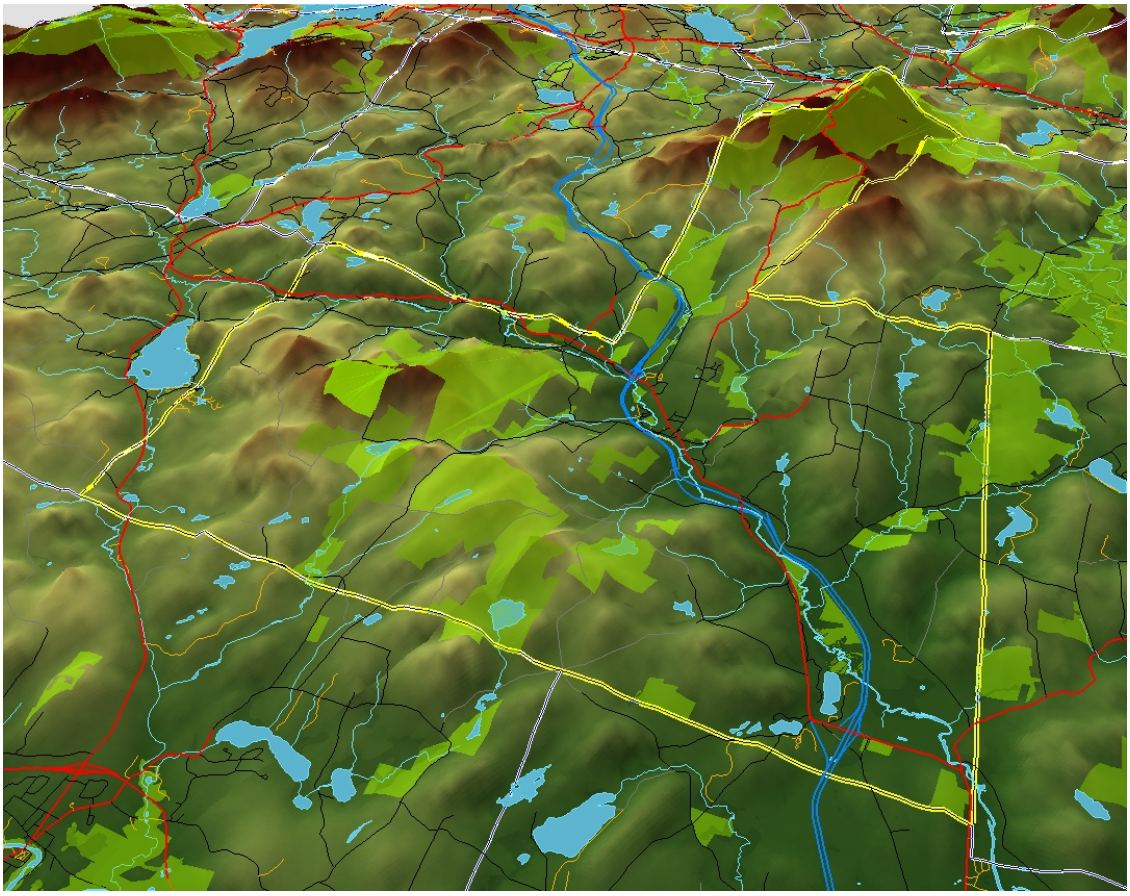
Town of Warner, New Hampshire

Natural Resources Inventory



Prepared by:

Society for the Protection of NH Forests

Research Department

Dan Sundquist
Research Director

Adam Bronstein
Research Associate

Prepared for:

Warner Conservation Commission

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Warner Natural Resource Inventory

EXECUTIVE SUMMARY

Background

Located along a major interstate highway twenty miles northwest of New Hampshire's rapidly urbanizing Merrimack River corridor, the town of Warner boasts one of the most dramatic arrays of natural resources anywhere in the state. The town also conveys a remarkable sense of community and rural quality of life that flows both from its history and its environmental setting. Spanning more than 55 square miles, the town is anchored by three thousand foot Mt. Kearsarge to the north, and the wild Mink Hills Range to the south. Through its valley heart flows the Warner River, entering the town as a sometimes wild and racing watercourse, and leaving peacefully amid broad floodplains and wetlands.

To advance the long-term protection of the town's natural resources, the Warner Conservation Commission engaged in a partnership with the Society for the Protection of N.H. Forests research department to gather and analyze data, to create reference maps, and to interpret the relative importance and protection status of a range of natural resources selected for study by the conservation commission.

Funding for this project was provided by the conservation commission through town appropriations made to conduct such studies. This ***natural resource inventory*** (NRI) also builds upon previous work accomplished by the conservation commission, especially a study of the Mink Hills Range to identify conservation priorities in that area of town.

Warner's Changing Landscape

The last two decades have seen significant change in population growth and land use conversion in Warner, creating development pressures on the natural resource land base in town. Population has jumped 30% -- nearly 700 persons – since 1990. The town is projected to grow by about 1,000 persons by 2030[1]. New housing construction has added more than 250 homes in the same time period, an increase of about 23%. At current occupancy rates, nearly 400 new homes will need to be built over the next twenty years. Where will these homes be located, and what will the impact be on the town's natural resources: drinking water, farmland, economic forest land, wildlife habitat, and remote recreation opportunities? How will Warner's rural quality of life change?

With growth and land use conversion comes the loss of important natural resource values provided by undeveloped land, especially for wildlife habitat, clean water, and the broader spectrum of "ecosystem services". The more intangible rural quality of life – the sum total of the natural and cultural resources of Warner -- will also be affected. To ensure a healthy natural and cultural environment into the future, it is essential that the town identify, retain, and protect the remaining undeveloped lands and waters that support the most important of these natural resource values and functions.

[1] N.H. Office of Energy and Planning, Population Estimates, 2007

Fortunately, it is not too late to protect the essential natural resources of Warner. Thanks to the legacy of state-owned public lands, and the foresight and dedicated efforts of the town conservation commission and conservation-minded citizens, more than 27% of the town is now permanently conserved. These protected lands and waters form the basis of a network of conservation areas that will help to safeguard the town's most critical natural resources, and provide opportunities to expand and link to key, unprotected land in the future.

By considering natural resources information in community planning and decision-making, Warner citizens can make a meaningful contribution toward maintaining a high quality of life for residents, and can help to preserve New Hampshire's irreplaceable natural heritage.

Goal Statement

The primary goal of this natural resource inventory is to build a science-based information system of maps and data that helps to focus conservation efforts on those lands and waters that are most important for conservation. This in turn will allow the town to:

- Develop a town-wide conservation plan, and
- Evaluate ordinances, land use regulations and development applications.

Identifying Conservation Priorities

Four principal resource analyses and maps were developed that capture key natural resource features in Warner. The maps that reflect the best remaining opportunities to conserve include:

- *Forest and Farm Resources*
- *Water Resources*
- *Critical Wildlife Habitat Features*
- *Scenic Resources*

These resource maps work to provide a visual reference to the location, and often the many-layered coincidence of various natural resources. An overlay of the town's tax parcel map on each map helps to locate natural resources that may exist on a given parcel or, in many instances, multiple ownerships, helping the conservation commission to plan outreach and communication. In the case of the complicated critical wildlife habitat features map, a ***resource co-occurrence map*** was also prepared to aid in identifying areas where several habitat values coincide and overlap, thus signaling locations with multiple conservation values and potentially higher priority for conservation.

Resource Protection Status

Warner currently enjoys nearly 9,700 acres of permanently protected land, or about 27% of the town's land area, in various locations around the town. The last ten years has seen about 2,900 acres of land conserved, signaling a concerted, on-going effort on the part of the conservation commission and local land trusts to protect important farm and forest land in town. On unprotected lands around town, current use assessment helps to maintain approximately 65% of the town's taxable land in a

natural condition. However, many important natural resources remain under-protected; the following table lists several of the most important resource factors, their acreage extent, and protection status.

Natural Resource Factor	Acres in Warner	Percent Land Base	Acres Protected	Percent Protected
Forest Cover	31,500	89.8%	8,800	27.9%
Productive Forest Soils	27,024	77.0%	6,819	25.2%
Best Agricultural Soils	1,159	3.3%	101	8.7%
Wetlands & Hydric Soils	3,872	11.0%	685	17.7%
Riparian & Shoreland Buffers	6,603	18.8%	1,835	27.8%
Floodplains	2,188	6.2%	545	24.9%
Aquifers	4,525	12.9%	490	10.8%
Drinking Water Protection Area	655	1.9%	24	3.8%
Special Wildlife Habitats	12,182	34.7%	4,440	36.4%

Obviously, Warner's agricultural soils and the Village District drinking water protection area have low levels of protection. While some natural resources appear to have relatively high levels of protection, the question remains: how much is enough? Additional information and interpretation of the importance of various natural resources can be found in the full report, along with more detailed statistics on many more resource factors in ***Appendix A***.

Implementation: Onward to a Conservation Plan

This collection of analyses and maps serves as a foundation of information on significant natural resources in the town. While this wealth of information can be very useful in community planning and conservation efforts in Warner, the results of this NRI should be seen as a necessary first step in the preparation of a townwide conservation plan.

With a little more work, all of the natural resource "suites" of data that are grouped in the four maps noted above should be evaluated, weighed, and developed into a master resource co-occurrence map, which then can be distilled into a conservation focus areas that represent the very best opportunities for conservation as well as the best use of limited conservation funding.

Such a planning exercise should involve a broad stakeholder group of town citizens who represent not only expertise in the natural resource realm, but also are knowledgeable about historic and cultural heritage resource values, community planning, and town infrastructure. In this way, a true "shared vision" of community priorities can be given shape and form that will endure into the future.

I. REPORT INTRODUCTION

This report presents the details for the 2006-2007 natural resource inventory (NRI) of Warner, New Hampshire. Through a formal Request for Proposal process, the Warner Conservation Commission (WCC) contracted with The Society for the Protection of New Hampshire Forests (Forest Society) to carry out this inventory. This report was written by the Forest Society and represents one of the final deliverables associated with the project.

WCC entered into this project in part to meet its statutory obligation under RSA 36-A:2 [2] which states that a town, having established a conservation commission for the proper utilization and protection of its natural resources and watershed resources, shall prepare an index of all open space and natural, aesthetic or ecological areas within the town, as well as all marshlands, swamps and all other wetlands, for the purpose of recommending to the selectmen a program for the protection, development or better utilization of all such areas.

Project Goals & Objectives

The primary goal of this project is to gather, map and analyze information on the natural resources of Warner, which will in turn serve as a critical tool to help the town

- Develop a town-wide conservation plan, and
- Evaluate ordinances, land use regulations and development applications.

Key objectives of the NRI include:

- Map and describe important natural resources, including forest and farm lands, water resources critical to habitats and as drinking water supplies, and a range of wildlife habitat values.
- Through GIS[3]-based co-occurrence mapping of, provide a prioritized basis for conservation action to protect the most important wildlife habitat features in town.
- Develop a scenic resource and viewshed analysis to identify lands important to maintaining Warner's scenic and rural character.
- Determine the current protection status of the natural resources studied, and interpret relative importance to help guide development of a future strategic conservation plan.

Project Contributers

This study and report would not be possible without the continuing involvement and participation of the members of the Warner Conservation Commission, who include:

Nancy Martin	Sarah Allen	Ted Young
Jim McLaughlin	Chris Connors	Russ St.Pierre
Brian Hotz	John Dabuliewcz	Peg Bastien

[2] RSA 36-A, Conservation Commissions, http://www.gencourt.state.nh.us/rsa/html/III/36-A/36-A-mrg.htm
[3] Geographic Information System: integration of hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information.

Others who contributed to this effort are Rebecca Courser and John Dowling.

The GIS mapping and analysis was conducted by a staff team at the Society for the Protection of NH Forests research department, led by Dan Sundquist, research director, Dave McGraw, GIS manager, and Adam Bronstein, research associate. This project was funded by the Warner Conservation Commission

Warner in Context

Warner is located in central New Hampshire in Merrimack County, just 25 miles northwest of the city of Concord, and covers approximately 35,500 acres, or 55 square miles. It is traversed east/west by State Route 103 which parallels Interstate 89 through the town. The town has three interchanges on the interstate highway, one with significant commercial development.

Warner has been a rural town through most of its history, with agriculture and forestry being important aspects of the town's economy and character. The town is now challenged by increasing population growth and land development as pressure moves northwest from Concord, a growth node along the major I-93 transportation corridor leading from the rapidly urbanizing southeast counties of New Hampshire. This is especially the case around the historical village of Warner along Route 103, which functions both as the town's cultural center and hub of commercial activities.

The town lies in the Warner River valley, a main tributary of the Contoocook River which connects with the Merrimack River. The river valley's alluvial floodplain soils contrast sharply with the steep, glacier-scoured mountainous terrain featuring Mt. Kearsarge to the north, and the Mink Hills to the south.

These ***natural and cultural resources*** are described in more detail in the following section.

II. WARNER'S IMPORTANT NATURAL RESOURCES

Introduction

The intent of this section is to characterize the extent, distribution and relative importance of the various natural resources included in the GIS mapping and interpretation described later in this report. General geographic data is presented in the discussion below. Please refer to **Table 1** below for a detailed breakdown of acreages and percents representing the town's natural resource land base.

Terrain

Identifying the physical structure and composition of a community's natural landscape is an important starting point and context for evaluating its specific ***natural resource suites***. Terrain provides the basic conditions for understanding how a landscape evolves into areas distinctly valuable for specific natural functions such as agriculture, forestry, hydrology, and wildlife habitat, or cultural functions such as scenic vistas.

Warner's topography presents dramatic contrasts between the broad, low-lying Warner River valley and the mountainous terrain to the north and south. Such distinct structural landforms also exhibit very different natural functions and processes.

Water processes dominate the river valley, and have been actively shaping the land, its soils, and its vegetation for several thousand years since the last glacial age in the New England region. In contrast, Mt. Kearsarge (2,937') and Black Mountain (2,560') dominate the rising elevation to the north, while the Mink Hills Range (~1,200' to 1,760') represents a broad area of complex terrain, dominating the southern third of Warner. Between the mountainous terrain and the river valley, gentler slopes and terraces are found both north and south of the river. Historically, this transitional landform has been the center of farming because of its favorable soils, and settlement because of the river's waterpower potential. Therefore, terrain has been an important factor in determining land use patterns within the town. In turn, the historical progression of these patterns over time has produced the land cover types we see today.

Land Cover

Land cover can be thought of as the mantle of surface features that lie on the physical landscape. Land cover types can be divided into naturally occurring vegetation or other features such as rock outcrops, versus human land uses such as farming, residential uses, human enterprises, and associated developed or cleared land.

Most of Warner is forested – about 87% or nearly 31,500 acres – with 75% of the forest cover being hardwood dominated (or mixed hardwood/conifer) and about 25% in pure conifer forest types. About 3% of the land base is in agricultural land use or open grasslands, largely north of the Warner River valley, 1% is represented by open surface waters (lakes, ponds, rivers), 3% in forested and non-forested wetlands, and about 7% in various types of developed land uses, including transportation, gravel pits and other open lands.

A detailed listing of the land cover types follows:

Table 1

Land Cover Type	Acres	Percent Total Land Area
Developed	408	1.1%
Tranportation	1,031	2.8%
Active Agriculture	1,050	2.9%
Beech/Oak Forest	8,014	22.1%
Paper birch/aspen	473	1.3%
Other Hardwoods	1,860	5.1%
White/Red Pine	3,881	10.7%
Spruce/Fir	909	2.5%
Hemlock	3,258	9.0%
Mixed Forest	13,171	36.2%
Water	417	1.1%
Forested Wetlands	171	0.5%
Non-forested Wetlands	709	2.0%
Disturbed	53	0.1%
Bedrock	21	0.1%
Cleared/Other Open Land	912	2.5%
	36,336	**100.0%**

Note: Total land cover acreage slightly exceeds the total land area cited earlier due to the nature of the GIS grid used in the land cover data which cannot be reconciled to the angular political boundaries of Warner.

These figures are derived from the state's land cover mapping issued in 2001, which is generated from satellite imagery with a resolution of 30-meters per grid cell. While the accuracy of the data are quite high statewide, it should be regarded as a coarse approximation of resource distribution at community scale. More precise GIS measurements and calculations are found below.

Forest Resources

Introduction

Farms and forests represent the great "working landscapes" of New Hampshire. They are important both historically and currently. The economic value that open space farms and forests represent has been calculated at more than $1.6 billion per year[4], or about 30% of the state's gross domestic productivity from its open space economic sectors. This includes only the products that flow from these working landscapes. If we add the less tangible service values and scenic resources they provide to tourism and recreation, the value rises to more than $5.2 billion. In terms of community

[4] *The Economic Impact of Open Space in New Hampshire*, The Society for the Protection of NH Forests, 1999.

legacy and integrity, forests and farming are much of what we ascribe to New Hampshire's quality of life.

Forest Structure

Warner's extensive forests are part of several much larger forest blocks in the state. A ***forest block*** is an area of intact and continuous forest canopy, without regard to property or political boundaries. Block edges are defined by highways and local roads, non-forest land uses, or by large water features.

Blocks function as structural matrices for wildlife habitat, with block-to-block connections being important for the movement of wildlife. Large forest blocks are also important for the natural management of water quality and quantity, and as an economic resource to sustainable forestry.

The map at the right shows the mosaic of forest blocks within town, and extending beyond into neighboring communities. Blocks smaller than 100 acres have been deleted for simplicity. The gray background shows where the forest cover is fragmented by transportation corridors primarily. Large forest blocks in excess of 23,000 acres are located in the Mt. Kearsarge "gore" area of the town and in the southwest part of Warner. The Mink Hills range centers on two large blocks totaling more than 17,000 acres, and separated by a lightly travelled local road; the majority of this block complex is within the town. Several other blocks ranging from about 1,000 to 5,000 acres are found around the north and east boundaries of the town. See ***Appendix A*** for more detailed data on forest blocks and protection status. Note that a special classification system of block sizes was used for statistical breakdown purposes, and the map above is a simplified version for the sake of clarity.

Approximately 8,800 acres (28%) of Warner's 31,500 forest acres are currently protected. Roughly 45% of the large Mt. Kearsarge block within Warner is protected, while only 27% (3,300 acres) of the large Mink Hills Blocks are currently protected.

Intact forest cover of this extent is not common in New Hampshire, especially to the south and east of Warner. It not only represents important wildlife habitat for a range of species, but is also considered significant in terms of long-range ecological processes such as soil nutrient accumulation and old growth forest species. See the ***Wildlife Habitat*** section below for more detail on forested habitat and the role of forest blocks in the NH Wildlife Action Plan.

Productive Forest Soils

Apart from the obvious economic values noted above, forests are also directly linked to the quality of other natural resources typically considered in natural resource inventory and conservation planning. The structure, composition, and ecological processes at work in forests are critical to a myriad of wildlife habitat values. Forests are also integral to maintaining water quality and regulating water quantity as they relate to both the natural world and to human uses.

While long-term forest management plans seek to maximize all the benefits and uses of our forests, the innate productivity of any forest is dependent in large part on landscape position (elevation, topography, etc.), and especially on soil types. These relationships have been well-studied in New Hampshire, and we are fortunate to have soils mapping that includes groupings of soil types according to general productivity and forest type. Three important forest soil groupings are of special note. These soils groupings can be thought of as our "most productive forest soils" for the given forest types, although forest management can and does produce significant economic results on less productive soils.

The map at right shows the extent and distribution of the three most important forest soils in Warner.

1A Soils

This group consists of deeper, loamy textured, moderately- and well-drained soils. Generally, these soils are more fertile and have the most favorable soil moisture for forest growth. The successional trends on these soils are towards stands of shade-tolerant hardwoods such as beech and sugar maple. Mixes of other hardwood species including yellow and white birch, aspen, white ash and red oak in combination with hemlock, spruce, fir, and occasionally white pine also occur.

In Warner, these soils are typically sandy loam soil types found on glacial till deposits on ridge tops and terraces north of the river valley, with a significant cluster along Burnt Hill Road and along the slopes leading up into the Mink Hills range. 1A soils total more than 8,500 acres, or 32% of Warner's most productive forest soils. Only 17% of this soils group is currently protected.

1B Soils

Soils in this group are generally sandy loams and complexes of several soils over till substrates. They are slightly less fertile than soils in group 1A. These soils are moderately- to well-drained and available soil moisture is adequate for tree growth but may not be as abundant as IA soils. Succession trends towards a climax of tolerant hardwoods, predominantly beech. Cut-over stands are commonly composed of a variety of hardwoods similar to those listed in group IA above.

Warner's IB soils form a ubiquitous matrix of "background" soils throughout the town, especially up-slope on Mt. Kearsarge and into the Mink Hills. They are also typically found down-slope from and in close association with the 1A soils noted above. 1B soils cover approximately 16,000 acres, or constitute more than 60% of the three productive soils detailed here. About 32% of the town's 1B soils are now protected.

1C Soils

These soils are comprised of outwash sands and gravels. Soil drainage is *somewhat excessively*- to *excessively*-drained or *moderately*-drained. Soil moisture is adequate for good softwood growth, but is limited for hardwoods. Successional trends on these coarse-textured, somewhat droughty soils are towards shade-tolerant softwoods such as red spruce or hemlock. White pine, red maple, aspen and paper birch are typical in mid-successional stands. Due to less hardwood competition, these soils favor softwood production, and ***provide the best high-volume white pine conditions in the state.***

Warner's IC soils are deep sandy loam and loamy sands found on kame terraces, in older, glacial alluvial deposits primarily just above the Warner River floodplain. They thus form a continuous corridor of soils directly associated with the river, running west to east across the town. A secondary cluster of 1C soils is also found along Schoodac Brook in the eastern part of town. 1C soils account for only 2,340 acres in Warner, or 8% of the productive soils. Less than 10% of 1C soils are currently protected.

It should be noted that most of Warner's 1A and 1B soils are classed by the U.S. Department of Agriculture's Natural Resource Conservation Service (NRCS) as highly erodible or potentially highly erodible if disturbed. IC soils are generally not highly erodible because they are flat. Since 1A and 1B soils are also found on steep slopes, ranging typically from 15% to 25%, conversion to other land uses such as residential development brings a considerable risk to the town's water quality due to soil erosion and sedimentation. About 9,800 acres of these soils are classed as highly erodible, and another 15,600 acres are potentially highly erodible, which amounts to about 95% of these soils in town.

Agricultural Resources

Productive Agricultural Soils

The Farmland Protection Policy Act of 1981 was established to assure that Federal programs are administered in a manner that will be compatible with state and local governments and private programs and policies to protect farmland. The NRCS uses the following criteria in New Hampshire for the purpose of carrying out the provisions of this Act.

- Prime agricultural soils: interpreting from technical soils data, prime agricultural soils have sufficient available water capacity to produce the commonly grown cultivated crops adapted to N.H. They have high nutrient availability, generally low slope and low landscape position, are not frequently flooded, and contain less than 10% rock fragments in the top six inches. Prime agricultural soils are best suited for cornfields and other row crops.

- Soils of statewide importance: land that is not prime but is considered farmland of statewide importance for the production of food, feed, fiber, forage or oilseed crops. Hay meadows not normally in row cropping could indicate soils of statewide importance.

- Soils of local importance: farmland that is not prime or of statewide importance, but has local significance for the production of food, feed, fiber and forage. In Merrimack County, this

includes all land that is in active farm use, but does not qualify as prime or of statewide importance. Pasture land and hay meadows may be common indicators of locally significant soils.

Excellent agricultural soils are found on the hills and terraces north of the Warner River valley however. These soils tend to cluster on the broad ridge tops along Pumpkin Hill and Burnt Hill Roads, and along Kearsarge Mountain Road. Another, smaller cluster is found on Waldron Hill, south of the river valley.

The map at the left shows the distribution of prime agricultural and statewide importance soils in the town. Soils of local importance are also shown in a light color. Soils of local importance not now farmed also exist extensively in Warner. The remaining active farms such as the Courser family operation are found on these soils.

As indicated by the map, Warner's agricultural soils are predominantly soils of local importance. More than 22,000 acres of these soils are found within the town, and they now primarily support forest growth. Warner's better agricultural soils are much more limited. Only 280 acres of prime agricultural soils, and 880 acres of soils of statewide importance are present. Combined, they amount to only 3% of the town's total land area, which is close to the statewide average of 5.6%. It is important to note, therefore, that these critical food and fiber growing soils are in very short supply. Only 12 acres (4%) of Warner's prime agricultural soils, and only 89 acres (10%) of its soils of statewide importance are currently protected.

Agriculture & Open Lands

While classification for soil productivity may indicate agriculture's relative potential and value, farming as a way of life in New Hampshire has been on the wane since the mid-1800s. In many places, very productive farming soils are now growing trees and houses, not crops. Therefore, it is important to recognize the historic and cultural value of those farming and agricultural enterprises still operating on good soils within our communities.

Warner's agricultural landscape is largely historical. Though some pastures and meadows are still utilized for hay and occasional grazing, intensive crop production is no longer common. Those areas that they have remained open are generally indicative of the fertile soils they contain. As described later, these open grasslands are also a critical and scarce wildlife habitat type in the state.

In order to better identify these open lands, volunteers from the WCC made a field investigations and used aerial photos to delineate the meadows, pastures, and other open lands. They were categorized as agricultural, other open lands, or gravel pits, which also function as special wildlife habitat. Other data such as current use or additional special attributes were also documented.

Actively farmed lands and other open agricultural lands are shown on the map to the left. There are only 573 acres of this land type in Warner, representing about 1.6% of the town's total land base. Approximately 145 acres (25%) of this type is currently protected.

Recreation Resources

Warner enjoys a wide range of recreation resources within town, spanning a range of opportunities both cultural and natural, active and passive, organized and elective. This section will address those recreation resources that are primarily dependant on the community's natural resources and natural settings for the quality of the recreational experience. Because aesthetics and scenic relationships are an important ingredient in outdoor recreation activities, the reader is encouraged to also review the ***Scenic Resources*** section of this report.

An extensive system of year-round and seasonal trails exists in Warner at present, as shown in the map to the right. The Sunapee-Ragged-Kearsarge (SRK) recreation trail connects mountains of the same name, including a segment and public trailhead in the Mount Kearsarge State Forest in the northernmost portion of the town. This 74-mile trail loop crosses both public and private land and provides a well-maintained regional hiking resource. Other public hiking trails in town are found on the Chandler Reservation and on the Indian Museum and Stockwell/Bartlett easements, looping around a wetland complex just east of the Indian Museum and connecting to trailheads on Pumpkin Hill Road. These trails are mapped as part of a statewide local trails database by NH OEP.

Another established but seasonal trail network involves a system of regional and local snowmobile trails that range from unmaintained occasional use trails, to club-maintained trails, and one trail series that is part of the state primary trail system network. This latter trail is important as a connector to other regional snowmobile trail systems, and can be thought of as an arterial route. The state primary trail is about 10 miles long; the maintained snowmobile trails total about 42 miles in town, with another 10 miles of unmaintained trails.

All snowmobile trails are used by permission of individual landowners under agreement with local snowmobile clubs, and thus are "limited use" trails for snowmobiling only. However, informal cross country skiing and snowshoeing use is often found on such trails, too. Some trails may be open to walking during other times of the year by landowner permission. Some snowmobiling trails utilize class 6 town road rights-of-way and class 5 summer maintained roads as trail ways, and these are open to public use year-round.

Relatedly, two other trail-oriented recreation resources exist in Warner, one official and the other an opportunity. Route 103 running through town east and west is a federally designated scenic byway, one of several in New Hampshire (see map on previous page). Known in that system of scenic highways as the Currier and Ives Trail, it links a series of picturesque towns and villages in the central part of the state. The federal designation confers no special status other than recognition of the scenic and cultural values found along that byway, but by implication those scenic qualities are integral to the experience along the byway, and merit attention and perhaps protection.

Parallel to Route 103 runs what is now an abandoned railroad right of way that once served as one of the "short lines" connecting towns and villages to Boston and other points outside New Hampshire. While the right of way itself has reverted to abutting landowners long ago, and parts have been developed for other uses, much of the original railroad bed, embankments, and bridge infrastructure

still exist, making for an opportunity in the future to establish a 10-mile east-west recreation trail system across town.

State GIS databases also show a few other recreation resources that should be noted here. The Warner River is listed as a canoe water in the state, with various segments of the river classified by difficulty. A canoe portage and access point is noted at Waterloo. Silver Lake and its reservoir area and beach are also listed, as is Camp Piesaule, a 380-acres private, non-profit youth camp facility located east of Lake Massasecum near the west boundary of Warner.

While permanent land protection does not necessarily ensure recreation opportunities or public access to private land, changes in land use from a natural to a developed condition certainly can and do make maintaining public outdoor recreation experiences a challenge. This is especially true with trail systems which rely on the generosity of private landowners for public access. The snowmobile trail system is only about 25% protected – about 16 of 62 miles total. Breaking that trail system down further, the state primary trail is only 15% protected, while 24% of the maintained trail system is located on conserved land. Only about one mile of the abandoned rail right of way is protected, less than 10% of its length. To the extent that land along these trail systems are protected, the quality of recreation experience is also maintained, and it should be understood that connected and conserved properties also create valuable wildlife corridors that work to link larger areas of protected lands in a regional network.

A reduced version of the full-sized composite map of town forest and farm resources follows on the next page. A detailed map of Warner's recreation resources is available for viewing from the conservation commission, but is not published here due to restrictions on the trails data.

INSERT FOREST AND FARM MAP HERE

III. WATER RESOURCES

Introduction

Water resources including both surface waters and groundwater resources are some of a community's most valuable assets. Most drinking water sources – whether public or private – depend on subsurface water in sand and gravel aquifers, or in bedrock. Surface waters offer many recreational possibilities, and are key elements in the value of scenic resources. Floodplains provide fertile farming soils, and are also valuable in attenuating damaging floods. Wetlands are well-known for diverse wildlife habitat values, flood storage, and water filtering values. All of these aspects of Warner's water resources are considered in this NRI.

Surface Water & Shoreline

Warner's principal surface water feature is the Warner River. Entering town from Sutton, it flows southeasterly for 11.5 miles before exiting into Webster. The principal tributaries of the Warner River are the Lane River and Stevens Brook flowing out of Sutton, Meadow Brook, French Brook, Willow Brook, and Frazier Brook flowing south from the Mt. Kearsarge high terrain; Schoodac Brook draining Lake Winnepocket in Webster; and Slaughter Brook, Davis Brook, Silver Brook, and Bartlett Brook draining northwards from the Mink Hills range. These perennial streams, and a few others not named, total nearly 50 miles[5] of tributary waters flowing into the Warner River. The water quality directly affects the Warner River and its natural resource values.

In contrast to the brooks flowing out of the steep terrain to the north and south, the Warner River is a low-energy, slow-moving water body over much of its course, typical of glacial outwash plains in New Hampshire. In the western half of the town above Warner village, the river is typically faster, with short rapids and riffles on stone bottoms and slower flatwater stretches between. In the eastern half of the river, the river meanders back and forth across its floodplain, creating low-lying wet areas where bends in the river have been cut off by new channels. Both the rapids and riffles, and the backwaters and floodplain swamps, are important water features, especially in terms of wildlife habitat, and are therefore of special value in conservation planning.

Warner also contains several small lakes and ponds including: Simmons Pond in the extreme northwest corner of town -- an undeveloped pond known as an excellent trout fishery; Bagley Pond and Meadow Pond in the east-central portion of town; Pleasant Pond and Tom Pond in the southeast where the Warner Rive leaves the town; and Cunningham and Bear Ponds in the Mink Hills. Bear Pond is the largest of these at 48 acres, whereas the average size is about 21 acres.

Riparian & Shoreland Zones

Stream networks and shoreline areas function as critical wildlife corridors and/or serve a number of habitat functions for wildlife. Shorelines offer multiple human benefits as well, including aesthetic enjoyment and recreational activities. The Warner River has approximately 23 miles of shoreline

[5] Calculated from the USGS National Hydrography Dataset, 2006.

within the town. The seven ponds mentioned above contribute another 50,000 feet of shoreline, with the being about 4,500 feet per pond. Land use and development within 250 feet of these shoreline areas is regulated by the Comprehensive Shoreland Protection Act in New Hampshire [6].

For this study, a riparian and shoreland buffer zone has been established around all perennial watercourses (brooks, streams, rivers) as well as ponds and lakes. The buffer zone extends 300 feet on both sides of a stream, or back from shorelines along rivers, lakes and ponds. This distance is well established in the scientific literature as a sound working minimum distance within which natural land cover should be maintained in order to effectively function as a wildlife corridor, maintain habitat quality, and act as a filter for soil erosion and stream sedimentation.

Warner has about 5,400 acres of riparian buffer zone along its streams and watercourse, and 1,250 acres of shoreland buffer zone around ponds and lakes. Nearly 1,450 acres of riparian zone (27%), and 386 acres of shoreland buffers (31%) are currently protected. Given the well-documented and critical role of these buffers in protecting water quality, more protection is warranted.

Floodplains

The western half of the Warner River floodplain is tightly defined and limited by rising terrain to the north and south. In the eastern half of town, the floodplain spreads widely as it transitions on to the sandy outwash plain in Davisville. There are actually two floodplains in the eastern valley: one which spans the entire valley and dates to a time when the river was much larger during the retreat of the last continental ice sheet, and today's current floodplain which is much smaller and closer to the river. Schoodac Brook also represents a significant floodplain feature in the town, due more to its flat terrain and backwater tributary status than to its watershed. A similar floodplain feature also connects Tucker Pond in Webster with the Warner River across flat terrain but with no mapped brook.

The Federal Emergency Management Agency (FEMA) has mapped the typical extent of expected river flooding as a "100-year floodplain" (Zones A and AE in the map). This means there is a 1% chance in any year that a flood will cover the mapped zone. Although the chance of flooding may seem small, the risk to property and life is real, and prudent community planning will seek to limit the land uses within such a flood zone. The fact that the Warner River's headwaters and tributaries drain large upstream watersheds, some of which are steep and rocky, means that floods will tend to be significant, of high-volume, and fast-rising during severe storm events. The recent increase in severe storm events in New England should also be a cause for concern.

There are about 2,200 acres of mapped floodplain in Warner, of which only 545 acres, or about 25% are protected. As with riparian and shoreland buffer zones, the critical role of floodplains warrants additional consideration for land protection.

Wetlands

[6] The NH Comprehensive Shoreland Protection Act (CSPA), RSA 483-B, became effective 7/1/94 and established the "protected shoreland." The protected shoreland is all the land located within 250 feet of the "reference line" of public waters. The CSPA was recently updated with more stringent regulations, and will become effective July 1, 2008. For details, refer to the document *NHDES_CSPA_RSA483-B.pdf* in the project's Metadata folder.

Currently, the primary data source for wetlands mapping is the National Wetlands Inventory (NWI). It is based on delineations completed by the US Fish and Wildlife Service using aerial photography. While some minor inaccuracies are known to exist in these data, they continue to serve as the baseline reference in locating wetlands. NWI maps contain only those wetlands visible on aerial photography. Additional jurisdictional wetlands can be found by including areas of poorly- and very poorly-drained soils (hydric soils).

The map at the right shows wetlands in blue and hydric soils in greenish-brown. Note that NWI mapping includes ponds and lakes. Warner contains approximately 3,890 acres of combined wetlands, representing 11% of the town's total area. Only 18% of these wetlands and hydric soils are currently protected.

Further discussion on significant wetlands mapped as habitat complexes and features can be found in the *NH Wildlife Action Plan* in **Section III** below.

Sand & Gravel Aquifer

An extensive aquifer of sand an gravel layers known as a stratified drift formation underlies the entire Warner River and Schoodac Brook floodplains. These formations are important statewide groundwater resources, supplying much of the municipal drinking water to the 800,000 people who depend on public water supplies.

Warner contains nearly 4,525 acres of sand and gravel aquifer, representing 12% of the town's total land area. While this is a significant fraction compared to many other upland NH communities, a large portion has already been disturbed as historical settlement patterns and more recent growth trends have typically utilized the Warner River valley. This development, including more than 8 miles of the Interstate 89 corridor, the village district itself, and the Intervale commercial district at the Exit 9 interchange, has disturbed the aquifer's natural state and increased it susceptibility to adverse water quality impacts.

Of the 4,525 acres of aquifer, around 81% of that area is classed as potentially low yield, or marginally suitable for municipal water supply development. That leaves 525 acres of higher yielding aquifer. However, that portion of the aquifer functions as primary recharge zone for the higher yielding areas of the aquifer, generally located in deeper "pools" within the aquifer structure.

Only limited areas within an aquifer are appropriate for the development of public water supplies due to land use constraints and contamination risks. NHDES identifies these areas as "favorable gravel well sites". While Warner's aquifer zone is sizeable, the actual area potentially suitable for future water supply development is only 540 acres, or about 12% of the total aquifer surface area. As development proceeds on or near the aquifer, the area for future water supply will be further diminished.

The map at left shows the aquifer with darker colors indicating more groundwater availability. The small red areas are the remaining favorable gravel well sites and orange indicates untested potential well sites.

Very little of Warner's groundwater resources are currently protected. A little more than 490 acres (11%) of the total aquifer area, and only 70 acres (13%) within the area designated suitable for municipal water supply development are now protected. Of particular importance to the future is a 157-acre high-yield aquifer associated with Tom Pond in the southeast portion of town. Less than half of its total surface area, and less than half of the 17.5 acres NHDES determined suitable for future municipal wells are currently protected.

Development on the aquifer, or within its immediate recharge zone has the potential to degrade water quality through contamination or reduce water availability through rapid runoff and diminished infiltration into the aquifer. Therefore, protection of these potential well sites should be a priority in the community's conservation plan.

Water Supply Infrastructure

Fourteen public water supply protection areas are recognized by NHDES within the town. Six areas are the community water sources listed below:

- Contoocook Village Precinct surface water intake on Bear Pond, serving 1600 persons;
- Two wells on Chemical Road near the Warner River west of the village district, serving 500 persons in the Warner Village Water District; and,
- Three wellheads serving 163 persons in the Pleasant Lake Mobile Home Park.

Several other sites serving the public also exist in town, including two wells at Magdalen College serving 80 persons, a well at the Southworth Milton, Inc. facility serving 40 persons, and a well at Rollins State Park capable of serving 100 persons. In addition, NH OEP data show more than 1,150 households in the town, most of which depend upon private wells.

Each of these public water supply protection areas has an officially delineated protection zone around its wellhead(s), as well as a smaller sanitary radius. It is important to note here that the best way to protect aquifer quality is to maximize the natural land cover within these protection areas.

By far Warner's most important water resources are the Village District water supply wells located along the Warner River (see map to right). These high-yield gravel wells lie in the sand and gravel aquifer along the river, and have a large, 655-acre drinking water protection zone delineated by NHDES to signal the need to protect the area up-aquifer affected by the well intake operation. Only 25 acres, or less than 4% of that area is currently town-owned or permanently protected. Because this area is situated between I-89 and village center, and is only three-quarters of a mile down-gradient from the commercial center at Exit 9, its protection should be a top priority of the town.

Similarly, the surface water intake at Bear Pond is important to the town of Hopkinton. While no NHDES protection zone has been delineated there, much of the land in the watershed feeding the

reservoir is now protected by the Contoocook village district and other conservation easements in the vicinity.

A reduced version of the full-sized composite map of town water resources follows on the next page.

INSERT WATER RESOURCES MAP HERE

IV. WILDLIFE HABITAT

Introduction

When Planning the Warner NRI, specific GIS-based plant and animal habitat data were unavailable. Therefore, it was proposed to evaluate Warner's wildlife habitat by analyzing those basic structural environmental factors important to wildlife such as: large forest blocks, riparian corridors, wetlands, and steep slope areas. Since then, however, a great deal of statewide information became available when the NH Fish and Game Department released its Wildlife Action Plan (WAP) in August, 2006 [7].

The sections that follow briefly describe the major working components of the WAP that are of use to the Warner NRI, including habitat types, regional scale habitat quality rankings, and conservation focus areas of statewide importance to the WAP. The adaptation of the new WAP data to this NRI is then discussed.

WAP Habitat Types

The WAP identifies nineteen different habitat types statewide, some of them common and some extremely rare. Of the nineteen, Warner is home to eight habitat types of special note, as well as one forest habitat type that is common and widespread in New Hampshire. The eight special habitat types are distributed fairly evenly around the town, depending on topography or elevation in some cases, or are concentrated within the Warner River valley.

The special habitats cover about 12,220 acres, or 34% of Warner's land base. The breakdown of acreages and percent land area for each habitat type can be found in **Table 2** below. Thanks to decades of extensive land protection by the state and the town, about 36% of Warner's special WAP habitat types are protected, although gaps remain as discussed in the summary below on habitat protection status.

It is important to note that the habitat features developed by the WAP and used in this study are predictive, and may not reflect actual on-the-ground features. The reason for this is that the modeling processes used in the WAP draw on many natural resource factors – soils, slope, solar aspect, vegetation, etc. – to identify those areas with high potential to harbor the types of habitats mapped. In most cases, the natural communities indicative of the habitats will actually be found in those locations; however, the exact extent and distribution of patches may not match existing field conditions. Only careful field reconnaissance can determine the actual location and extent of natural communities and habitat features, and this was not within the practical scope of the WAP. On the other hand, natural resource inventories and town conservation plans can and often do invest in this level of detail.

Brief descriptions of the nine habitat types follow, in rank order of total acreage in Warner[8]:

[7] Refer to the N.H. Wildlife Action Plan report for details on this plan. See Metadata directory in NRI project CD.
[8] Descriptions adapted from the WAP publication *One Granite State, Many Habitat Types*, 2006.

Hemlock/Hardwood/Pine Forest: This forest is the most widely distributed forest type in N.H., covering nearly 50% of the state, and nearly 2/3's of the town. These forests are transitional, occurring between hardwood/conifer to the north and at higher elevations, and oak/pine forests typical in the south. It is common on dry, sandy soils with red oak and white pine.

Note: Since this forest type functions as an extensive matrix habitat type found throughout the town, it has not been selected for NRI mapping and habitat analysis; however, all of the following habitat types are included in the wildlife co-occurrence mapping, discussed further along in this report.

Appalachian/Oak Forest: These forests are found mostly below 900' elevation in southern N.H., and include oak, hickory, and sugar maple on nutrient-poor, dry sandy soils. Warner's generally lower elevations in the river valley leading north from the Contoocook and Merrimack River basins foster this forest type at its northernmost range. This forest type has been dramatically reduced in southern N.H. due to development pressures, and so is of special concern in conservation.

Northern Hardwood/Conifer Forest: This habitat type is usually found between 1,400' and 2,500' in elevation, and is comprised mainly of beech, sugar maple and yellow birch. It is home to several threatened and/or endangered species. This forest is found on the slopes of Mt. Kearsarge and in the higher points of the Mink Hills range.

Lowland Spruce/Fir Forest: This habitat system is a mosaic of lowland spruce-fir forest and red spruce swamp communities. Although covering only 10% of the state, these forests are home to more than 100 vertebrate species in N.H. Warner has a little more than 1,000 acres of this forest type on the mid-slopes of Mt. Kearsarge and high ground in the Mink Hills.

Floodplain Forest Complexes: Floodplain forests occur in valleys adjacent to river channels, are prone to periodic flooding, and support diverse natural communities. They also protect and enhance water quality by filtering and sequestering pollution and erosion sediments. Extensive floodplain forest communities exist along the Warner River east of the village.

Marsh Complexes: Emergent marsh, wet meadows and shrub swamp systems are important food sources for many species, and perform many flood control and water quality services. These complexes are found along the Warner River and upland stream tributaries in town.

Grasslands: Grasslands are dominated by grasses, wildflowers, and sedges with little or no shrub or tree cover. Warner's many hayfields, pastures, and croplands all are considered as grassland habitat. Grasslands account for only 4% of New Hampshire's land base, and are a habitat type of special concern statewide.

Note: This dataset is not taken from the WAP data library; rather, it is the product of mapping and delineation by WCC volunteers, and is therefore taken to be much more accurate.

High Elevation Spruce/Fir Forest: These forests are found between 2,500' and 3,500' in elevation on upper mountain slopes and ridge tops. Tree species include red spruce, balsam fir, and heartleaf, paper, and yellow birches, all adapted to harsh climatic extremes and erosive soils found in these

habitats, which represent only 4% of the state's land area. In Warner, this community is found only on the high elevation slopes of Mt. Kearsarge.

Peatland Complexes: Peatlands have water with low nutrient content and higher acidity cause by limited runoff and groundwater input. Eleven different natural communities are associated with peatlands. Several small peatlands occur in central Warner, and in association with the lowlands along Schoodac Brook and the Warner River in the southeast.

These habitat features are mapped with other data in a large format reference map displayed in page size at the end of this section. They are also used in the ***wildlife co-occurrence model*** discussed below.

Habitat Type Protection Status

Table 2 below summarizes the extent of each of the WAP habitat types described above, its share of Warner's land base, and the acres and percent of each type presently protected. Some habitat types are very well protected, as with the high elevation and lowland spruce/fir component. Although small in land area, the northern hardwood/conifer forest is reasonably well protected at 74%. The same might be said of the hemlock/hardwood/pine forest that covers 2/3's of the town. Good progress has also been made in protecting the marsh complexes and grasslands in town, but more protection is probably warranted given their scarcity. The floodplain communities are fairly extensive in acreage, but not well protected, and the peatlands while a tiny proportion of the town's land area are scarcely protected.

Table 2

Regional Scale Habitat

The WAP also evaluated habitat resources and condition at landscape scale to develop a statewide and regional ranking, and to identify the highest condition habitat relative to all instances of a given habitat type in the state. The results of this analysis provide regional and local conservation planners a means to identify the most critical wildlife habitat locations. Tiers of habitat quality were assigned based on an intensive statewide analysis, as follows:

- **Tier 1** rating was given to areas that contain the highest condition habitat in the state.

- **Tier 2** areas contain the highest condition rank in the biological region (defined by eco-region for terrestrial habitats, and watershed for wetland and aquatic habitats.)

- **Tier 3** includes supporting landscapes such as watersheds containing top-ranked stream networks and lakes, large forest blocks, or specific animal, plant and natural community occurrences of special note.

Warner enjoys an abundance of Tier 1 rated wildlife habitat, totaling more than 21,200 acres of land throughout the town and including the floodplain communities noted above. As can be seen in the map to the left, these Tier 1 lands are very extensive, ranging well into neighboring Salisbury, Andover, Henniker and Bradford, and unusual in both size and integrity compared to more southerly communities. There are many reasons for this designation, but chief among them are the very large forest blocks surrounding Mt. Kearsarge and the Mink Hills Range. The high-ranked aquatic habitats (see next section) also contribute to the Tier 1 status, and this is again due to the presence of the unbroken forest cover.

About 25% of this Tier 1 habitat is currently protected, mainly in the Mink Hills range and on town lands along Stevens Brook.

Tier 2 habitat occurs mainly on the high elevation areas of Mt. Kearsarge and the Mink Hills. It is associated with the spruce/fir forests and the northern hardwood/conifer forests. At slightly more than 3,000 acres, it represents only about 10% of the town's land area, but is currently 72% protected, thanks to Rollins State Park and extensive ongoing land protection in the Mink Hills.

Warner contains about 4,700 acres of Tier 3 supporting landscape. It is generally scattered in small areas throughout the Tier 1 habitat, with one large concentration located along the Webster town line. This important buffer and connecting habitat is only about 25% protected, with virtually no protection in the largest occurrences in the southeast.

Aquatic Habitat Rankings

Aquatic habitats, including lakes, ponds, stream networks, and rivers, are also mapped by the WAP in a manner similar to the habitat quality mapping described above. Since the health of those features depends largely on conditions in surrounding uplands, riparian corridors and entire watersheds of critical importance are also mapped. The quality of these aquatic habitats is based on degree of development, road density and other environment factors, and also includes a rating for the habitat requirements of fish, mussels, and aquatic birds.

Warner contains two areas of important aquatic habitat, one ranked Tier 1 (best in state) in the extreme northern area of the Mt. Kearsarge "gore", and the other ranked Tier 2 (best in bio-region) on the south-facing flanks of the Mink Hills. Both encompass large, entire watersheds of 32,275 and 13,125 acres respectively. Only 1,480 acres of the Tier 1 habitat extends into the town, but the Tier 2 aquatic system overlaps into Warner by 4,975 acres, or about 40% of that watershed. The Tier 1

stream network flows to the Blackwater River via Mill Brook in Salisbury and Bagley Lake in Andover. The Tier 2 aquatic system includes Day Pond, Cunningham Pond, and Bear Pond, in addition to Warner Brook and Amey Brook flowing into the Contoocook River. Currently, 805 of Warner's Tier 1 aquatic habitat and 42% of its Tier 2 aquatic habitat are currently under protection.

WAP Conservation Focus Areas

Further analysis of overlapping habitat types and habitat condition mapping has been done by the WAP to identify conservation focus areas (CFA) statewide. CFAs are places where a number of high-ranked terrestrial and aquatic habitats can be found overlapping in relatively small areas. Because conservation focus areas have the greatest concentration of high-ranked habitats in one place, they can support the highest number of wildlife species. Another way of viewing CFA is that they represent the "best of the best" habitat conditions on a statewide scale.

Warner contains portions of two very large CFAs mapped by WAP and extending beyond the town's boundaries. It also contains three other very small CFAs within the town.. The two largest are associated with the east flank of Mt. Kearsarge and the south flank of the Mink Hills range. Both are closely related to the aquatic habitats discussed above. The northerly CFA contains nearly 20,000 acres, of which only 320 acres are located in Warner. The southerly CFA contains 7,650 acres and 3,500 are located in Warner. The three smaller CFA range from 30 to 50 acres in size. All are associated with important marsh wetlands; one within the Warner Town Forest along Stevens Brook, another on the east boundary with Webster, and the third in the eastern Mink Hill range above Iron Kettle and Joppa Roads.

The CFA in the Kearsarge gore is 92% protected, but the companion focus area in the Mink Hills is only 37% protected, about 1,300 acres. Or the three smaller CFAs, the town forest protects one in its entirety, the wetlands along the Webster boundary are about 2/3s protected, and the 30-acre tract in the east Mink Hills is not protected at all. *Further research into the critical features within each CFA and the modeling process that together work to rate the area highly can be done using WAP data, but is not within the scope of this study.*

Adapting WAP to the Warner NRI

An analysis was made of the various wildlife habitat factors originally selected for use in the Warner NRI, and recommendations were made by Forest Society staff for an updated suite of resource factors to be considered in the NRI. **Table 3** outlines the crosswalk between the old and the new list of factors, some of which are the same in both lists.

Table 3

Original NRI Scope Items	Updated Scope Items
Forest cover type from GRANIT land cover data	Substitute unique forest cover types from WAP > High elevation spruce-fir > Lowland spruce-fir > Appalachian oak-pine > Northern hardwood-conifer
Agricultural lands	Substitute ag fields mapped by WCC > More precise than WAP grasslands
Composite wetlands (NWI+hydric soils)	Composite wetlands (NWI+hydric soils)
Priority wetlands (large, important)	Substitute WAP data > Marsh complexes >250 acres > Peatland complexes >250 acres
Hydrography (Lakes, ponds, rivers, streams)	Hydrography > Add WAP T1 & T2 watersheds as priority
Riparian corridors & shorelands (300' buffer)	Riparian corridors & shorelands (300' buffer) > Double count WAP riparian networks (T1 & T2)
South-facing slopes >10% (SE to WSW)	South-facing slopes >10% (SE to WSW)
Slopes >25%	Slopes >25%
Unfragmented forest blocks (by acres class)	Substitute WAP block data > Tier 1, Tier 2, Unranked
Natural communities	Use WAP habitat types, eg, floodplain communities

Wildlife Co-Occurrence Map

After a careful review of the wildlife habitat data available for mapping, the WCC selected a list of (20) factors to consider in the NRI. **Table 4** below describes the data layers selected. Note that additional information about each ***data layer*** is also described in more detail in earlier sections of this report.

In order to identify priority wildlife habitat conservation areas in Warner, two approaches were taken to integrate the various data available. One approach was to simply map all the data factors to learn where the greatest co-incidence of habitat-related features occurred in town. The other approach invested in a weighted co-occurrence model that attributed relative importance values to the data factors. Each approach has its own values, and is discussed below.

Table 4

Category	Classification or Factor
Forest Blocks	
	100 - 300 acres
	300 - 950 acres
	950 - 3,000 acres
	3,000 - 10,000 acres
	>10,000 acres
WAP Habitat Features	
	High Elevation Spruce/Fir Forest
	Lowland Spruce/Fir Forest
	Northern Hardwood/Conifer Forest
	Floodplain Complexes >500 acres
	Marsh Complexes >250 acres

	Peatland Complexes >250 acres
	Grasslands & Meadows
WAP Tier 1 & 2 Aquatic Habitats	
	WAP Tier 1 Watercourses
	WAP Tier 2 Watercourses
	WAP Tier 1 Watersheds
	WAP Tier 2 Watersheds
Other Habitat Features	
	NWI Wetlands & Hydric Soils
	Riparian & Shoreland Buffer Zones (300')
	Southfacing Slopes
	Steep Slopes >25%

Co-Incidence Model

This model assigns equal value to each data factor or layer. Each layer representing a particular data factor from the table above is converted in the GIS to a grid with a cell resolution of 30 meters (about a quarter acre in size). The grids are then spatially superimposed with each other, so that all locations align. as in the diagram at the right. Each cell is given a value of (1), and then all the factors are added together layer by layer in the GIS to arrive at an arithmetic sum of the value of all cells co-incident in each grid. The result is displayed as a color gradient where light hues represent the lowest number of co-incident factors and dark hues represent the highest. See map next page.

It is important to note that this map shows only where more or fewer habitat factors overlay one another, based on the list of factors above. No importance values are ascribed to any data layer. Thus, the map is most useful as a starting point in looking for concentrations of habitat features at community scale. The highest possible number of co-incident factors is 8 from the total of 20.

The highest levels of co-incidence are found in the Mink Hills range and on the Mt. Kearsarge high ground. This is a result of several spatially-extensive data layers (e.g., large forest blocks, WAP Tier 1 and 2 watersheds, and steep and south-facing slopes) overlaying each another, together with a certain amount of double-counting, as might occur when riparian and shoreland buffers are counted together with a similar resource such as WAP stream networks.

Co-Occurrence Model

A ***co-occurrence model*** is quite similar to the co-incidence model above with one exception: instead of being considered equally, each data layer is assigned a weigh reflecting its relative importance. The GIS model then uses the methods outlined above to tabulate scores, but the results are skewed towards the expressed preferences.

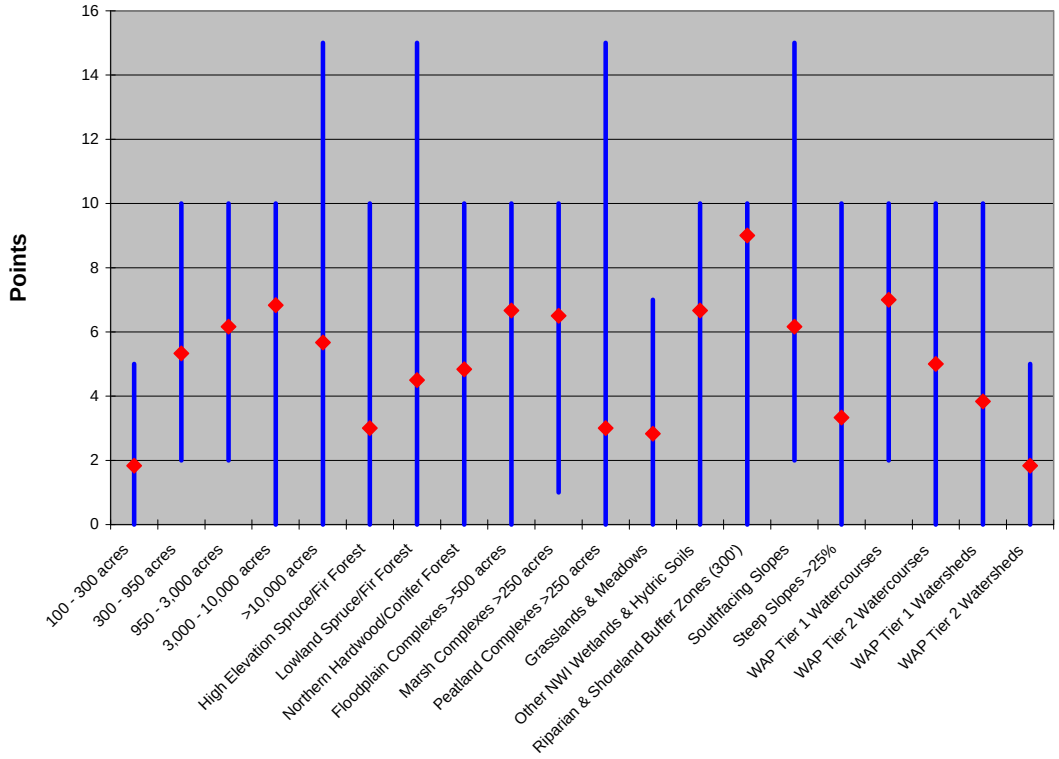
Therefore, determining the weighted values is an important process. In some co-occurrence models, a team of scientific experts rates and ranks each factor, with an emphasis on mathematic modeling and statistical analysis. Because public involvement and the planning process are important, as with the Warner NRI, a "shared vision" of relative values may be generated by means of a Delphi process

of voting and group consensus-building. This latter method was used in the development of the Warner wildlife habitat co-occurrence map.

The process is simple once the ground rules are understood. First, the group, in this case the WCC, discusses the list of data layers to be rated; this is to be sure that everyone agrees that what needs to be on the list is there, and that everyone understands the information displayed in the mapping process. Then the group engages in anonymous voting to distribute a budget of 100 points across the data layers in the list, according to their own sense of relative worth and importance to conservation planning. The individual votes are pooled and summarized, ideally by a neutral third party – in this case, Forest Society staff. A mean (average) value is calculated for each data layer, and fed into the GIS model to produce a first-run co-occurrence map.

At this point, the group has an opportunity to review the anonymous vote/value range, and the resulting map. Questions or comments can be posed that serve to clarify each person's understanding of the result of the first-round voting. The point of the anonymous voting is to eliminate the usual group dynamic where the most skilled debater wins the point. The results are not intended to be debated. Each participant then has a second chance to vote, perhaps shifting points with better understanding or changed view-of-point. With the Delphi process, consensus is usually reached in two rounds of voting.

The mean values (red pips) and the high-low range (blue bars) of votes used for this study are shown in the chart below. Habitat factors are grouped by forest blocks, then individual WAP/WCC habitat features, and finally the WAP Tier 1 and 2 watersheds and watercourse. As can be seen, the WCC has emphasized aquatic resources in its collective voting. The top two vote-getters are riparian and shoreland buffer zones and WAP Tier 1 water courses, followed by WAP floodplain natural communities, NWI wetlands, and WAP marsh complexes. Large forest blocks 3,000 to 10,000 acres in size ranked third. On the other end of the scale, habitat factors such as small forest blocks, grasslands, peatlands and steep slopes evidently hold less overall value to the group.



Wildlife Habitat Factor Weighting

The map to the left displays the results of the voting. Note that in this map the data is clipped to the municipal boundary of the town to eliminate the effect of grid cells outside the town's purview. There are many ways to display the range of values in such maps; the co-incidence map above is a simple graded color scheme. The data in this map are classified along a color gradient of continuous value, i.e., high to low. Conservation and public land is overlaid on the value gradient to show protection status. It is interesting to note that in certain places, such as the Mt. Kearsarge "gore", high scores appear but the level of protection is already relatively high. In contrast, although it is protected, the 1,425 acre Chandler Reservation in the Mink Hills range, does not exhibit high values. That does not mean there are no conservation or wildlife habitat values within the Chandler Reservation; what we see in the map is merely a reflection of how the WCC decided to assign relative values to the factors considered in this study.

Another way present the same data is by classification according to standard deviation. This is a statistical technique translated into the GIS that shows the *average value* of all data, as well as the lowest values and the highest values, represented with a two-color gradient. The average value here is ~11.0, within a range of 0 to 46 points. The higher the scores rise, though, the fewer grid cells occur, so the average is driven down. As can be seen, the orange color gradient represents the above average scores across all 20 datalayers, while the gray tones descend down to the lowest scores. White in this map equal a "0" score. This map is useful to quickly identify where the "best of the best" resources are found, and how well they are protected.

Interpretation

This voting appears consistent in terms of group-assigned values in two areas: the forest blocks classifications, and the WAP watershed/watercourse tiers. In the first dataset, the value trend places more weight on the largest forest blocks with significant occurrence in town; the very largest blocks only partially overlap into the town. In the WAP dataset, more emphasis is given to the watercourses (stream network), than the watershed, and both rate Tier 1 higher than Tier 2. The group may wish to revisit the WAP voting, however, since so little land area of Tier 1 exists in the town, and much of it is already protected.

Some limited inconsistencies can be noted in the ranking of WAP habitat features. For example, floodplain communities and NWI wetlands/hydric soils were rated high, but peatlands were rated low. This might be explained by the scarcity of peatlands in town, but scarcity also indicates rarity, so the importance of this feature may need be reconsidered. Steep slopes and south-facing slopes are separated by six steps in the list of factors, and ~ 3 points in the numerical values. Since steep, south-facing slopes represent good denning and sunning sites for wildlife, the strength of the two factors might also need to be reconsidered. Finally, it is worth noting that grasslands and meadows as a habitat feature are scarce statewide – totaling only about 4% of the state's land area and *only 1.6% of the town's land area*. Thus, the WCC might also want to rethink the value of this special habitat.

See reduced version of the full-sized wildlife co-occurrence map on next page.

INSERT WILDLIFE CO-OCCURRENCE MAP HERE

V. SCENIC RESOURCES

Introduction

Scenic assessments are often thought of as subjective (beauty is in the eye of the beholder), and thus not compatible with the typical suite of natural resources that are mapped, measured, and evaluated in most natural resource inventories. However, to the extent that our experience of place, and therefore our quality of life, depends upon the physical features of the land – the forests, hills, lakes, ponds, and wildlife – aesthetic considerations are strongly linked to conservation.

The key point is that the natural landscape features and the terrain of Warner are dramatic in and of themselves. The valley of the Warner River contrasts sharply with the rising topography on either side of the valley, lending a strong, structural "sense of place" to the town, especially with Mt. Kearsarge anchoring the view to the north, and the Mink Hills range defining the southern reaches of the town. In the center of it all is the village district with its historic character and charm.

This type of well-defined but spatially complex landscape is relatively uncommon in New Hampshire, and thus represents a visual resource that has value beyond the town itself. It is shared by neighboring towns and travelers alike. Imagine the Warner River valley in without its river or its village center. Something vital is lost in the experience and quality of the place. Fill the valley with developed land uses, and Warner becomes something different.

In contrast, the forested slopes of the valley provide a very definite containment of the valley that is wild and unsettled, thus magnifying the contrast. The skyline ridges to the south are especially important scenic resources to the town. Imagine these ridgelines and slopes with extensive new residential development, and the sense of Warner again changes.

Therefore, in setting conservation goals for the town, development of the valley floor and the valley walls is as important as considering the need to protect water quality or wildlife habitat.

Methods

The Warner NRI scenic resources assessment was conducted as a team effort between members of the Warner CC, the community, and the Forest Society. Based on a proven GIS methodology used in other NRI efforts in N.H., volunteers were provided with base maps of the town upon which to record important viewpoints and vistas, including the direction and azimuth limits of each view. These points were typically found along town roads where open lands allow a vista. Key locations along I-89 and Route 103, around Exit 9, and along the shore of key water bodies were also recorded.

A database of approximately 90 points was thus developed, which was then fed into a GIS modeling routine that determined those "viewsheds" in the town that shared the most viewpoints. This model used a digital elevation model to calculate what could and could not be seen by line of sight from each viewpoint. Note that this was done without regard to vegetation, which screens or sometimes filters views. To a great extent, the selection of the viewpoint on the ground and determination of the azimuth (viewing angle) compensated for the raw elevation data.

Designated scenic roads in Warner, and important foreground areas associated with hay meadows and other open lands were also mapped and comprise many of the 90 viewpoints.

Before the GIS model was run, the WCC volunteers painstakingly rated each of the viewpoints using an elaborate evaluation model adapted by WCC from Vermont Cultural By-ways program. A brief synopsis of the criteria and method can be found in **Appendix C**, but since the report is sizeable the entire rating scheme and viewpoint data is not included. A full copy may be requested from the WCC; a tabular summary of viewpoint value ratings is also found on the large format maps produced as part of this project.

The net result was a co-occurrence map similar to the one described for the wildlife habitat factors above. The darker colors show those places in town that are viewed from multiple viewpoints, and are thus more important to preserve from the standpoint of scenic quality. Two key areas stand out: the north-facing slopes of the Mink Hills range obviously serve as an important backdrop for many views whether in the valley or on the rising terrain north of the village district; and, Kearsarge Mountain Road following the ridge up to Mt. Kearsarge. A few other smaller areas of shared views also seem important. One is the undeveloped land on the northwest quarter of Exit 9 interchange on I-89. Another is an unnamed hill in a bend of the Warner River, just south of Morse Loop, as well as a series of smaller hills stringing west along Route 103.

See reduced versions of full-sized maps on scenic resources on next page. In the viewshed map, the darker brown color tones indicate areas in town that are viewed from more locations, and thus share the viewshed. The parcel rating map assigns relative scenic resource values to land ownership parcels, based on the viewshed modeling.

INSERT SCENIC VIEWSHED MAP HERE

INSERT SCENIC PARCELS MAP HERE

VI. RECOMMENDATIONS

It should be clear from the results of this NRI study presented here that Warner possesses abundant and diverse natural resources that contribute significantly to both the ecological richness and health of the town, as well as socially to its quality of life for its townspeople. This NRI is not and should not be viewed as a conservation plan of action. Rather, it is an encyclopedia of information based on the best currently available data, with a measure of interpretation and some initial recommendations about what is important to conserve. The NRI is really a baseline characterization, and a beginning in what should be an ongoing process of updating and refinements. More work lies ahead for both the Warner CC, and the planning board in town.

Next Steps

1. A commitment should be made to transforming the NRI information and interpretation into a policy-related, strategic conservation plan for the town. This work would include, but not be limited to:

- Refining selected data, e.g., the WAP natural community delineations that are based on potential, not actual existence of habitat.
- Developing a more precise list of key factors to be included in a conservation plan; for example, historical and cultural features not included in the NRI, by definition.
- Broadening the stakeholder group beyond the WCC to include representatives from other boards in town, as well as knowledgeable professionals and persons with special information to bring into the discussion.
- Generate a true, "shared vision" of the town's conservation plan by using a facilitated consensus-building process to assign relative importance values to key factors, as with the wildlife co-occurrence mapping exercise described above. This will serve to integrate all data into a single "road map" for conservation, including work already done on forest and agricultural resources, and the scenic assessment.
- Analyze the results of the master resource co-occurrence mapping quantitatively and qualitatively to identify the highest-value conservation focus areas in town in which to move forward to protect land with scarce dollars.
- Investigate opportunities to enhance connectivity among key natural areas and along riparian and shoreland corridors.

2. A well-crafted public information plan will be needed to keep townspeople apprised of the planning process, opportunities to become involved or learn more about the plan, and most important, to interpret and build voter support for the strategies within the plan. This work would include, at a minimum:

- Announcement and notice of the commitment to create the conservation plan in various local media, including the town website.
- Periodic public information sessions to allow people to enter into the planning process along the way.
- Means of contacting key WCC members and/or volunteers in the stakeholder group to get questions answered.

- Collaborative, joint sessions with the WCC and the Warner Planning Board, especially as action items emerge in the planning process that need to be reflected in town land use regulations.
- Maps and posters displayed at Town Hall for convenient viewing, and electronically on the town website.

End

Appendix A: Summary statistics on natural resources

Summary of Statistics for Key Natural Resources in the Town of Warner, November 2008				
Natural Resource Factor	**Acres in Warner**	**Percent Warner Land Base**	**Acres Protected**	**Percent Protected**
Forest Cover	31,500	89.8%	8,800	27.9%
Forest Blocks 100 - 314 acres	1,075	3.1%	0	0.0%
Forest Blocks 314 - 940 acres	5,225	14.9%	522	10.0%
Forest Blocks 940 - 3,014 acres	3,718	10.6%	646	17.4%
Forest Blocks 3,014 - 10,217 acres	5,337	15.2%	1,707	32.0%
Forest Blocks >10,217	13,962	39.8%	5,774	41.4%
(See text for acre classification method)				
Productive Forest Soils				
1A Soils -- Prime Northern Hardwoods Sites	8,571	24.4%	1,448	16.9%
1B Soils -- Prime Red Oak Sites	16,114	45.9%	5,150	32.0%
1C Soils -- Prime White Pine Sites	2,339	6.7%	221	9.4%
Agriculture				
Prime Agricultural Soils	280	0.8%	12	4.3%
Soils of Statewide Importance to Agriculture	879	2.5%	89	10.1%
Active Farmland	573	1.6%	145	25.3%
Water Resources				
Wetlands & Hydric Soils	3,872	11.0%	685	17.7%
Riparian Buffers	5,356	15.3%	1,449	27.1%
Shoreland Buffers	1,247	3.6%	386	31.0%
Floodplains	2,188	6.2%	545	24.9%
Aquifers	4,525	12.9%	490	10.8%
Favorable Municipal Well Sites in Aquifers	540	1.5%	70	13.0%
DES Drinking Water Protection Area	655	1.9%	25	3.8%
Wildlife Habitat				
WAP Tier 1: Highest Ranked Statewide	21,216	60.5%	5,377	25.3%
WAP Tier 3: Highest Ranked in Bio-region	3,061	8.7%	2,215	72.4%
WAP Tier 3: Supporting Landscape	4,798	13.7%	1,218	25.4%
Special Habitats				
Appalachian Oak/Pine Forest	5,699	16.2%	809	14.2%
Northern Hardwood/Conifer Forest	2,620	7.5%	1948	74.4%
Lowland Spruce/Fir Forest	1,069	3.0%	1002	93.7%
Floodplain Communities	1,057	3.0%	158	14.9%
Marsh Complexes	875	2.5%	208	23.8%
Grassland and Meadows	574	1.6%	145	25.3%
High Elevation Spruce/fir Forest	161	0.5%	161	100.0%
Peatland Complexes	127	0.4%	9	7.1%
Total of Special Habitats	12,182	34.7%	4,440	36.4%

Appendix B: GIS Methodology & Data Sources

The methodology behind this project relied to a great extent on the tremendous power and capability of GIS to develop important new datasets and for carrying out the mapping and analysis described in this report. GIS, short for Geographic Information System, is a powerful computer-based system for creating, manipulating, analyzing, and displaying spatial data.

The Forest Society began a formal research program and started to build a computer based GIS in the mid-1990s to enhance its land protection efforts with scientific data and analysis. Much of the work has been in providing hard evidence to support the Forest Society's policy initiatives, which have led to public-funded, state land protection programs such as the Land and Community Heritage Investment and Water Supply Land Grant Protection programs.

This advanced computing technology not only put the Forest Society in a leadership role in terms of strategic conservation planning in New Hampshire and New England but also fostered a successful program of providing conservation-based GIS services to communities as well as local and regional land trusts. This natural resource inventory for the town of Warner is one example of such a community-based project.

In addition to the methods developed by Forest Society staff, this study applied many of the items and approaches described in the following two natural resource publications:

- *Natural Resource Inventories: A Guide for New Hampshire Communities and Conservation Groups* [9], and
- *Identifying and Protecting New Hampshire's Significant Wildlife Habitat: A Guide for Towns and Conservation Groups* [10].

Data Overview

This appendix provides an overview of the data that was applied in this study including a brief summary of the delineation methods that were applied to develop most new datasets. It contains additional source data details including specifics for each data layer such as description, source, derivation method, data dictionary, file names of the corresponding datasets provided in the project CD, and more.

A significant portion of the base data layers applied in this study represent existing digital data that is available from NH GRANIT [11]. Digital data in NH GRANIT represent the efforts of many contributing agencies ranging from state agencies including the department's of Environmental Services, Transportation, and Fish & Game; federal agencies including the United States Geological Survey, USDA Natural Resource Conservation Service, Environmental Protection Agency, and USDA Forest Service; and private organizations such as the Forest Society.

[9] Amanda Stone / Phil Auger / Jeanie McIntyre, University of New Hampshire Cooperative Extension, 2001.
[10] John Kanter, Rebecca Suomala, Ellen Snyder; NH Fish & Game, Nongame & Endangered Wildlife Program, 2001
[11] NH GRANIT is based at the University of New Hampshire's Complex Systems Research Center and hosts NH's statewide geographic information system, accessible via their web site http://www.granit.sr.unh.edu/.

In addition to existing digital data, a considerable amount of data development and verification was carried out by the Forest Society (GIS processing and model runs) and the WCC (intensive field work and documentation of viewpoints, vistas, and scenic road features).

Appendix C: Scenic Road & Vista Value Criteria

The WCC has prepared the following criteria for establishing a methodology for evaluating the town of Warner's scenic roads and scenic vistas. The VT Cultural Byways' criteria was used as a basis for the preparation of these documents because this process clearly provides a well-rounded and in-depth methodology that enables evaluation of each scenic road and scenic viewpoint subjectively, while also establishing a numeric rating for each subject.

Only a brief synopsis of the methodology is provided here, based on a more substantial report which can be obtained from the WCC. The numerical values generated by this inventory were used in weighting the GIS-based scenic resource mapping discussed earlier in this report.

Methodology & Evaluation of the Above Subject Matter

The following analysis provides for an evaluation of each of 79 selected scenic road/viewpoint according to these seven criteria. An average of the seven criteria is used to arrive at an overall value of the particular scenic road/viewpoint. The lowest number exemplifies the highest ranking corridor/viewpoint.

Evaluation of the Subject

- Archeological quality
- Historic quality
- Natural Quality:
- Recreational Quality
- General Scenic Quality

Number of subject occurrences within corridor/viewpoint.

Visual Rating of Scenic Road/Vista (as exists within surrounding landscape)
Rate the visual contrast, sense of order, layering of foreground, midground and background, and presence/absence of focal points.

Popularity and Visitation
Rate the current use of these certain public roads/paths/viewpoints relative to traffic in Warner.

Overall accessibility
Rate the current accessibility of these certain public roads/paths/viewpoints.

Uniqueness to Warner and/or Region, State, Nation
Rate the unique quality of these certain public roads/paths/viewpoints.

Degree to which viewshed/viewpoint is Intact
Rate the degree to which these certain public roads/paths/viewpoints are intact.

Method for Determining Mathematical Value

1. Values were determined by site exploration over several days.
2. Values were doubled checked afterwards to determine consistency over initial field work.
3. Visual ratings (contrast, order, layering, and focal point) were averaged, see column III.
4. Overall rating was an average of all criteria PLUS the average of the visual ratings thereby placing a higher importance on visual criteria.

The final field inventory and values for 32 roads and 97 key viewpoints are shown in the following matrix beginning on the next page.