during the accumulation of rain in autumn. They may also fill when the groundwater level rises above the level of the depression, and they have no inlet or outlet. Because vernal pools lack fish (due to the pool being temporary, too warm, too shallow, oxygen poor, or because they may freeze in winter), they provide a unique habitat for a number of aquatic organisms that would otherwise be prey for fish - including many species of amphibians. For example, wood frogs and mole salamanders only breed in vernal pools, and ten other species of reptiles and amphibians use these habitats for breeding or feeding.

Insects and invertebrates, including tiny snails and clams, also live in vernal pools. While some may spend part of their life cycle in other habitats besides vernal pools, a number survive in the mud during dry periods. During these times, matted and discolored leaves in a small depression may be the only evidence that signifies this area as a vernal pool. So, while vernal pools are quite inconspicuous, they provide critical habitat for a number of species - and protection of these pools is especially important in maintaining local amphibian populations. It is then very important to manage vernal pools as amphibian habitat by avoiding temperature increases from loss of shade and by preventing siltation.

i. Seeps (DeGraaf et al. 1992, NHDRED 1997)
Seeps, or seepage wetlands, are small areas (less than ¼ acre) that occur where the groundwater comes to the surface. In New England these wetlands usually occur on lower slopes of glacial till hills and bedrock - as hillside forest seeps in sloping headwater areas, or as larger sloping seepage forests in till outwash and river terrace sediments. The soil at these sites stays saturated through some or all of the growing season, and may stay wet through the winter. These sites are the first to green-up in the spring, and are therefore frequented by a variety of wildlife. Black bear, moose, deer, and wild turkeys use seeps for food, water, and occasionally elements like sodium or calcium that may be present in the groundwater.

Other animals also depend on seeps. Seeps are the preferred habitat of the northern dusky and two-lines salamanders, and also to their predators as well - skunks, raccoons, and river otters. Spring migrating birds, including woodcock and robins, depend on these sites for water, food, and as a refuge after early spring snow storms. Seeps that are located near streams or rivers maintain coldwater habitats for species such as trout and salmon during the summer months

when cooler water temperatures prevent fish mortality. They also help to ensure fish survival in the winter by creating a warmer environment. As a result, such seeps have been instrumental in elevating trout and salmon abundance. Therefore, because seeps are areas of critical habitat, it is important to protect them and to minimize disturbance to the forest floor (organic layer) adjacent to them during timber harvesting operations.

j. Woodland raptor nest trees (NHDRED 1997)

In New Hampshire, many species of raptors - including red-tailed, red-shouldered, broad-winged, sharp-shinned, northern goshawk, and Cooper's hawks - build large stick nests in the major forks of mature hardwoods and on whorls of large branches of white pines. Many species often reuse the same nest year after year. Some may build a new nest nearby, while others may remodel a nest originally constructed by another species. However, suitable trees for supporting large stick nests are limited in present-day forests.

This is especially critical for those species of concern in New Hampshire, including the red-shouldered hawk, northern goshawk, and Cooper's hawk. Compounding this problem is the fact that these raptors can be sensitive to human disturbance as well as habitat changes in the vicinity of their nests. Excessive activity around their nests during the early weeks of the breeding season may cause a pair to abandon the nest. It may also cause the female to flush from the nest, leaving the eggs vulnerable to predation or fatal chilling. Therefore, it is important to manage for suitable nest trees for woodland-nesting raptors and avoid disturbance of nesting pairs.

k. Bald eagle and osprey nests (NHDRED 1997)

Both the bald eagle and osprey are species of concern in New Hampshire. While the osprey is a state-threatened species, the bald eagle is state-endangered and federally-threatened, and the only nesting pair can be found at Lake Umbagog. In order to ensure their existence in New Hampshire, an adequate amount of nest trees must be provided. They also require large bodies of water for foraging since the osprey feeds almost exclusively on fish, and the bald eagle feeds mostly on fish and waterfowl. Bald eagles nest in large live or dead (often white pine) trees usually within ½ mile of the shore a large water body. Ospreys nest in dead or dead-topped trees, and these too are often white pines or other tall softwoods. Osprey nests may be miles away from open water. Many are associated with a wetland or riparian areas, or in upland settings. In New Hampshire, ospreys nest in the upper Androscoggin drainage basin, the Connecticut Lakes region, and around Great Bay. With both bald eagles and ospreys, their nests are used for years or even decades, with pairs adding additional nesting material annually. Therefore, forest management should include maintaining existing eagle and osprey nest trees and potential replacement trees. It is also important to avoid disturbance in the vicinity of active nests during the breeding season.

l. Natural areas (John Sloan Dickey Natural Area)

Natural areas, those areas which are unmanaged, are unique habitats - especially amidst large expanses of managed areas. They provide necessary habitat for a number of species that otherwise would not be accommodated for. The John Sloan Dickey Natural Area at the Second College Grant is a protected area which consists of 357 acres. The management goal here is to provide and maintain nearly mature residual stands of species in a mix characteristic of the area. Timber harvesting is limited due to the inoperable terrain, road and river protection zones, and cooperative arrangements with the New Hampshire Fish and Game Department. This area

encompasses a vast expanse of deer wintering areas, as well as a pair of nesting peregrine falcons on the Diamond Peaks. There are also signs of pine marten and bobcat utilizing this area, as well as a number of other species. Any timber harvesting in this area will be performed as a selection system for the purpose of removing those trees infected with disease, infested by insects, or which are otherwise unhealthy and detrimental to the perpetuation of a mature forest. This area is (and should continue to be) managed primarily for aesthetic values, where production of timber is of secondary importance.

m. High elevation forests (MOU, NHDRED 1997)

High elevation forests, those found over 2,700 feet, are sites possessing many unique ecological characteristics. Because of the harsh climate, shallow soils, steep slopes, and short growing seasons, the spruce-fir forest type is the dominant forest cover in these areas. They provide unique habitats for a number of wildlife species, including Bicknell's thrush, black-backed woodpecker, blackpoll warbler, spruce grouse, and pine marten. In New Hampshire, over 80% of high elevation land is publicly owned. The remainder is in private ownership where the objectives of the owners vary, with timber production being a high priority for many. In order to safeguard these unique high-elevation habitats, care should be taken when managing these sites. In recognition of this, Dartmouth College has entered into a cooperative agreement with the State of New Hampshire in the management of high-elevation land (Appendix 10). The management goal is to maintain the long-term ecological integrity of high-elevation forests and the systems they influence, while continuing to manage the land for the sustained production of forest products.

n. Zoning

There are county zoning laws and other guidelines that must be followed when considering any wildlife habitat improvement project. A zoning map of the different zoning districts can be seen in Figure 19. Coos County Zoning Ordinances for Unincorporated Places take into account three basic districts related specifically to wildlife, PD-3 Critical Wildlife Habitat, PD-6 Steep slopes and high elevation areas, and PD-7 Wetlands.

o. Partnerships

It is important for the College to continue cooperative efforts and partnerships in managing wildlife habitat. Existing and potential relationships include:

- Universities of NH, Vermont, and Maine
- N.H. Fish and Game Department
- Wildlife Management Institute
- U.S. Fish and Wildlife Service

IV. Resource Management
C. Water Resources

C. Water Resources

History

The rivers of the Second College Grant have had a surprising history of varied land-use practices. Agriculture was tried in the early 1800's as part of a land-leasing program. The climate and terrain was not really conducive to crop production and so it didn't take long for people to look to the timber on the property for income. Since the mid 1800's logging and forest management has become the main land use, in line with the rest of the region.

Since then the industry has seen many differences in the way timber has been harvested. From logging camps, horses and oxen, and river drives over a century ago, we've advanced to today's harvesting technologies of feller bunchers, slashers and logging trucks. This modernization has also created new challenges for the health of our river systems. As the demand for timber increased so did the necessary construction of roads to extract that timber. Inadequate road design and the failure to employ proper erosion control measures resulted in the loss of soils into streams through runoff, especially during rainstorms. Forestry practices in the mid 1900's also led to an increase in siltation; clearcuts and removal of the largest trees left little residual tree cover to hold back erosion during snow melt in the spring and heavy rain showers.

Rivers and Streams

The brooks and rivers of the College Grant are on the whole, high-quality wildlife habitats *that* support hundreds of invertebrate species, several species of fish, including a naturally sustained brook trout fishery, at least three salamander species, including the rare spring salamander, beaver, river otters, and at least nine bird species. In addition, the riparian habitat along stream corridors provides critical habitat for numerous plant and animal species, including moose, deer, bears, fishers, and several bird species. The Grant has three major rivers flowing through it, the Magalloway River, Dead Diamond River and the Swift Diamond River. The Magalloway cuts through the south east corner of the Grant and is controlled flow by a dam to the north; from the Grant it flows into Lake Umbagog. The Dead Diamond river runs north to south, is a slow flowing river with many oxbows. Running west to east is the Swift Diamond River which is a fast flowing river. Each of these rivers is considered a fourth order stream by the State of New Hampshire and is afforded additional protection under wetland and timber harvesting laws.

The rivers of the Grant are very high gradient streams which allow for great fluctuations in flow in short periods of time. The rivers are very exposed to sunlight thus, the spring ice flows tend to scour the sides preventing much vegetation from becoming established. The brooks feeding these streams are very important cool water refuges for native trout in the summer. However the lack of vegetation on the banks makes the temperature become dangerously high for their survival. The absence of the cold water streams and or a change in their temperature could be extremely detrimental to the trout populations.

Maps of College Grant brooks and rivers are presented in Figures 20, 21 and 22. A more detailed description of riverine habitats can be seen in Appendix 11.

Riparian Areas

Sediment and erosion eventually will make streams wider, more shallow, with a smooth bed of sediment. These can result in the loss of spawning gravel, increased water temperature, such fine textured sediment that insect larvae and fish eggs cannot survive the reduced oxygen levels. Over time a shaded, gravel, cool, stream can be transformed into a warm-water flat stream, and the habitat is wholly changed. Excellent management of the Grant's forests since the 1970's has ensured minimal areas where this has actually happened, but the description is important to understand the management practices near streams in the Grant.

The brooks and rivers of the College Grant are mostly high-quality riparian habitats that support hundreds of invertebrate species, several species of fish, including a naturally sustained brook trout fishery, at least three salamander species, including the rare spring salamander, beaver, and river otters. In addition the riparian habitat along stream corridors provides critical habitat for numerous plant and animal species, including moose, deer, bear, fishers, and several bird species. The Grant has three major rivers flowing through it, the Magalloway River, Dead Diamond River and the Swift Diamond River. The Magalloway cuts through the south east corner of the Grant and is a controlled flow by a dam to the north; from the Grant it flows into Lake Umbagog. The Dead Diamond River runs north to south, is a slow flowing river with many oxbows. Running west to east is the Swift Diamond River which is a fast flowing river. Each of these rivers is considered a fourth order stream by the State of New Hampshire and is afforded additional protection under wetland and timber harvesting laws.

These rivers are very high gradient streams which allow for great fluctuations in flow in short periods of time. The rivers are very exposed to sunlight because the spring ice flows tend to scour the sides preventing much vegetation from becoming established. This lack of vegetation, and shade, on the banks makes the temperature become too high for survival of our native trout population. The brooks feeding these streams are very important cool water refuges for the trout in the summer. The absence of the cold water streams and or a change in their temperature could be extremely detrimental to the trout populations.

Research

Forest management at the Grant includes a priority to keep brooks, streams, and rivers cool with shade from forest cover. Managers recognize that baseline and continuous population and condition data will support and drive particular management strategies. Around 2000 the Woodlands office teamed up with the N.H. Fish and Game department to do long term population monitoring of fish populations at the Grant. This consisted of measuring conditions in riparian habitats and tracking particular populations of fish. Two primary components of the research are an annual population assessment done with volunteers, and tagging fish with radios that can be tracked using telemetry. This research partnership has yielded solid and useful data to guide management in riparian zones at the Grant.

Research shows us that the tributaries of Lamb Valley, Loomis and Alder Brooks have biomass estimates greater than 13 lbs/acre, a very healthy level. This is attributed to the optimal habitat

characteristics found in these brooks such as adequate shading. These brooks seem to be nurseries for the Swift and Dead Diamond Rivers. The brooks have a large variety of pool and riffle habitats, as well as cool temperatures. These water bodies were identified as wild brook trout waters in 2004 and regulations indicating them as such went into effect January 2005.

In the summer of 2006 the New Hampshire Fish and Game Department decided to tag and follow Eastern Brook Trout in the waters of the Dead Diamond. The initial phase was to capture and fit 10 trout with a radio tag and follow it through the summer. This was accomplished and all fish were tracked until the radios eventually lost power. The first year, as with any study, turned out to be most valuable as a learning experience. Fish mortality was high due to tagging under high temperatures late in the year.

For the summer of 2007 the goal was to tag 10 more fish. This was accomplished early in the year, and fish mortality was less due to the cool water temperatures and more experienced helpers. The information gained was very helpful in learning about the Grant's fish populations. Tracking data showed us that fish not only use the Dead Diamond river but all the tributaries in the greater Androscoggin watershed. One fish originally tagged in the Dead Diamond River was found in the Magolloway River, Abbot Brook, and even the Androscoggin River. The same fish seemed to have spent the winter in Lake Umbagog and was last tracked on the Dead Diamond river near the site of original tagging. This fish travelled a total of 50+ miles in one year's time. Another tracked fish travelled 6 miles in one day. During the third year of the study 10 brook trout and 10 small mouth bass were captured. The study wanted to see if the Bass caught in the gage pool would move into the Dead Diamond watershed. The telemetry tracking indicated that they came up as far as the gauge pool and then went back down to the Magalloway River.

This effective study of the movement of the brook trout led the N.H. Fish and Game to review the fishing policies in the region. New regulations, beginning in January 2009, include limitations of catch and release, flies, and single hook lures with no barbs to be placed on fishing in the Diamond River. Specific location in the Grant is from Peak's Cabin down to the Magolloway River.

Successful data collected on the Dead Diamond encouraged research in the Swift Diamond watershed. In the summer of 2010, and for two subsequent years following, we will study the trout of this river to track their movements. Further study in the watershed will see how the regulations that have been placed on the watershed have changed the current conditions. The plan is to keep monitoring stream temperatures in the region, and to see how regulations and riparian management is affecting these streams. A creel survey would further allow the N.H. Fish and Game department to asses fishing pressure on the watershed.

Other projects

In 2008 the Woodlands Office conducted a culvert survey of the entire Second College Grant. This information was used to formulate a plan to reduce the number of hanging culverts which blocks fish travel. In the fall of 2008 we obtained a Wildlife Habitat Improvement Project Grant for the removal of two culverts and replaced them with bridges to allow for better fish travel.

Additionally, a bridge over Alder Brook will be completed in the summer of 2010, and a bridge over a stream on the Southside Road will occur in the summer of 2011.

Cold-water brooks

These ground water-rich brooks are extremely valuable in maintaining cool-water conditions in the main channels of the Swift Diamond and Dead Diamond Rivers. They tend to be heavily shaded and run crystal clear and cold from spring to fall. **Merrill Brook** lies within a relatively undisturbed catchment. The low gradient, full canopy and cold water combine to produce large, in stream accumulations of slowly decomposing foliage. The invertebrates that consume these resources are abundant at times when other streams have very little leaf material remaining from the previous season. Their predators include young brook trout and large populations of several salamander species, including the rare spring salamander. **Johnson Brook** harbors a diverse and abundant cold-water insect fauna. Johnson Brook enters Swift Diamond below ground, forming a slough in the main channel. This laterally flooded backwater area contains pond-dwelling invertebrates which occasionally fall prey to cruising brook trout. **No-Name Brook 1** flows into the Swift Diamond River near the Hand on the Rock. It is inhabited by an unusually diverse caddisfly fauna. **Washburn Brook** is largely unexplored by biologists. The bridge built in 1998 provides excellent access to the headwaters for fish, salamanders, and invertebrates.

Run-off brooks

These small brooks are precipitation dominated, which makes them prone to frequent flooding and drying. Fish are rare or absent (although systematic surveys are yet to be conducted) and the insect taxa are necessarily disturbance tolerant. Most of the **Horne Brook** catchment lies outside of the Grant. It was clear-cut in 1998 and invertebrate recovery studies are underway. **Halfmoon Brook** is a very dynamic, small stream that remains under-explored. A high, hanging culvert functionally splits the stream into headwaters and downstream reaches. In addition, there are many very small runoff brooks in the Diamond River watershed that have little or no flow during dry weather. They are particularly numerous along the Dead Diamond River channel upstream from Washburn Brook.

Black-water brooks

These streams have naturally acidic, tea-colored water produced by high concentrations of tannins. Beaver ponds can create or add to these conditions as tannins and other plant compounds soak into solution from accumulations of foliage and macerated wood. **Bennett Brook** contains a large population of small brook trout. Its mouth at the Swift Diamond features a distinctive chemical environment where acidic brook water mixes with nearly neutral river water. **No-Name Brook 4** is a small, acidic, beaver-pond brook.

Brooks disturbed by 1980' spruce budworm outbreaks

The spruce budworm is a native forest pest that periodically decimates large stands of spruce and fir. Outbreaks create wide-open riparian habitat, which greatly increases levels of primary production in streams. **Bennett Brook** (see above) is one such stream. **No-Name Brook 2** now has a channel lined with thick growths of young soft-wood. It is believed to contain the only

population within the College Grant of a poorly understood species of riffle beetle (*Promoresia tardella*).

Major brooks

This term is used to describe relatively large brooks with multiple tributaries. Much of **Four-mile Brook** lies within the College Grant. This long brook-trout stream requires further exploration. It could benefit from culvert improvement. **Alder Brook** and **Larry's Brook** harbor a population of small brook trout and provide spawning habitat for larger fish that move in from the Swift Diamond River. Brook trout access to the Swift Diamond River is excellent, with relatively deep water and overhanging banks at the mouth. The heavily damaged road crossing at Alder Brook Cabin poses a potentially serious impediment for trout, salamanders, and insects. **Loomis Valley Brook** and **Lamb Valley Brook** are picturesque streams with numerous cascades and plunge pools. Both have good access for brook trout to and from the Dead Diamond River.

Unexplored brooks

In general, all of the streams of the College Grant warrant further study. **Cedar Bog Brook** is an under-explored tributary of the Magalloway River that flows through a large wetland. Its brook trout and salamanders would benefit from culvert improvement. **Kendall Brook** is also under-explored. The downstream impoundment is critical osprey habitat. Information about **Sanderson Brook, Kendall Brook, and No-Name Brooks** is particularly limited.

Cold-water river

The **Little Dead Diamond River** is threatened by heavy logging outside of the Grant boundaries due to loss of shading. It receives cold groundwater along its course, which dramatically cools Dead Diamond River water where the two streams meet. Consistently cool water and clean gravel at this juncture provide prime spawning habitat for brook trout. Cascades with deep plunge pools full of small brook trout occur at several places along the channel.

Cool-water rivers

The **Swift Diamond** and **Dead Diamond Rivers** are the most important recreational waters in the College Grant. Both contain thriving populations of naturally reproducing brook trout. Potential threats to wildlife include siltation and warmed water from logging and road sites. The Swift Diamond River flows rapidly through the College Grant and the Dead Diamond River includes long stretches of flat, slowly flowing water. These flow patterns produce large differences in stream bed substrates. The Swift Diamond River channel is dominated by cobble and gravel underlying current-scoured boulders and bedrock, while the Dead Diamond River channel contains many large deposits of silt and sand. The **Diamond River** (the Swift and Dead combined) downstream from the gorge has a moderate-gradient and is subject to the action of frequent, powerful floods. These characteristics produce a broad floodplain with a braided channel and predominantly cobble and larger substrates. Summer water temperatures periodically exceed 72° F, which may force brook trout to move downstream to seek refuge in cooler water.

Warm-water river

The short stretch of the **Magalloway River** within the College Grant has relatively slow flow, warm summer water temperatures, and harbors populations of several fish species that thrive in warmer water than brook trout can tolerate (e.g., smallmouth bass, landlocked Atlantic salmon).

Other Riverine Habitats

Rock pools

These aquatic habitats are sculpted in bedrock by stream flow and the scouring action of sediments. Community composition of rock pools is governed by the frequency of flooding and drying. Highly disturbed holes usually only contain small numbers of larval flies that feed on algae and deposits of detritus. Large, infrequently disturbed pools are populated by larval frogs and a variety of insect species. Rock pools occur near gorges and ledges along the Diamond, Swift Diamond, Dead Diamond, and Little Dead Diamond Rivers.

Iron seeps

Not to be confused with the iron-red polluted waters that drain many abandoned New England mine sites, these natural features are teeming with life, including several insect groups not found elsewhere, including two species of ptychopterid flies which feed on thick accumulations of rust-red bacteria. Iron seeps dot the courses of many College Grant streams. Prominent seeps have been identified at sites along Four-mile Brook, Alder Brook, and the Little Dead Diamond River.

Oxbows

Oxbow lakes are formed when bends in a river are cut off from the main channel by redirected current. The many oxbows in the Dead Diamond flood plain are home to pond-dwelling invertebrates, amphibians, reptiles, and fish.

Protection of the Water Resource

Protecting water quality at the Grant is of paramount importance. The Woodland's Manager uses a variety of measures and guidelines to protect water quality. A general plan for riparian habitat protection in the College Grant is presented in Table 13. Also a map and table of stream temperature logger locations and associated data can be seen in Figure 23 and Table 14

- The Coos County Zoning Laws for Unincorporated Places include substantial riparian buffers on the rivers
- NH Wetlands Laws
- self imposed riparian management zones
- best management practices are followed in timber harvesting
- stream crossing are done with portable bridges and steel culverts which are removed when the operation is complete
- bridge designs and construction are now longer and higher to avoid bank disturbances
- increased use of bridges over culverts

By utilizing these protective measures the College can insure that its land management and recreational programs do not harm the water resources at the Grant.

Table 13. General recommendations for riverine wildlife habitat protection in the College Grant

Stream type	College Grant streams	Comments	Recommendations
Rivulets - very small streams of ground water and/or runoff that flow in the riparian zones of larger streams	flow into all College Grant streams, including many examples along Swift Diamond R., Dead Diamond R., and Diamond R. (e.g., at Peaks Cabin)	• should provide silt-free water to main channels • some sedimentation is inevitable at road crossings	• culverts should be sufficiently long to prevent road-sloughing • do not mow or clear brush near channels • selective cutting near channels • ≥ 30 ft. separation from roads, skidder trails, and log decks
Headwater springs - ground water sources for brooks that begin in the College Grant	upper reaches of: Johnson Br., Alder Br., Loomis Valley Br., Lamb Valley Br., Washburn Br., Halfmoon Br., Merrill Br., Sanderson Br., Kendall Br., No-Name Brooks	• critical for maintenance of cool-water conditions downstream • extremely sensitive to logging disturbance	• survey and map prior to logging • site log decks, skidder trails, and roads away from water • selective cutting near water, leave trees for sediment retention, and shading • monitor water temperatures during logging operations
Brooks - small- to medium-sized streams	24 examples, see Fig. 1	• the most of ecologically diverse flowing-water habitats in the College Grant • critical habitat for brook trout and salamanders	• ≥ 30 ft. separation from selective cutting, vehicle operations, and logging debris • ≥ 50 ft. separation from roads and skidder trails • ≥ 100 ft. separation from log decks and clearcutting • provide greater protection for critical wildlife habitat • curtail logging activities during spring runoff and summer rains • conduct biological inventories prior to logging • monitor water quality and stream invertebrates before, during, and after logging operations • eliminate hanging culverts
Rivers - main channels	Little Dead Diamond R. Swift Diamond R. Dead Diamond R. Diamond R. Magalloway R.	• subject to negative effects of heavy logging upstream from the College Grant	• ≥ 100 ft. buffer strips

V. Recreation

V. Recreation

Recreation is a primary activity at the Second College Grant. Members of the Dartmouth community have enjoyed this remote area for decades. The first recreational cabin on the Grant was built in the 1930's by the Dartmouth Outing Club. Today visitors enjoy a variety of activities on the Grant including hiking, biking, fishing, hunting, and skiing.

The College encourages traditional, quiet, wilderness activities at the Grant. Trail bikes and All - terrain-vehicles (ATV's) are not presently allowed at the Grant for recreation. Snowmobiles have thus far been discouraged at the Grant; the College feels there is adequate opportunity for this activity nearby so that the Grant trails and roads can be utilized by people cross country skiing or traveling on snowshoes. Visitors are always reminded that it is unlawful to ride snowmobiles on plowed roads, and it is dangerous at the Grant given the logging trucks on the roads in the winter. There is a small section of state maintained snowmobile trail on the southwest corner of the Grant off Larry Brook Road for visitors who need to access the state trail system.

A. Cabins

There are twelve cabins located on the Grant; some are owned and maintained by the Outing club, and the rest are taken care of by the Outdoor Programs office. See Figure 24 for locations.

Outdoor Program Cabins

1. Gate Camp on Dead Diamond Road
2. Management Center on Dead Diamond Road
3. Sam's Cabin on Dead Diamond Road
4. Merrill Brook on Dead Diamond Road
5. Hell Gate Gorge on Dead Diamond Road
6. Hell Gate Hilton on Dead Diamond Road
7. Pete Blodgett Camp on Dead Diamond Road
8. Johnson Brook on Four Mile Brook Road
9. Town Office on Airport Road

Outing Club Cabins

1. Peak's Cabin on Dead Diamond Road
2. Alder Brook Cabin on Swift Diamond Road
3. Stoddard Cabin on Loomis Valley Road

These cabins accommodate four to twelve people, have running water, and an outhouse. The Management Center is the largest, it has indoor plumbing as does the Gate Camp.

The management, maintenance, and renting of the cabins is handled by the Outdoor Programs office and the Facilities Operation and Management.

B. Trails

There are twelve trails described in the Infrastructure chapter. (See section 3)

Trails are constructed and maintained by the Outdoor Programs office, often in cooperation with the Outing Club. Proposed locations for new trails should be discussed with the Woodland's Manager, Grant Management Team, and Grant Advisory Committee. There is also a trail adoption program run by the OPO office.

C. Water

The waters of the Second College Grant are used for many recreational activities including canoeing, fishing, and swimming, as well as the drinking supply for some cabins. These activities are primarily by the Dartmouth family visiting the Grant, however other people accessing the Grant by foot or bike often partake of these as well. Recreational users of the rivers must pay special attention to the dangerous conditions in the Hell Gate Gorge and the Diamond Gorge. Signs warning of the upcoming gorges should be checked annually and maintained.

Water resources at the Grant for recreational activities include

- Swift Diamond River - canoe, fish, swim
- Dead Diamond River - canoe, fish, swim
- Kendall Pond - walk to, birdwatch, fish, rowboat there to use
- Lamb Valley Pond - walk to, fish
- Hellgate Pond - walk to, fish, rowboat there to use
- Washburn Brook - fish
- Alder Brook - fish
- Bennett Brook - fish
- Loomis Valley Brook - fish
- Merrill Brook - fish
- Larry's Brook - fish
- Lamb Valley Brook - fish

The Dead Diamond River and the Swift Diamond River converge near the Peaks Cabin, then flow together as the Diamond River. This flows through an incredible gorge and out to meet the Magalloway River in the town of Wentworths Location. An expert level kayaker has done this gorge successfully during spring high water.

Grant visitors should also be aware of two spring sources of water:
Brungot's Spring located ½ mile north of Perley Churchill (Gate Camp) Bridge on east side of Dead Diamond Road, and Dart Wentworth Spring ¼ mile north of Peak's cabin on the east side of Dead Diamond Road.

D. Timber management

The College strives very hard to balance the multiple uses of the Grant property. There are 27,000 acres available for recreation. Timber is harvested on approximately 800 acres each year. There are likely to be conflicts where a hunter's favorite spot is cut, or perhaps near a hiker's favorite trail, but the woodland's manager tries to minimize impacts in these areas; there are standard buffer areas around cabins, along trails, and near roads.

The woodlands manager reports current harvesting areas and conditions to the Outdoor Program office on a regular basis. The Woodlands Manager also writes a summer and winter newsletter telling people about the location of road work and timber harvesting, road opening and, other work related happenings for each season. The Woodlands Office has also produced a demonstration tour for recreational users that can be seen in Figure 25.

VI. Cultural Resources

VI. Cultural

Dartmouth College's long term ownership provides a unique situation in the identification and protection of cultural resources found on the Second College Grant property. Most of the cultural sites on the Grant are related to the logging history of the region and specific activities such as horse logging, river drives, and log camps. For a brief but valuable discussion of some of these sites, see the excerpt from "The Dead and Swift Diamond Rivers - Preliminary Watershed Resource Assessment" done by the National Park Service in January 1989. Another good reference is "Dartmouth's Second College Grant A History" by Jere Daniell and Jack Noon. Photos of early logging in the Grant can be found at Plymouth State University's interactive, online exhibit: "Beyond Brown Paper" http://beyondbrownpaper.plymouth.edu

Sites on the Grant with historical importance include:

- Hell Gate Field - Logging Camp and Fish & Game Cabin
- Hell Gate Gorge Dam
- Upper College Farm - Merrill Brook area
- Lower College Farm - near airfield
- Dam at Diamond Gorge
- Hand on the Rock
- Sam's Lookout

Sites on the Grant with natural significance include:

- Hell Gate Gorge Natural Area - 50 acre site. One of two sites in New England where a rare orchid is found
- John Sloan Dickey Natural Area - 350 acre site where timber harvesting is limited
- Hell Gate Pond Natural Area - 950 acre site where timber harvesting is limited
- Halfmoon Mountain Natural Area - 550 acre site where timber harvesting is limited
- Diamond Peaks Natural Area - 1000 acre site where timber harvesting is limited
- Forks of the Diamond Natural Area - confluence of Dead and Swift Diamond Rivers
- Various sites designated by the New Hampshire Heritage Inventory - locations kept confidential

Land and recreation management policies and activities shall strive to protect these cultural resources.

VII. Protection of the Grant

VII. Protection

A. Protection of working forest

Dartmouth College has the Second College Grant property enrolled in the State's Current Use Taxation Program. This program taxes land on a current use basis as opposed to a potential use basis. The Second College Grant property is assessed at approximately $ 6 million; however, with the current use designation actual taxes paid are calculated on about a $ 3 million value. This is a valuable protective measure which helps Dartmouth to continue owning the Grant.

B. Protection of natural communities and Endangered and Threatened Species

The College in 1986 entered into an agreement with The Nature Conservancy to protect the Hell Gate Natural Area in order to preserve the site where the rare orchid Aurieled Twayblade is found.

In 1989 the College signed an agreement with NH Fish and Game Department for the preservation of the Osprey nesting site at Kendall Brook at the south entrance to the Grant.

The College participated in the development of a Memorandum of Understanding for High Elevation (land above 2700 feet) Management to protect the unique habitats and fragile environment found at these elevations. The College signed this MOU Agreement in 1999 with the NH Fish and Game Department; this is still in effect today and can be seen in Appendix 8.

The John Sloan Dickey Natural Area was established by the College in the 1970's for the purpose of preserving "nearly mature residual stands." However much of this area was hit hard by the spruce budworm in the early 1980's, the dead timber was salvaged to avoid fire potential, and today the area is comprised of a young mixed stand.

In April 2000 the Grant Management Team decided to set aside an additional 2250 acres as "no harvest areas" in recognition of their value as representative natural communities at the Second College Grant. These are located in the Halfmoon Mountain and Hell Gate areas. These areas combined with the existing John Sloan Dickey area, at 350 acres, means 2600 acres are now set aside at the Grant. Additionally 1100 acres will be managed as "low impact forestry" areas in order to protect the unique habitats found in the Loomis Valley Brook region. These areas are mapped in Figure 26.

C. Protection against forest fire

The College participates in the State's fire protection program in the following ways:

- Fire fighting equipment is stored at the Grant.
- The Woodland's Manager and the caretaker are wardens in the fire protection system.
- Open camp fires are not allowed on the Grant.
- In dry seasons logging contractors are required to have pumps with them, and the crews are not allowed to smoke cigarettes in the woods

NOTES

Glossary