DEERFIELD RIVER WATERSHED
Assessment Report

2004-2008

Downstream of Fife Brook Dam

The Commonwealth of Massachusetts
Executive Office of Environmental Affairs

The Commonwealth of Massachusetts

Executive Office of Environmental Affairs

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Dear Friends of the Deerfield River Watershed:

It is with great pleasure that I present you with the Assessment Report for the Deerfield River Watershed. The report helped formulate the 5-year watershed action plan that will guide local and state environmental efforts within the Deerfield River Watershed over the next five years. The report expresses some of the overall goals of the Executive Office of Environmental Affairs, such as improving water quality, restoring natural flows to rivers, protecting and restoring biodiversity and habitats, improving public access and balanced resource use, improving local capacity, and promoting a shared responsibility for watershed protection and management.

The Deerfield River Watershed Assessment Report was developed with input from the Deerfield River Watershed Team and multiple stakeholders including watershed groups, state and federal agencies, Regional Planning Agencies and, of course, the general public from across the Watershed. We appreciate the opportunity to engage such a wide group of expertise and experience as it allows the state to focus on the issues and challenges that might otherwise not be easily characterized. From your input we have identified the following priority issues:

- Water Quantity
- Water Quality
- Fish Communities
- Wildlife and Terrestrial Habitat
- Open Space
- Recreation

I commend everyone involved in this endeavor. Thank you for your dedication and expertise. If you are not currently a participant, I strongly encourage you to become active in the Deerfield River Watershed restoration and protection efforts.

Regards,

Ellen Roy Herzfelder

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BRPC	Berkshire Regional Planning Commission
cfs	cubic feet per second
CMR	Code of Massachusetts Regulations
COE	United States Corps of Engineers
ConEd	Consolidated Edison
CRASC	Connecticut River Atlantic Salmon Commission
DO	Dissolved Oxygen
DRWA	Deerfield River Watershed Association
EOEA	Executive Office of Environmental Affairs
FERC	Federal Energy Regulatory Commission
FRCOG	Franklin Regional Council of Governments
ft/mi	feet per mile
gpd	gallons per day
gpm	gallons per minute
IWPA	Interim Wellhead Protection Area
MDCR	Massachusetts Department of Conservation and Recreation
MDEP	Massachusetts Department of Environmental Protection
MDFW	Massachusetts Department of Fish and Wildlife
MDPH	Massachusetts Department of Public Health
mi^2	square miles
mgd	Million gallons per day
mg/l	milligrams per liter
MS4s	Municipal Separate Storm Sewer Systems
MWI	Massachusetts Watershed Initiative
MWRC	Massachusetts Water Resource Commission
MWQS	Massachusetts Water Quality Standards
msl	Mean Sea Level
NPDES	National Pollution Discharge Elimination System
ntu	Nephlometric Turbidity Units
ppm	parts per million
SWQS	State Water Quality Standards
TMDL	Total Maximum Daily Loads
µg/l	microgram per liter
USFWS	United State Fish and Wildlife Service
USGen	USGen New England Inc.
USGS	United States Geological Survey
VDFW	Vermont Department of Fish and Wildlife
VWQS	Vermont Water Quality Standards
YAEC	Yankee Atomic Electric Company
WAP	Watershed Action Plan
WMA	Water Management Act
WMZ	Waste Management Zones

1 INTRODUCTION

The Deerfield River Watershed[1] is a part of the 27 major river basins that lie within the Commonwealth of Massachusetts. The Deerfield River, a tributary to the Connecticut River, is located in western Massachusetts. The watershed supports a wide variety of ecological, recreational, and commercial uses, and there are many active stakeholders that have a vested interest in maintaining a high degree of watershed quality and stewardship.

This watershed assessment summarizes much of the existing physical, ecological, and social information that is currently available for the Deerfield River Watershed. Information has been gathered from numerous sources including several federal, state, and municipal agencies as well as non-governmental organizations, universities, and business interests.

This watershed assessment is written as part of the five-year watershed cycle under the Massachusetts Watershed Initiative (MWI) and will be a useful source of information for the citizens of the watershed as well as for municipalities, government agencies, private and non-profit organizations, schools, and research institutions. The watershed assessment also identifies priority issues currently affecting the watershed's resources.

In addition, this watershed assessment will form the basis for a Watershed Action Plan (WAP) that will be subsequently prepared with the assistance of community input and watershed partners. The forthcoming watershed action plan will address the priority issues currently affecting the resources within the Deerfield River Watershed, and define priority actions to protect, improve, and restore these watershed resources.

[1] A watershed is an area of land that catches precipitation and in turn drains or seeps the resulting runoff into a marsh, stream, river, lake, or groundwater. Similar terms include basin, subwatershed, drainage basin, catchment, and catch basin.

2 GENERAL DESCRIPTION OF THE WATERSHED

The Deerfield River begins near the towns of Glastenbury and Stratton in Vermont and flows approximately 70 miles mostly south and east to its confluence with the Connecticut River in Greenfield, Massachusetts (Figure 2.0-1). The watershed drainage area is 665 square miles with about half the area in southern Vermont (318 square miles) and half in western Massachusetts (347 square miles).

The Deerfield River Watershed is bordered by the Connecticut River Watershed to the east, the West River Watershed to the north, the Hudson-Hoosic River Watershed to the southwest, and the Westfield River Watershed to the southeast. There are 149 rivers, streams, brooks, or creeks in the Massachusetts portion of the Deerfield River Watershed covering 345 total river miles (MDEP 2003a). There are also 27 lakes, ponds, or impoundments in the watershed covering 749 acres.

2.1 Subwatersheds

The entire Deerfield River Watershed is comprised of 12 major subwatersheds (Figure 2.0-1).

East Branch Deerfield River Subwatershed

The East Branch Deerfield River subwatershed has a drainage area of 36.9 square miles with Grout Pond (84 acres) and Somerset Reservoir (1,568 acres) forming its headwaters within Stratton and Somerset, Vermont. From Somerset Reservoir, the East Branch flows south for approximately 5.5 miles until it reaches the mainstem of Deerfield River, just upstream of Searsburg Impoundment in Searsburg, Vermont (VANR 2003).

North Branch Deerfield River Subwatershed

The North Branch Deerfield River enters Harriman Reservoir approximately 2 miles east of where the mainstem Deerfield River enters, and drains 55.9 square miles of land northeast of Harriman Reservoir. The North Branch begins in the Green Mountain National Forest, near Mount Snow, in Dover, Vermont and flows approximately 11 miles to Wilmington, Vermont, before entering Harriman Reservoir (VANR 2003).

West Branch Deerfield River Subwatershed

The West Branch Deerfield River drains an area of 31.8 square miles (VANR 2003), and begins in Woodford, Vermont within a large wetland complex and flows approximately 10.5 miles before entering the mainstem Deerfield River in Readsboro, Vermont.

Pelham Brook Subwatershed

The total drainage area of the subwatershed is 13.7 square miles. Pelham Brook begins at the outlet of Pelham Lake in Rowe, Massachusetts, and flows southwest for approximately 4.9 miles through a narrow and steep valley before entering the mainstem Deerfield River in Charlemont, Massachusetts. Land use is comprised primarily of forest (87.1%), agricultural (4.0%), and residential (3.9%) (MDEP 2003a).

Cold River Subwatershed

The Cold River drains an area of 31.7 square miles and lies on the western border of the Deerfield River Watershed and flows south through Florida, Massachusetts then east through Savoy and Charlemont, Massachusetts before entering the mainstem Deerfield River. Most of its 14 river miles are characterized by a steep gradient flowing through a narrow river valley. Land use in the subwatershed is primarily forest (93%) with a small number of farms (2%) and residential properties (2%) (MDEP 2003a).

Chickley River Subwatershed

Located in the southern portion of the Deerfield River Watershed, the Chickley River flows 8.7 miles east and north through Savoy and Hawley, Massachusetts before entering the Deerfield River in Charlemont, Massachusetts approximately 2 miles downstream of the Cold River confluence. Much of the 27.4 square mile subwatershed is forested (93%) with some farmland located on floodplains in Hawley, Massachusetts (2% agriculture) (MDEP 2003a).

Mill Brook Subwatershed

Mill Brook begins in Heath, Massachusetts and flows south through a steep, narrow valley for approximately 5.7 miles to its confluence with the Deerfield River in Charlemont, Massachusetts. A tributary, Davis Mine Brook, enters Mill Brook just south of the Heath, Massachusetts border. The total drainage area of the subwatershed is approximately 15 square miles. Land use is primarily forest (90%), agricultural (6%), and residential (3%) (MDEP 2003a).

Clesson Brook Subwatershed

The headwaters of Clesson Brook begin at an unnamed pond in Hawley, Massachusetts and then flow through Cox Pond. From the outlet of Cox Pond the brook flows easterly through steep terrain entering Buckland, Massachusetts, before flowing southeasterly until it reaches Buckland Four Corners. From this point, the brook flows northeast with a lower gradient and the floodplain widens which allows farming. Clesson Brook then continues to its confluence with the Deerfield River in Buckland, Massachusetts. Land use in the 21.2 square miles subwatershed is primarily forest (81.4%), agriculture (9.6%), and open land (4.7%) (MDEP 2003a).

North River Subwatershed

The North River is formed at the confluence of the East and West Branches of the North River in Colrain, Massachusetts and flows approximately 3 miles through Shelburne, Massachusetts to its confluence with the Deerfield River. The East and West Branches flow south from their headwaters in Halifax and Whitingham, Vermont through Colrain and Heath, Massachusetts. The total drainage area of the North River Subwatershed is 92.9 square miles; most of this area is very hilly terrain, which results in very flashy streamflows. Fifty-two percent (48.4 square miles) of the watershed lies in Massachusetts with land use totaling 83% forest, 9% agriculture, and 3% residential (MDEP 2003a).

South River Subwatershed

The South River begins at the outlet of Ashfield Pond in Ashfield, Massachusetts and flows east then north through Conway, Massachusetts to its confluence with the mainstem Deerfield River approximately 4 miles downstream of the Station No. 2 Dam. Agriculture and residential properties dominate the floodplains in the lower 7 miles of river where the valley widens. Overall, land use in the 26.3 square miles subwatershed is 77% forest, 13% agriculture, 6% residential, and 2% open land (MDEP 2003a).

Green River Subwatershed

The Green River begins in Marlboro, Vermont and flows east through Halifax, Vermont into Guilford, Vermont where it turns south toward Massachusetts for a total of 13 river miles in Vermont. Once in Massachusetts, the Green River flows approximately 20 miles south through Leyden and Greenfield, Massachusetts to its confluence with the Deerfield River. The total drainage area of the Green River subwatershed is 89.8 square miles. Land use in the Massachusetts portion of the subwatershed (52.6 square miles) is primarily forest (65%) and a nearly equal amount of agricultural and residential (13% and 11% respectively) land with the majority of the residential properties in the Town of Greenfield (MDEP 2003a).

Deerfield River Mainstem Subwatershed

The Deerfield River mainstem begins in Glastenbury and Stratton in Vermont and flows approximately 70 miles (25 miles in Vermont and 45 miles in Massachusetts) mostly south and east to its confluence with the Connecticut River in Greenfield, Massachusetts. The total drainage area of this subwatershed is 259 square miles. Land use is predominantly forest (approximately 88%) with agricultural land use ranging from approximately 2% in the upper portion of the subwatershed to approximately 8% in the lower 20 river miles, where the river and floodplain gradient begins to diminish (MDEP 2003a).

2.2 Population by Community

The watershed includes all or part of 16 Vermont towns and 20 Massachusetts towns. Stratton, Sunderland, Glastenbury, Somerset, Dover, Woodford, Searsburg, Wilmington, Marlboro, Brattleboro, Readsboro, Stamford, Whitingham, Halifax, Guilford, and Wardsboro are in Vermont. Adams, Ashfield, Bernardson, Buckland, Charlemont, Colrain, Conway, Deerfield, Florida, Greenfield, Hawley, Heath, Leyden, Monroe, North Adams, Plainfield, Rowe, Savoy, Shelburne, and Goshen are in Massachusetts.

In 2000, the population of all towns in the Massachusetts portion of the watershed was approximately 64,640 (Table 2.2-1) with about one quarter of these people in the Town of Greenfield (18,168). The population within the actual watershed, however, is less than the total population since not all communities lie completely within the watershed and some densely populated areas might fall outside the watershed boundaries. The total population of towns in the Vermont portion of the watershed is 24,764; however, not all towns lie completely within the watershed (Table 2.2-2). The estimated total number of people living within the watershed boundaries is approximately 47,000.

Table 2.2-1: Population of Communities within the Deerfield River Watershed (Massachusetts) (Source: United States Census Bureau 2004)

Community	Percent of Community In Watershed	Total Population
Buckland	100%	1,991
Charlemont	100%	1,358
Colrain	100%	1,813
Heath	100%	805
Monroe	100%	93
Rowe	100%	351
Shelburne	100%	2,058
Florida	95%	676
Hawley	94%	336
Greenfield	85%	18,168
Leyden	76%	772

Community	Percent of Community In Watershed	Total Population
Ashfield	61%	1,800
Conway	60%	1,809
Savoy	59%	705
Deerfield	43%	4,750
Bernardston	12%	2,155
North Adams	5%	14,681
Plainfield	2%	589
Adams	2%	8,809
Goshen	1%	921
Total		**64,640**

Table 2.2-2: Population of Communities within the Deerfield River Watershed (Vermont) (Source: United States Census Bureau 2004)

Community	Percent of Community In Watershed	Total Population
Halifax	100%	782
Searsburg	100%	96
Somerset	100%	5
Whitingham	100%	1,298
Wilmington	100%	2,225
Readsboro	95%	809
Dover	68%	1,410
Stratton	41%	163
Woodford	40%	414
Glastenbury	39%	16
Marlboro	35%	978
Guilford	26%	2,046
Stamford	9%	813
Sunderland	6%	850
Wardsboro	2%	854
Brattleboro	1%	12,005
Total		**24,764**

2.3 Surficial Geology

The surficial geology of the Deerfield River Watershed is primarily till and bedrock. There are some sand and gravel deposits located within the river and stream valleys and along the eastern Deerfield Watershed lowlands. Some floodplain alluvium also exists towards the Connecticut River Valley (Figure 2.3-1). The groundwater supply potential of these surficial formations are discussed in more detail within Section 3.1.

2.4 Topography

Land surface altitudes range from just under 4,000 feet above sea level in the Vermont Mountains to 120 feet above sea level in the Connecticut River Valley (Figure 2.4-1). The river gradient through Vermont and upper Massachusetts is steep and averages 28.4 feet/mile from the Massachusetts border to West

Deerfield (33 river miles). The steep gradient makes the river ideal for power generation and there are 11 hydroelectric facilities along the mainstem that effectively control the river flow. The steep gradient and cool mountainous source waters also make the river ideal for kayaking and cold-water fish species like trout and salmon.

2.5 Precipitation

Annual precipitation ranges from approximately 53 inches at Searsburg (Table 2.5-1) in the upper, mountainous reaches (elevation 2,100 feet) of Vermont to approximately 45 inches at Greenfield (Table 2.5-2) in the lower reaches (elevation 250 feet) closer to the Connecticut River Valley. On average, November is the wettest month, while February is the driest.

Table 2.5-1 Monthly and Annual Precipitation (inches) Statistics at Searsburg, Vermont (Source: MDCR 2004)

	Average	Median	Standard Deviation	Minimum	Maximum
January	4.2	3.9	1.9	0.8	11.8
February	3.6	3.5	1.3	0.3	10.9
March	4.4	4.2	1.9	1.6	10.6
April	4.7	4.8	1.5	0.9	8.31
May	4.7	4.0	2.3	1.3	12.5
June	4.2	4.0	1.9	0.7	8.76
July	4.5	4.2	1.9	0.9	10.7
August	4.5	4.0	2.1	1.7	11.3
September	4.7	4.7	2.3	0.5	13
October	4.2	3.7	2.6	0.4	13.9
November	5.0	4.9	1.9	1.3	9.24
December	4.6	4.7	2.0	0.9	10.9
Annual	**53.3**	**4.1**	**0.3**	**0.3**	**13.9**

Table 2.5-2 Monthly and Annual Precipitation (inches) Statistics at Greenfield, Massachusetts (Source: MDCR 2004)

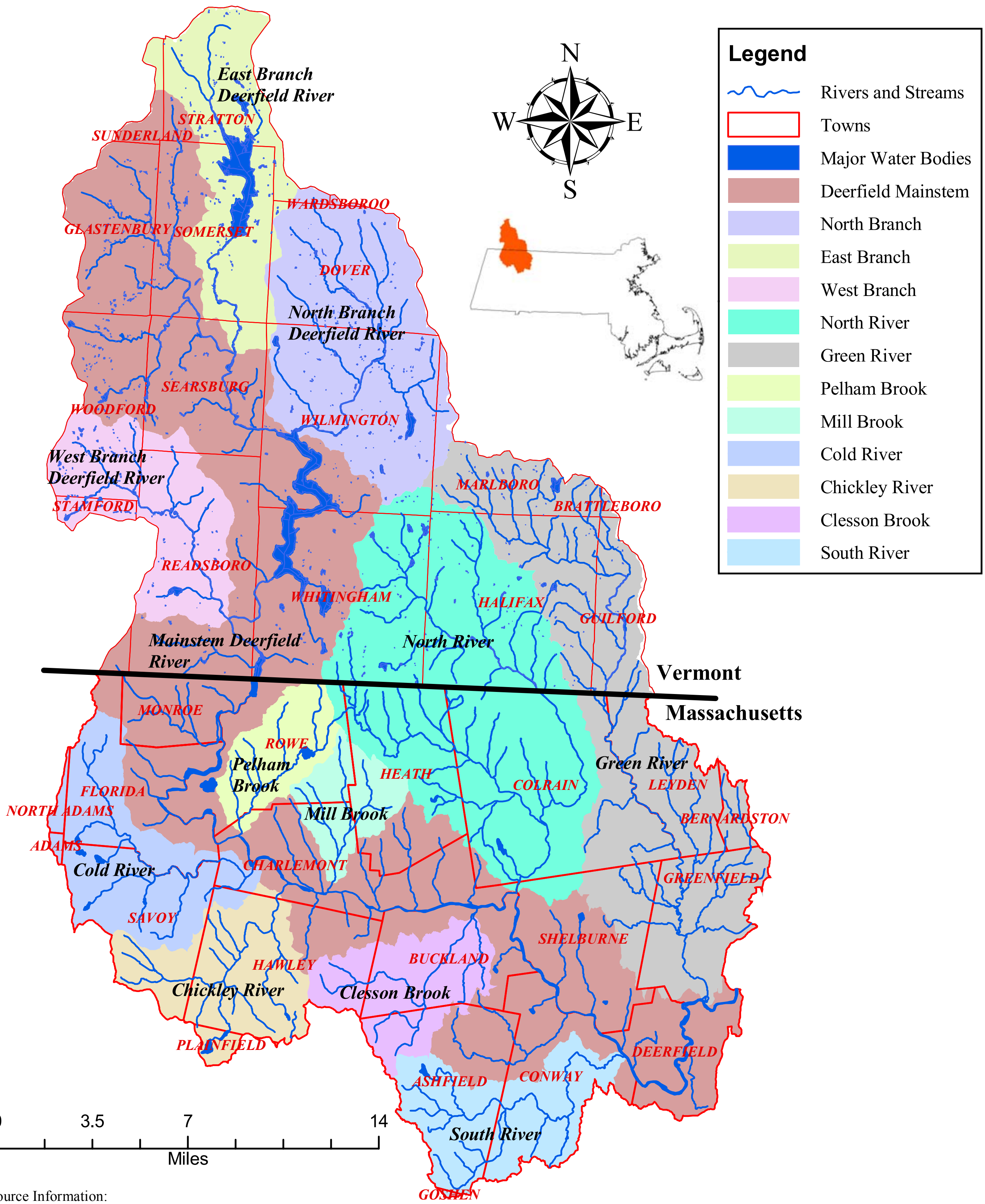
	Average	Median	Standard Deviation	Minimum	Maximum
January	3.4	3.0	1.7	0.6	8.9
February	2.9	2.9	1.3	0.2	10.4
March	3.7	3.4	1.7	0.6	8.6
April	3.9	3.9	1.7	0.8	9.1
May	4.1	3.8	2.2	1.0	12.8
June	3.9	3.5	2.0	0.6	8.5
July	3.9	3.7	1.8	0.6	9.7
August	3.9	3.5	2.2	0.4	11.3
September	3.8	3.2	2.5	0.8	13.0
October	3.4	2.9	2.0	0.6	11.1
November	4.2	4.0	1.9	0.8	9.0
December	3.7	3.5	1.8	0.5	10.3
Annual	**44.8**	**3.5**	**0.3**	**0.2**	**13.0**

2.6 Roads

Major roads running through the watershed include Interstate 91, State Highway Route 2, Route 10, Route 112, Route 116, and Route 8A-L (Figure 2.6-1). A major railroad also runs along the Deerfield River from Deerfield to Florida. The eastern portion of the watershed (specifically Greenfield and Deerfield) is the most populated part of the watershed and has the greatest density of roads.

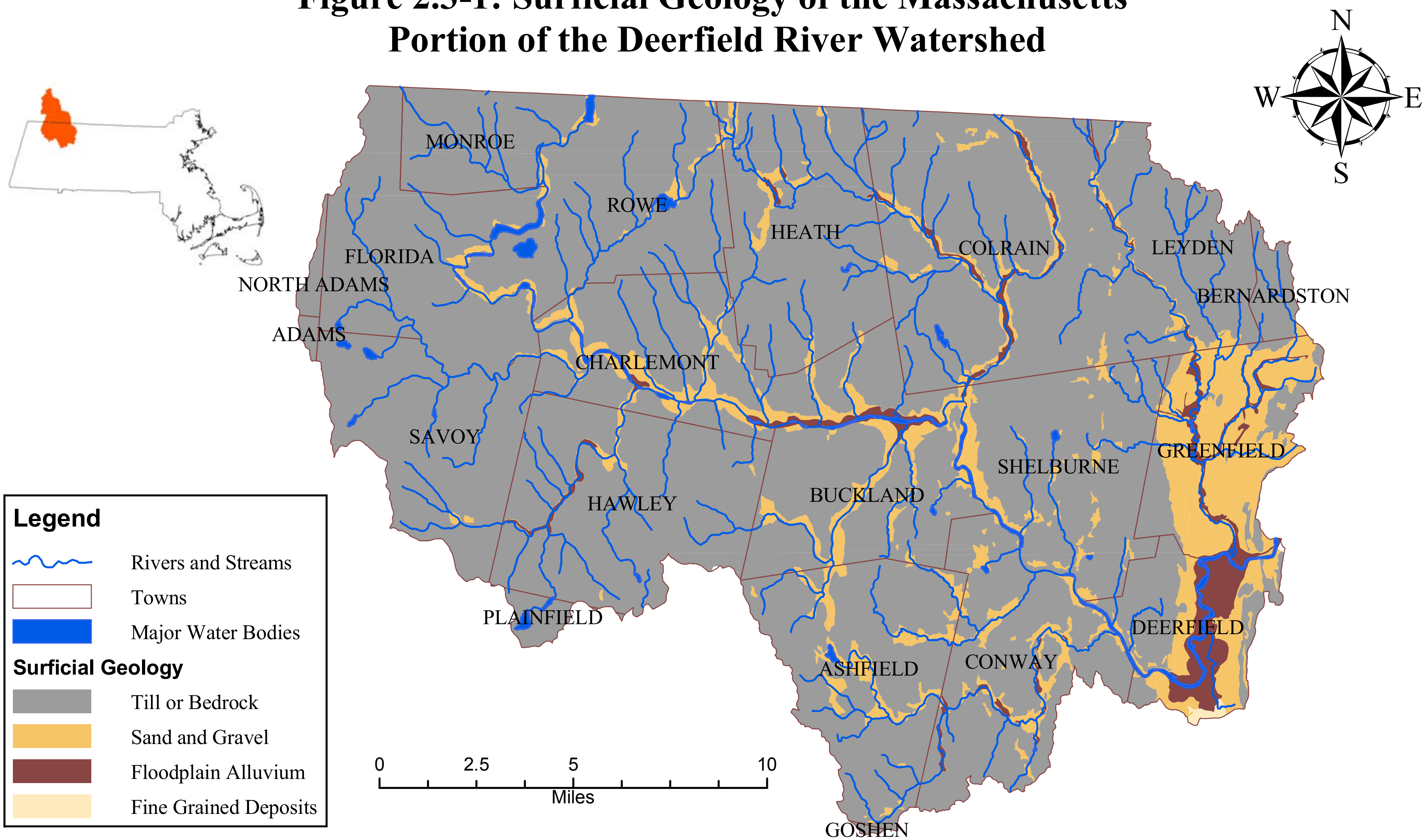
Major road crossings in the eastern portion of the watershed include Interstate 91 in Deerfield and Route 10 in Greenfield. Interstate 91 also crosses the Green River in Greenfield. Major road crossings in the central portion of the watershed include Route 2 (3 times), Route 8A-L, and Route 2A. Route 112 crosses the North River and East Branch North River four times in Massachusetts. There are no major road crossings in the northern Massachusetts portion of the Deerfield River watershed. Major road crossings in Vermont include Route 9 in Wilmington and Searsburg, and Route 100 in Readsboro, Wilmington, and Dover. In addition, there are several rural roads that either cross or run along the mainstem Deerfield River or its tributaries. Roadways adjacent to rivers can impact water quality, riparian habitat, and overall aesthetics through increased stream bank erosion, reductions in overhanging cover for fish, and limiting riverbank access for land mammals.

Figure 2.0-1: Deerfield River Watershed Map



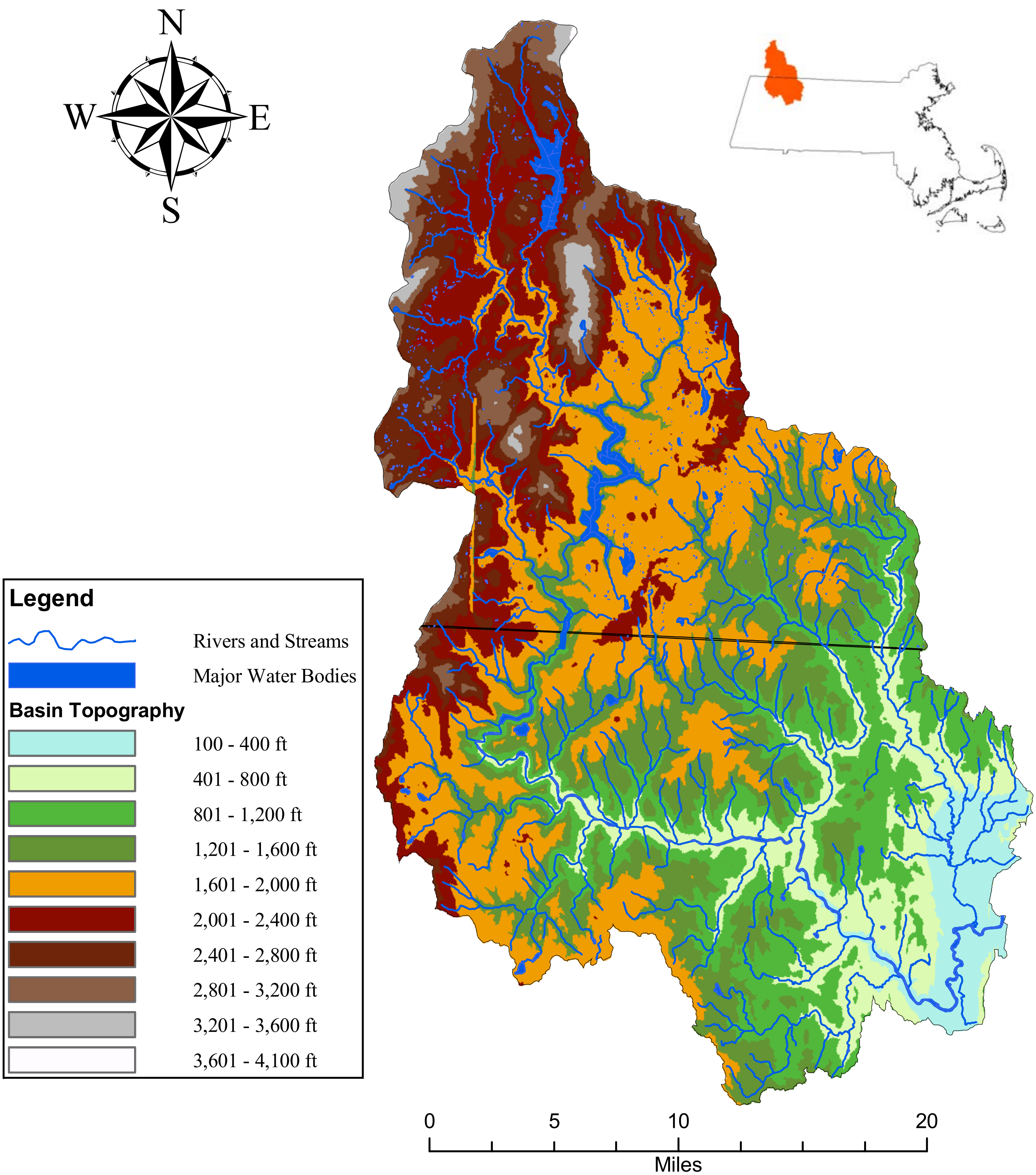
Source Information:
- Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Environmental Affairs
- Vermont Center for Geographic Information

Figure 2.3-1: Surficial Geology of the Massachusetts Portion of the Deerfield River Watershed



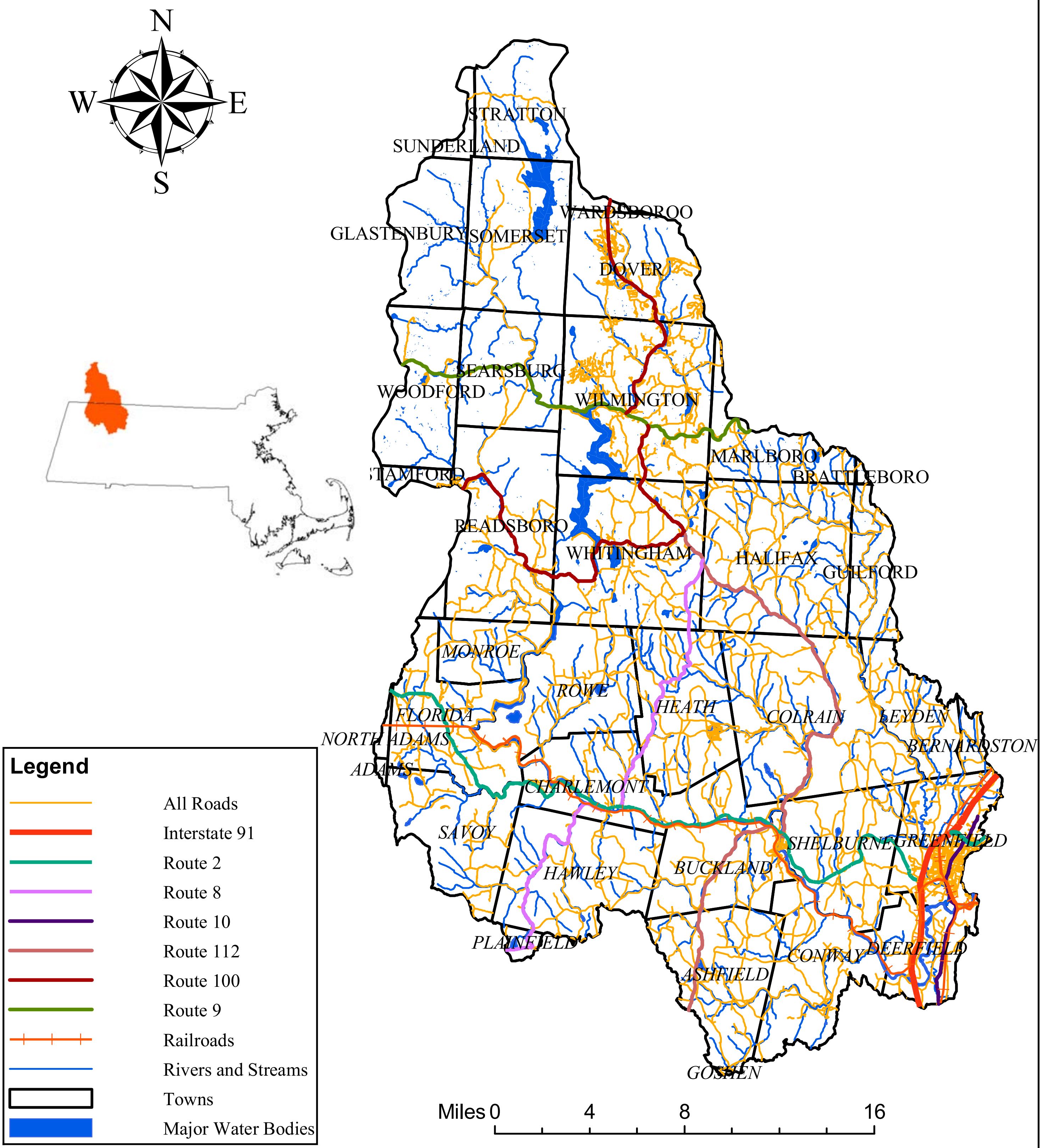
Source Information:
- Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Environmental Affairs

Figue 2.4-1: Topography in the Deerfield River Watershed.



Source Information:
- Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Environmental Affairs
- Vermont Center for Geographic Information

Figure 2.6-1: Major Roads and Railroads in the Deerfield River Watershed



Source Information:
- Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Environmental Affairs
- Vermont Center for Geographic Information

3 ASSESSMENT OF ENVIRONMENTAL CONDITIONS

The following sections describe the environmental conditions of the Deerfield River Watershed in terms of water quantity, water quality, fisheries, wildlife, open space, and recreational resources. The information in this section comes from a variety of sources, including data that has been collected by federal and state agencies, municipalities, the Deerfield River Watershed Association (DRWA), as well as USGen New England, Inc. (USGen) and its predecessors. In addition, priority projects funded by the MWI also serve to describe the watershed's natural resources with recent projects providing information on water quality conditions, amphibians and marshbirds, and open space/recreation.

This section will be used to identify the main environmental issues (i.e., priority issues) in the watershed, as well as some of the gaps in information that might be the focus of future data collection efforts. An effort was made not only to describe the resources associated with the mainstem of the Deerfield River, but its subwatersheds as well.

3.1 Water Quantity

Much of the terrain within Deerfield River Watershed is characterized by shallow depth to bedrock with relatively steep valley slopes. These conditions contribute to the "flashiness" of the Deerfield River and its tributaries. Dam construction on the Deerfield River began in the late 18th and early 19th centuries with the establishment of several mill dams. By 1880, the lower portion of the Deerfield River provided hydromechanical power for approximately 117 mills; however, the longevity of these facilities remained at the whim of the wild and flashy nature of the river (FERC 1997).

The "flashiness" of the Deerfield was finally tamed by construction of the present-day hydroelectric generation facilities, which began in the early 20th century. In particular, the Somerset (1,623 acres) and Harriman (2,039 acres) reservoirs were constructed for seasonal water storage; retaining the majority of spring runoff, thereby, allowing for augmented summer flows for downstream projects to enhance power production. Currently, the Somerset and Harriman reservoirs are drawn down about 15 feet and 40 feet, respectively, over the course of the fall and winter to accommodate spring runoff and may be drawn down more in anticipation of higher-than-normal spring runoff.

3.1.1 Streamflow Magnitude and Patterns

The United States Geological Survey (USGS) currently maintains five stream gages in the Massachusetts portion of the watershed, two on the mainstem Deerfield River and one each on the North, Green, and South rivers. An additional gage on the Deerfield near Rowe, Massachusetts was decommissioned in 1997 (Figure 3.1.5-1). Gage identification, drainage area, and period of record are found in Table 3.1.1-1.

Table 3.1.1-1: USGS Gages in the Deerfield River Watershed within Massachusetts (Source: USGS 2003)

Gage	Gage No.	Drainage Area (square miles)	Period of Record
Deerfield River at Rowe, MA	01168151	254	1974-1997
Deerfield River at Charlemont, MA	01168500	361	1913-Present
North River at Shattuckville, MA	01169000	89.0	1939-Present
South River near Conway, MA	01169900	24.1	1967-Present
Green River near Colrain, MA	01170100	41.4	1966-Present
Deerfield River near West Deerfield, MA	01170000	557	1904-Present

Streamflow data were analyzed for the Deerfield River at the West Deerfield USGS gage for the period 1940-2002 to illustrate the long-term flow conditions within the watershed. Table 3.1.1-2 shows the annual and monthly average, standard deviation, median, minimum, and maximum flows for the gage. The watershed area at the gage location is 557 square miles, and it is located approximately 9.5 miles from the river's mouth. These flows reflect upstream hydroelectric water regulation, particularly at Somerset and Harriman reservoirs. Monthly average flows ranged from 569 cfs (August) to 2,896 cfs (April) over the period of record.

Figure 3.1.1-1 was developed to illustrate the seasonal variation in streamflow for the mainstem Deerfield River and several of its tributaries. Specifically, this figure compares average monthly flows (in units of cfs per square mile[2]) for the period 1967-2002 in the Deerfield River at the Charlemont and West Deerfield gages with the South River and North River gages. Both mainstem Deerfield River gages reflect regulated conditions, while the South River and North River gages are essentially unregulated. The effects of seasonal flow regulation are demonstrated by generally higher spring flows (March through May) within the South and North rivers compared to the Deerfield River mainstem as a result of spring runoff being stored within Somerset and Harriman reservoirs. During the summer, fall, and winter period, (July through February), flows are higher along the Deerfield River mainstem compared to the South and North Rivers, due to mainstem flows being augmented by releases from Somerset and Harriman reservoirs.

Table 3.1.1-2: Streamflow Statistics at the West Deerfield USGS Gage, Mainstem Deerfield River (Source: USGS 2003)

	Average	Std. Deviation	Median	Minimum	Maximum
January	1,406	927	1,300	109	19,100
February	1,439	872	1,320	130	14,500
March	2,105	1,654	1,685	180	17,800
April	2,896	2,101	2,385	356	29,300
May	1,715	1,661	1,270	82	26,800
June	994	1,170	650	66	16,100
July	594	677	437	28	11,900
August	569	684	426	34	14,500
September	575	610	426	44	8,130
October	835	1,297	558	44	30,000
November	1,224	1,150	965	50	16,400
December	1,430	1,315	1,260	60	38,300
Annual	1,315	693	1,057	28	38,300

The USGS Streamstats program (USGS 2000) was used to estimate an unregulated/natural flow regime for the mainstem of the Deerfield River. The program estimates a variety of low flow statistics including the annual and August median flows. Table 3.1.1-3 shows a comparison of the estimated natural and actual annual and August median flows for the mainstem Deerfield River at both Charlemont and West Deerfield. Due to the flow augmentation provided by Somerset and Harriman reservoirs, actual annual and August median flows are much higher than would naturally occur in the watershed without flow regulation.

[2] Cubic feet per second per square mile (cfsm) is the number of cubic feet of water flowing per second from each square mile are drained, assuming the runoff is distributed uniformly in time and area.

Table 3.1.1-3: Comparison of the Estimated Natural and Actual Annual and August Median Flows for the Mainstem Deerfield River (Source: USGS 2003 and USGS 2000)

	Charlemont		West Deerfield	
	Actual	Estimated Natural	Actual	Estimated Natural
Annual Median Flow (cfs)	761	383	1060	598
Annual Median Flow (cfsm)	2.11	1.06	1.90	1.07
August Median Flow (cfs)	448	106	457	161
August Median Flow (cfsm)	1.24	0.29	0.82	0.29

In addition to altering seasonal flow regimes, hydroelectric flow regulations affect daily streamflow patterns as well. Several hydroelectric projects operate on a daily peaking schedule and release variable flows throughout the day, often ranging from full generation to minimum flows. Figure 3.1.1-2 illustrates daily streamflow patterns on the North River and the Deerfield River mainstem (Charlemont and West Deerfield) from November 17 to December 1, 2003. The rise and fall of the North River hydrograph is very smooth in contrast to the frequent flow fluctuations and reversals exhibited on the mainstem Deerfield River.

Approximately 19 % of the 72-mile long Deerfield River has reaches that are diverted or bypassed from the main river channel due to hydroelectric operations. Since 1997, all of these river reaches have been subject to minimum flow requirements per a FERC license for the Deerfield River Hydroelectric Project (FERC No. 2323). These minimum flows were determined through studies and negotiations with stakeholders during the hydroelectric project relicensing process, and were established to protect aquatic life in the Deerfield River. They are summarized in Table 3.1.1-4.

Table 3.1.1-4: Minimum Flows at Deerfield River Hydroelectric Facilities (Source: FERC 1997)

Time Period	Project	Minimum Flow (cfs)
October 1-December 15 December 16- February 28 March 1-April 30 May 1 to September 30	Somerset	30 48 30 12 (9 if necessary)
June 1-September 30 October 1-May 31	Searsburg	35 55
October1-June 30 July 1-September 30	Harriman	70 57
All Year	Sherman	57
All Year	Station No. 5	73
All Year	Fife Brook	125
October 1-May 31 June 1-September 30	Station No. 4	100 125
All Year	Station No. 3	100
All Year	Gardners Falls	150
All Year	Station No. 2	200

3.1.2 Groundwater Flow and Aquifers

Porous deposits of proglacial and fluvial stratified drift (i.e., sand and gravel) are ideal for the production of groundwater resources. The largest aquifers in the watershed are located in its eastern portion (Figure

3.1.2-1). Bedrock and fine-grained clay-like till often transmit less groundwater and are not good public water supply sources.

A study conducted by the USGS (Friesz 1996) found that stratified drift thickness ranged from 0 to 385 feet along 7.4 miles of the Deerfield River east of Interstate 91 to its confluence with the Connecticut River. The thick deposit fills a deep north-south trending valley with coarse-grained alluvium below finer glacial lake deposits. The deposit is a valuable source of groundwater.

The study also detailed hydraulic properties and groundwater recharge characteristics in the eastern Deerfield Valley (east of Interstate 91), in the Clesson Brook Valley of the Berkshire Hills, and in the Green River Valley north of the Deerfield. These areas contained the largest deposits of stratified drift and groundwater capacity within the watershed. It was found that groundwater levels within stratified drift areas adjacent to the Deerfield River responded instantaneously to streamflow fluctuations. For example, the water table at the riverbank in Charlemont rose 1.06 feet during a 1.49-foot rise in streamflow level (the effect diminishes away from the river). Groundwater flow patterns also change with rising and falling streamflow levels. In early spring (high flows), the direction of groundwater flow is nearly perpendicular to the valley length, whereas in late summer (low flows), groundwater flow is nearly down-valley. The nature of groundwater flow patterns could have implications on any future groundwater solute transport studies.

3.1.3 Water Withdrawals

Within the Vermont portion of the Deerfield River Watershed, the Mount Snow/Haystack ski area maintains three water withdrawals for snowmaking purposes. Firstly, Snow Lake on the North Branch of the Deerfield has a withdrawal capacity of approximately 5.76 mgd. There is no limit on the amount of water that can be withdrawn at this location as long as the minimum flow requirements downstream of the site are met. A second withdrawal is located at an on-stream pond on Mount Snow. The source is an intermittent stream and small wetland. At this site, there is no limit on the withdrawal, as long as the minimum flow requirement at the site is met. The third withdrawal is located on Cold Brook, a tributary to the North Branch Deerfield. The maximum pumping rate is 5.18 mgd, but higher withdrawals are possible during high flow periods. There is a minimum flow requirement at the site as well (VANR 2004).

Figure 3.1.3-1 shows the 85 public water supply withdrawals listed by Massachusetts Department of Environmental Protection (MDEP). Also, shown in Figure 3.1.3-1 are the surface water supply protection zones (A, B, and C) delineated per the Massachusetts Drinking Water Regulations. These zones are defined as the following:

- ZONE A: represents a) the land area between the surface water source and the upper boundary of the bank; b) the land area within a 400 foot lateral distance from the upper boundary of the bank of a Class A surface water source, as defined in 314 CMR 4.05(3)(a); and c) the land area within a 200 foot lateral distance from the upper boundary of the bank of a tributary or associated surface water body.

- ZONE B: represents the land area within one-half mile of the upper boundary of the bank of a Class A surface water source, as defined in 314 CMR 4.05(3)(a), or edge of watershed, whichever is less. Zone B always includes the land area within a 400 ft lateral distance from the upper boundary of the bank of the Class A surface water source.

- ZONE C: represents the land area not designated as Zone A or B within the watershed of a Class A surface water source, as defined in 314 CMR 4.05(3)(a).

Surface water protection zones have been delineated within Colrain, Shelburne, Monroe, Ashfield, and Leyden.

Wellhead protection areas are also shown on Figure 3.1.3-1. These areas are important for protecting the recharge area around public water supply wells. Zone II is a wellhead protection area that has been determined by hydrogeologic modeling and approved by the MDEP. In cases where hydro-geologic modeling studies have not been performed and there is no approved Zone II, an Interim Wellhead Protection Area (IWPA) is established based on MDEP well pumping rates. Certain land uses may be either prohibited or restricted in both approved (Zone II) and interim (IWPA) wellhead protection areas. Zone II wellhead protection areas have been identified in Colrain, Greenfield, and Deerfield. Many of these withdrawals in the watershed are quite small; however, there are several larger water users within the watershed as represented in Table 3.1.3-1 (MDEP 2003a). The largest water user is the Greenfield Water Department with a permitted withdrawal amount of 2.12 million gallons per day (mgd). A combination of surface and groundwater withdrawals within the Green River subwatershed is the source of the water. BBA Nonwovens, which withdraws from the North River, is the next largest water user at 0.89 mgd. Several fire departments and agricultural businesses in the watershed also have modest withdrawal totals as well.

Table 3.1.3-1: Major Water Withdrawals within the Massachusetts Portion of the Deerfield River Watershed (Source: MDEP 2003a)

Facility	PWS ID#	WMA[3] Registration #	Source	Authorized Withdrawal (mgd)	Location
BBA Nonwovens		10306601	North River	0.89	Colrain
Shelburne Falls Fire District	1268000	10326801	Fox Brook Reservoir-01S Well #1 Replacement-03G Well #2-02G	0.21	Colrain
Deerfield Fire District	1074000	10307401	Harris Spring-04G Keats Spring-02G Stillwater Spring-06G Stillwater Well-05G Wells Spring-03G GP Well Rt. 5/ Wapping Well-01G	0.10	Deerfield
Savage Farms Inc.		10307402	Savage Farm #1 Savage Farm #2 Savage Farm #3 Savage Farm #4	0.29	Deerfield
Williams Farm Inc.		10307402	Williams Farm #1 Williams Farm #2 Williams Farm #3 Pond Williams Farm #4 Pond	0.08	Deerfield

[3] WMA- Water Management Act.

Facility	PWS ID#	WMA[3] Registration #	Source	Authorized Withdrawal (mgd)	Location
Greenfield Water Department	1114000	10311401	Green River-03S Glen Brook-Upper Reservoir-01S Millbrook Well #1-04 Millbrook Well #2-05 Millbrook Well #3-06	2.12	Greenfield
Bernardston Fire & Water District	1029000	10302901	Dug Well-01G Gravel Dug Well #2-02G	0.17	Bernardston
Trew Corporation		10307402	Trew Corp Well	0.14	Deerfield

3.1.4 Stressed Basins

An interagency committee, formed by the Massachusetts Water Resource Commission (MWRC), identified several methods to identify stressed river basins in Massachusetts (MWRC 2001). The stressed basin classification system is intended to identify areas requiring a more comprehensive and detailed review of environmental impacts prior to the implementation of a proposed project. Factors that are considered to affect stress include streamflow quantity, quality, and habitat. To date, a preliminary investigation of stressed rivers has been conducted based solely on water quantity, as streamflow data is readily available.

A lack of adequate biological and hydrological data has necessitated the development of an interim methodology for defining quantitative stress, which was applied at the major watershed and major subwatershed level. The state evaluated 72 USGS stream gages in Massachusetts and developed three parameters to quantify streamflow, median of annual 7-day low flow, median of annual 30-day low flow, and median of low pulse duration. The statistical results were then used to determine a watershed's stress level as low, medium, or high. At this juncture, only the quantity of streamflow has been examined; water quality and habitat factors have not been examined. The reported stress levels for the Deerfield River and several tributaries are shown in Table 3.1.4-1.

Table 3.1.4-1: Final Stress Classifications for the Deerfield River Watershed USGS Gages (Source: MWRC 2001)

Station No.	Gage Name	Final Stress Level
01170100	Green River near Colrain	Medium
01169000	North River at Shattuckville	Medium
01169900	South River near Conway	Medium
01168500	Deerfield River at Charlemont	Low
01170000	Deerfield River near W. Deerfield	Low

3.1.5 Hydroelectric Generation Facilities and Dams

There are 11 hydroelectric facilities along the Deerfield mainstem (8 in Massachusetts, 3 in Vermont) including one pumped storage facility (Bear Swamp Pumped Storage Facility on Negus Mountain in Florida, Massachusetts) (Figure 3.1.5-1 and Table 3.1.5-1). All of the facilities are currently owned by USGen, with exception of the Gardners Falls facility, which is owned by Consolidated Edison (ConEd). These facilities utilize ten dams, and their impoundments effectively control the river flow and serve to alleviate downstream flooding as well as produce electricity. Most of the power projects were built in the early 1900's and their impoundments have since become an integral part in the river's ecologic and recreational character.

The hydroelectric facilities on the Deerfield River mainstem are regulated by the Federal Energy Regulatory Commission (FERC). There are three FERC licensed projects on the Deerfield River including:

- Deerfield River Project (FERC No. 2323) which includes the following eight projects: Somerset, Searsburg, Harriman, Sherman, Station Nos. 5, 4, 3 and 2.
- Bear Swamp Pump Storage Project (FERC No. 2669) which includes the following facilities: Fife Brook Reservoir which serves as the lower reservoir and Bear Swamp Reservoir which serves as the upper reservoir for the pump storage project.
- Gardners Falls Project (FERC No. 2334) which includes only the Gardner Falls facility.

Every 30 to 50 years, a new FERC license is required to operate these projects. As part of the relicensing process, project owners are required to conduct various environmental studies to determine the impact of project operations on environmental resources. New FERC 40 year licenses were issued for the Deerfield River Project and Gardners Falls Project in 1997 (expiration 2037). The Bear Swamp Pump Storage Project has a license expiration date of March 2020 (it was licensed in 1970).

A brief description of each project from upstream to downstream is provided below.

Somerset

Somerset Dam, located at river mile 66 in Vermont, is the most upstream facility and is the only dam that does not produce hydroelectric power. Somerset Reservoir serves to retain runoff for downstream power generation and flow augmentation throughout the summer and fall, as well as flood reduction during high flow periods. During normal operations, Somerset Reservoir has a maximum winter drawdown of 15 feet and an average summer drawdown of 5 feet. The amount of drawdown varies seasonally depending on the amount of precipitation. Maximum normal reservoir elevation is reached by June 1. Reservoir fluctuations are limited to +/- 3 inches during the period June 1 through July 31 to facilitate common loon nesting. The reservoir then begins a slow drawdown until December and then a steady drawdown to minimum reservoir elevation in March.

Searsburg

Water leaving Somerset Reservoir flows approximately six miles to the Searsburg Dam for use in hydroelectric power generation. Water is diverted from the main river reach through a three-mile penstock to the Searsburg powerhouse, which discharges to the Deerfield River in Wilmington, Vermont just upstream from the Harriman Reservoir. Water is also released from the Searsburg Dam to the bypass reach created by the flow diversion. It should be noted that all of the facilities described below have minimum flow requirements that are described later in this report.

Harriman

The Harriman Reservoir (river mile 48.5) is the most downstream facility in Vermont and is the largest of all reservoirs on the Deerfield River (2,039 acres). It has average drawdown of 42 feet during the winter and an average drawdown of 11 feet from the spillway crest in the summer under typical hydrologic conditions. The reservoir is typically filled in May. The reservoir levels are maintained as stable or rising from May 1 through June 15 and can drop no more than 1 foot per day from June 16 to July 15. After

July 15, the reservoir falls slowly until December and then falls steadily to normal maximum winter drawdown in March. Water from the Harriman reservoir is either diverted downstream through an excavated tunnel for power generation at the Harriman powerhouse, or released from the dam where it flows approximately 4.4 miles along the Deerfield River into Sherman reservoir. Concerns have been raised that the water level management plans adopted as part of USGen's 1997 relicensing could reduce the ability of the reservoir to store runoff during flood events.

Sherman

The Sherman Reservoir straddles the Vermont and Massachusetts border with the power generation facility located at the Sherman Dam in Rowe, Massachusetts. Power is generated at the Sherman facility without bypassing the mainstem. Due to the proximity of Sherman Dam to the Station No. 5 dam (0.8 miles) there is no riverine reach between the two facilities (i.e., the Sherman powerhouse tailwater flows directly into the Station No. 5 impoundment).

Station No. 5

Water from the Station No. 5 dam (river mile 41.2) is diverted about five miles downstream through a penstock to the Station No. 5 powerhouse, where it eventually re-enters into the Fife Brook impoundment. The Station No. 5 bypass reach is historically known as the "dryway" because the entire flow of the river was often diverted for power generation prior to the issuance of the new FERC license in 1997.

Fife Brook/Bear Swamp

The Fife Brook impoundment is located at river mile 37 in Florida, Massachusetts, where water is also pumped to the Bear Swamp Storage Facility on Negus Mountain, and used for power generation at the Fife Brook powerhouse. Water pumped up to the storage facility is released back down into the impoundment to generate electricity during periods of peak demand. Power is generated at the Fife Brook facility without bypassing the mainstem.

Station No. 4

From the tailwaters of the Fife Brook powerhouse, the river flows unimpeded for 17 miles to Charlemont, Massachusetts until it enters the Station No. 4 impoundment. Water from this impoundment is diverted 1.5 miles downstream for energy generation at the Station No. 4 powerhouse, after which it re-enters the river just above the Station No. 3 impoundment. The North River, a major tributary, enters the Deerfield River in the Station No. 4 bypass reach.

Station No. 3/Gardners Falls

Located in Shelburne Falls at river mile 17, the Station No. 3 dam diverts water 0.4 miles to the project powerhouse for generation. The tailwaters from this plant flow into the Gardners Falls impoundment. Water is diverted for approximately 0.3 miles at the Gardners Falls Dam to the project powerhouse.

Station No. 2

Water leaving the Gardners Falls facility flows about 2.5 miles to the Station No. 2 facility located at river mile 13.2. This facility is the last on the Deerfield River and power is generated at the dam without bypassing the mainstem.

Table 3.1.5-1: Hydroelectric Projects Located on the Deerfield River (Source: FERC 1997)

Station Name	Approximate River Mile	State	Capacity (MW)	Drainage Area (square miles)
Somerset	66.0	VT	0	30
Searsburg	60.3	VT	4.2	90
Harriman	48.5	VT	33.6	184
Sherman	42.0	VT / MA	7.2	234
Station No. 5	41.2	MA	17.6	237
Bear Swamp	39.0	MA	600	254
Fife Brook	37.0	MA	11.3	254
Station No. 4	20.0	MA	4.8	404
Station No. 3	17.0	MA	4.8	500
Gardners Falls	15.7	MA	3.6	502
Station No. 2	13.2	MA	4.8	505

Overall, there are at least 33 dams in the Deerfield River Watershed in Vermont. Aside from the hydroelectric facilities located on the mainstem Deerfield River, other significant dams include Heartwellville (breached) on the West Branch of the Deerfield River and Snow Pond on the North Branch of the Deerfield River (Figure 3.1.5-1).

Within the Massachusetts portion of the watershed, there are over 50 dams (MDEP 2003a). Aside from the aforementioned USGen hydroelectric facilities located on the Deerfield River, other major dams are located on the North, South, and Green rivers. Specifically, they include the BBA Nonwovens dam on the North River; the Shelburne Falls Road and Conway Electric dams on the South River; and the Greenfield Water Supply, Swimming Pool, Mill Street, and Wiley & Russell dams located on the Green River (Figure 3.1.5-1). None of these dams have provisions for fish passage. Many of the other dams that occur throughout the watershed are small, impounding relatively little water.

Several dams no longer fulfill a useful purpose and have fallen into a state of disrepair. The MDEP's 2000 water quality assessment report for the watershed (MDEP 2003a) stated that many of the unused dams may pose a threat to human lives, ecosystems, and downstream properties, since they are not well maintained. In addition, sediments deposited behind dams were identified as a possible source of contamination.

The United State Army Corps of Engineers (COE) is currently undertaking a feasibility study of four dams located on the Green River. The purpose of the study is to investigate the hydrologic, environmental, physical, cultural, and economic impacts of dam removal and/or fish passage structures on these dams as well as other potential stream ecosystem restoration activities. Recommendations are expected to include dam removal and/or fish passage structures at Wiley Russell Dam and Mill Street Dam and fish passage structures at Swimming Pool Dam and the Water Supply Dam. The Conway Electric Dam on the South River is currently inactive and is now owned by the Massachusetts Department of Conservation and Recreation (MDCR). There are no fish passage facilities at the site.

Figure 3.1.1-1: Seasonal Flow Comparison of the North River, South River, and Mainstem Deerfield River (Source: USGS 2003)

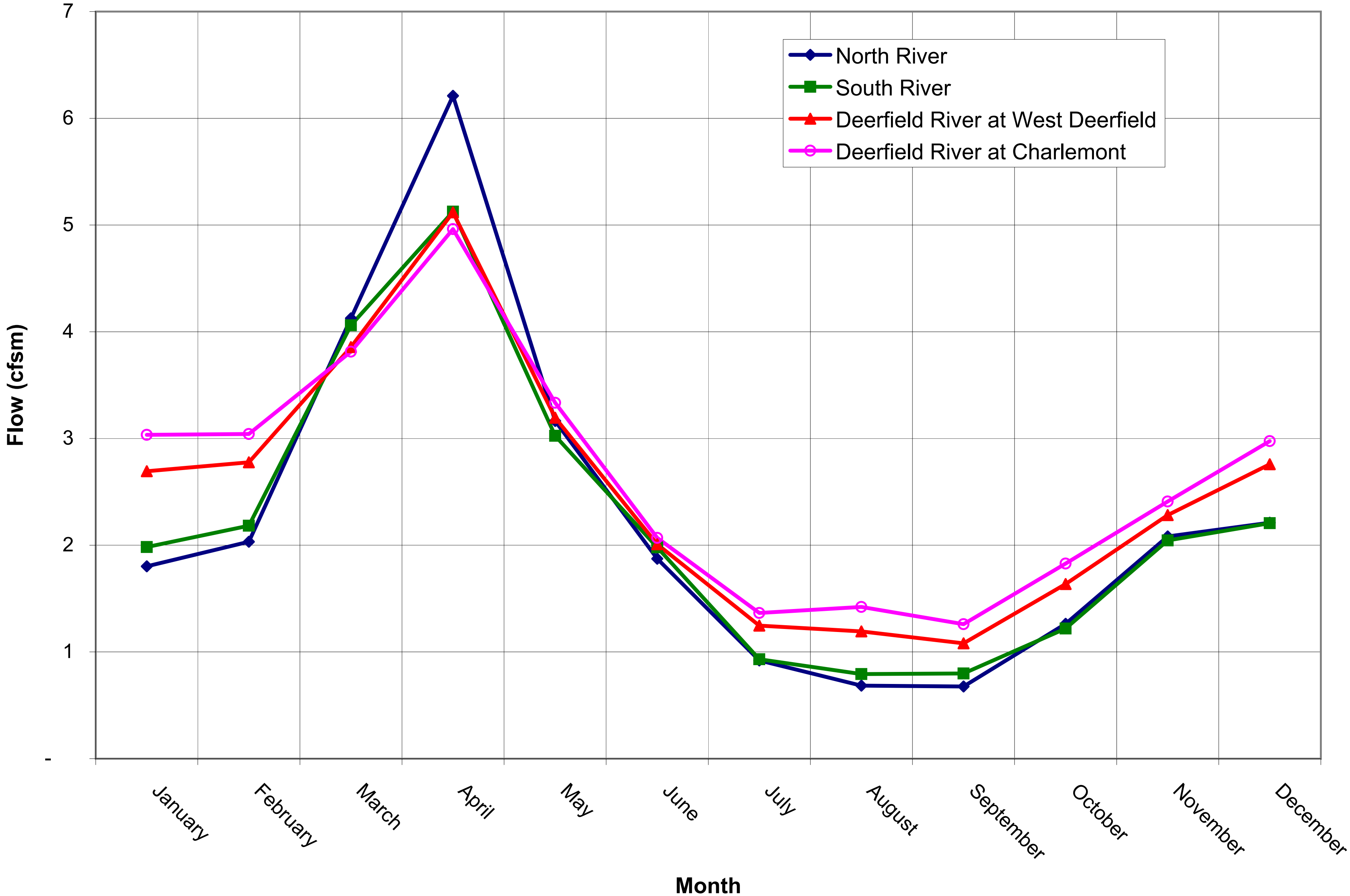


Figure 3.1.1-2: Daily Streamflow Patterns on the North River and the Deerfield River Mainstem (Source: USGS 2003)

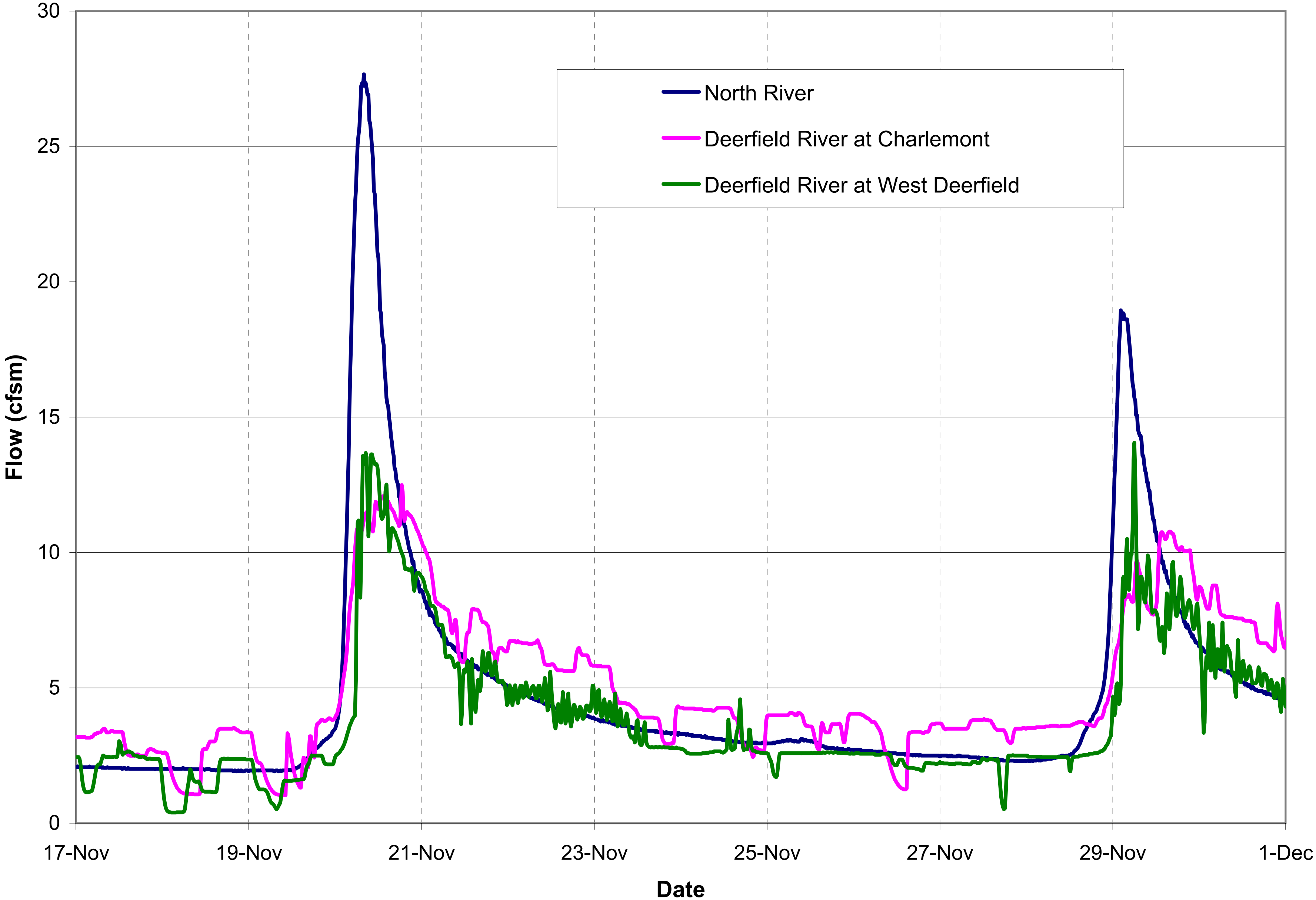
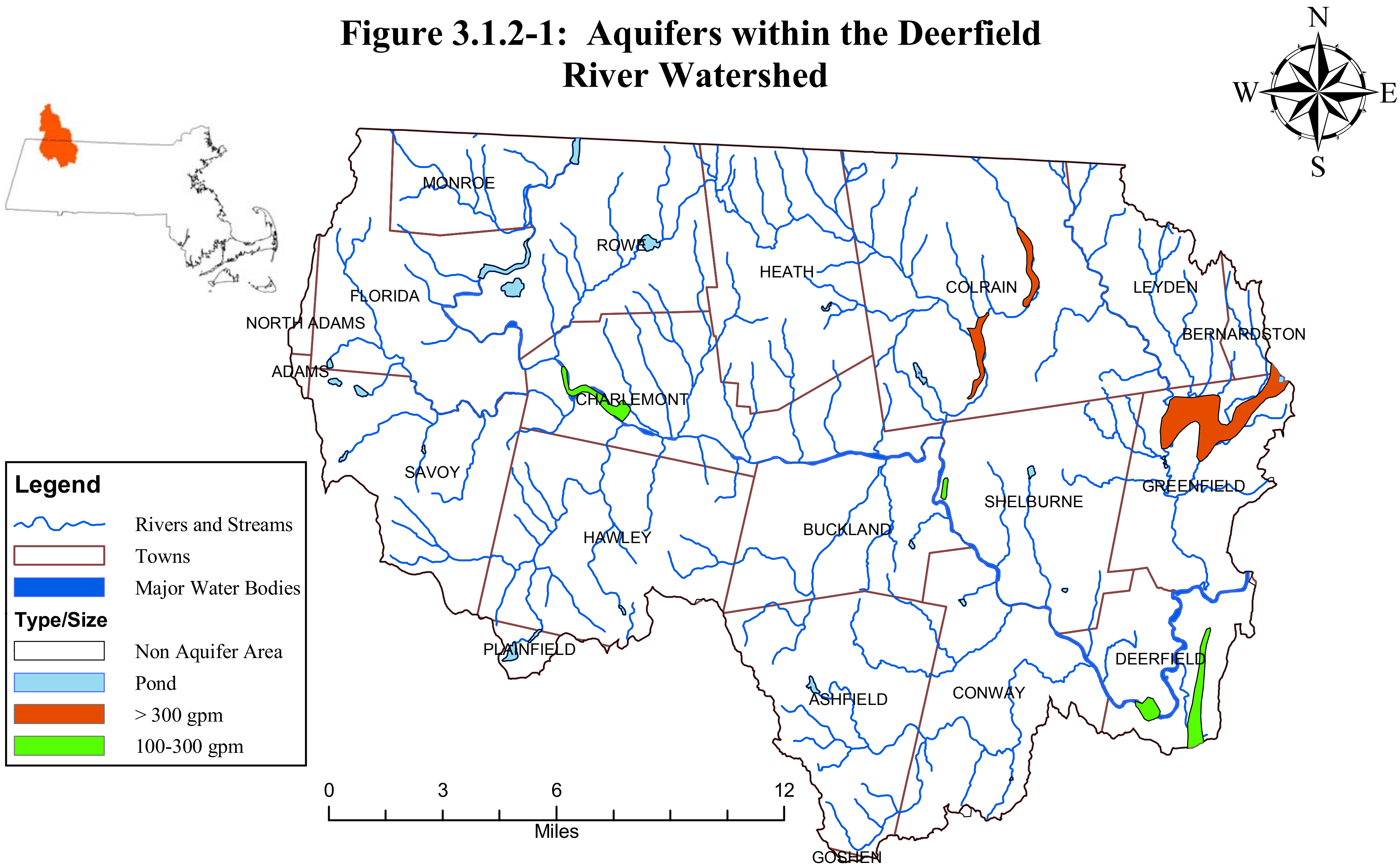
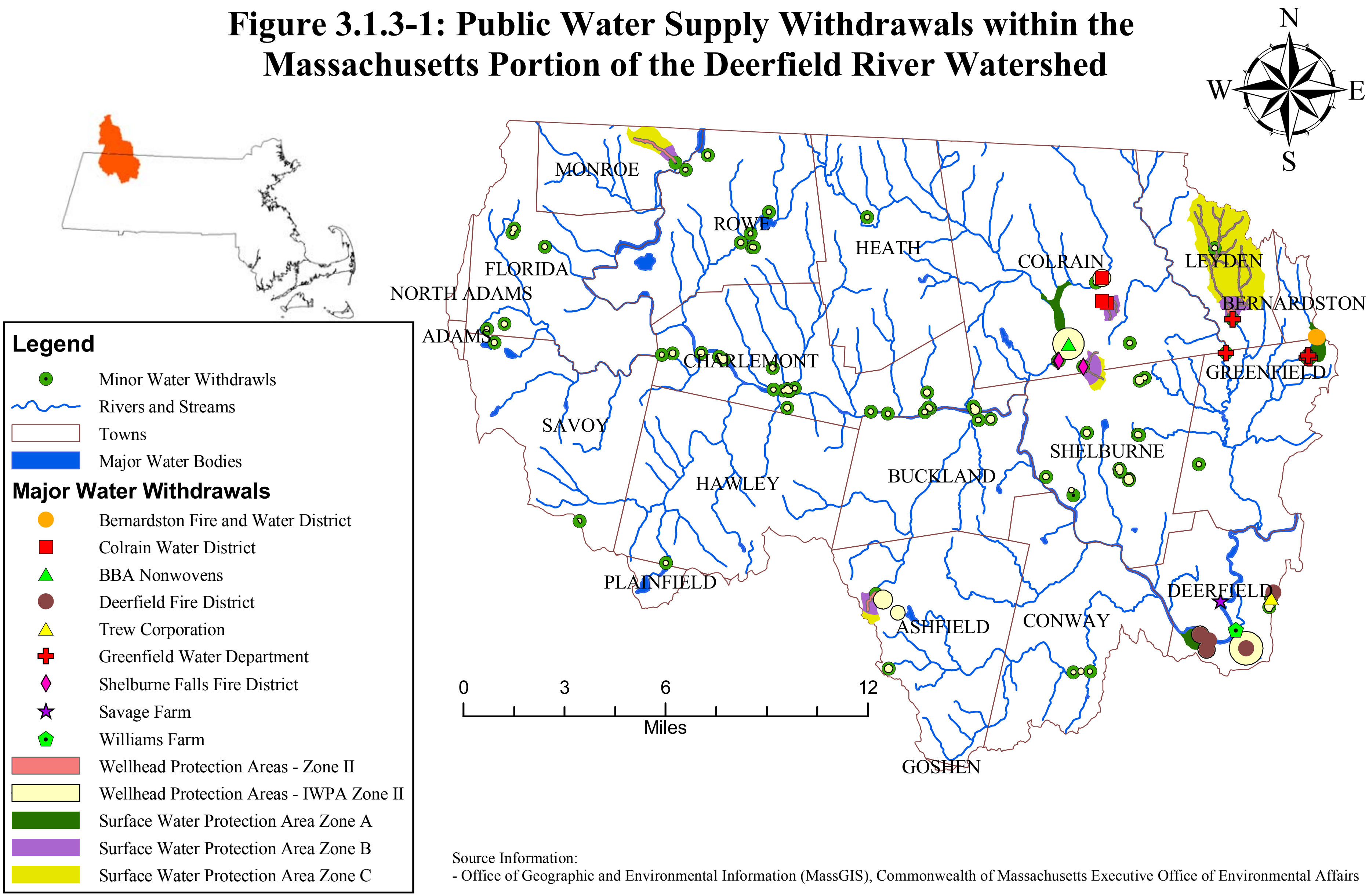


Figure 3.1.2-1: Aquifers within the Deerfield River Watershed



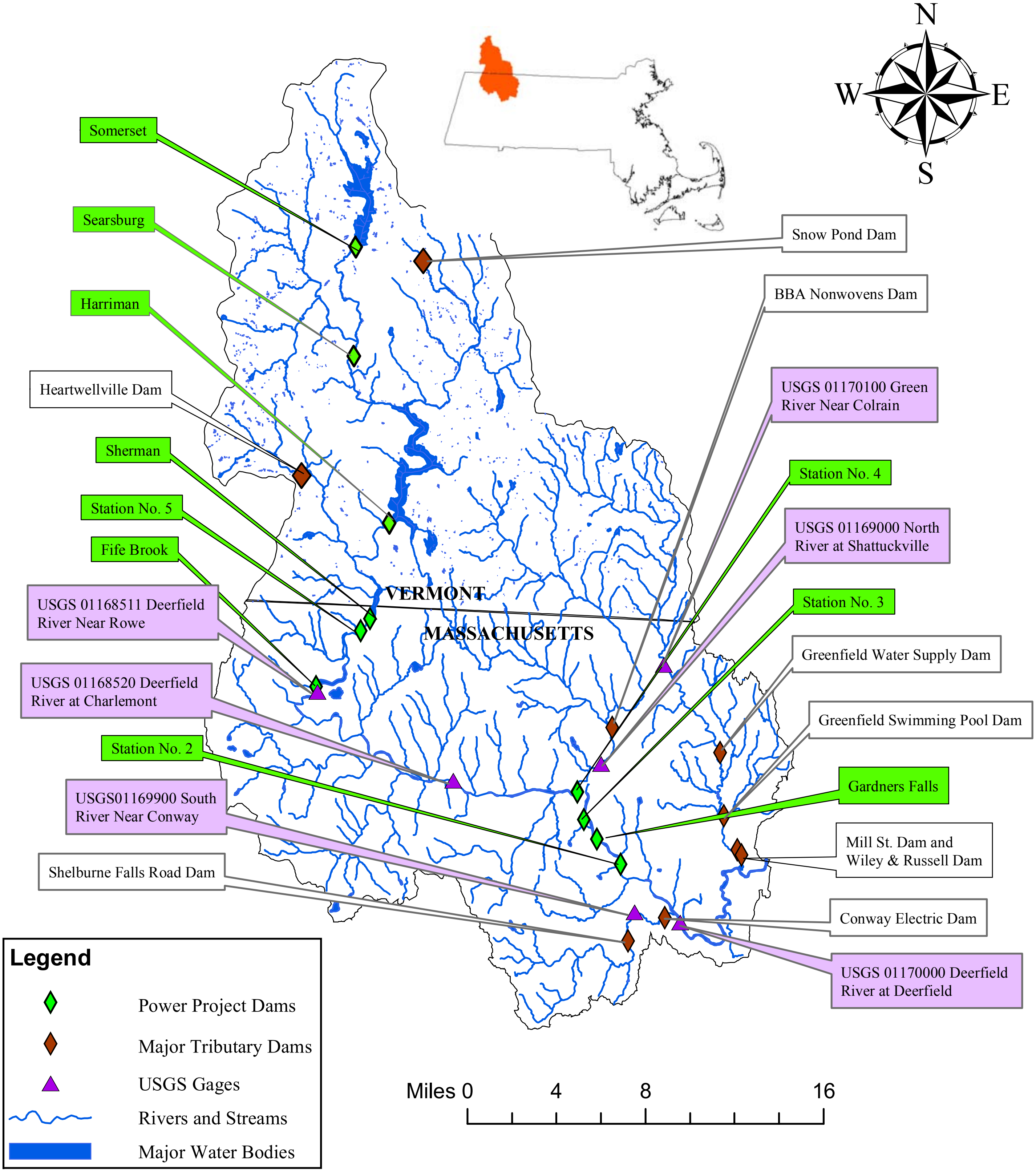
Source Information:
- Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Environmental Affairs

Figure 3.1.3-1: Public Water Supply Withdrawals within the Massachusetts Portion of the Deerfield River Watershed



Source Information:
- Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Environmental Affairs

Figure 3.1.5-1: Major Dams and USGS Gages Within the Deerfield River Watershed



Source Information:
- Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Environmental Affairs
- Vermont Center for Geographic Information

3.2 Water Quality

Overall, water quality in the Deerfield River Watershed is quite good; however, several areas have encountered local water quality problems. The principal water quality problem has been fecal coliform counts that exceed state standards occasionally during wet weather events.

One area of concern for many of the major waterbodies in the upper portion of the Deerfield Watershed is the low buffering capacity of the environment. Due to a lack of natural buffering materials, waters tend to be slightly acidic, and this circumstance can be further exacerbated by the deposition of acid rain (VANR 2003). Water quality sampling that was conducted in the upper watershed during April 2002 showed only the Deerfield River near Stillwater meeting the Massachusetts pH standard of 6.5 (DRWA 2002). Non-point source pollution particularly from localized illegal dumping, acid mine drainage, stormwater runoff, failing septic systems, and agricultural activities, as well as elevated levels of arsenic within sediments behind several impoundments are also areas of concern

3.2.1 State Water Quality Classifications

Current Vermont Water Quality Standards (VWQS) classify waters in Vermont as being either Class A or Class B, with specific reaches of Class B waters designated as Waste Management Zones (WMZ). Waters designated as WMZ have permitted discharges of treated wastes within the reach. Table 3.2.1-1 describes the potential uses for Class A and Class B waters. In addition to having a designated class, stream reaches are categorized either as a coldwater fishery or a warmwater fishery. Criteria for coldwater streams that must be satisfied include standards for turbidity (less than 10 nephlometric turbidity units [ntu]), dissolved oxygen (DO) (concentrations of greater than or equal to 6 milligrams per liter [mg/l]), saturation (greater than or equal to 70%), and temperature (less than or equal to 20°C (68°F)).

All waters within the Vermont portion of the watershed are Class B except for Haystack Pond, Howe Pond, Howe Pond Brook, Cold Brook, and all waters above elevation 2,500 feet, mean sea level (msl), which are Class A (Vermont Water Resources Board, 2000).

Table 3.2.1-1: Vermont Water Quality Classification (Source: Vermont Water Resources Board 2000)

Class A	Waters of a quality which is suitable for public water supply with disinfection when necessary. When compatible, for the enjoyment of water in its natural condition.
Class B	Waters suitable for swimming, recreation, irrigation, and other agricultural uses; good habitat for aquatic biota, fish and wildlife; good aesthetic value, acceptable for public water supply with filtration and disinfection.

According to the 1996 Massachusetts Water Quality Standards (MWQS) there are three classifications of inland waters in Massachusetts, Class A, B, and C (Table 3.2.1-2). In addition, stream reaches are categorized as either a coldwater fishery or a warmwater fishery.

Table 3.2.1-2: Massachusetts Water Quality Classification (MDEP 2003a)

Class A	These waters are designated as a source of public water supply. To the extent compatible with this use they shall be an excellent habitat for fish, other aquatic life and wildlife, and suitable for primary and secondary contact recreation. These waters shall have excellent aesthetic value. These waters are designated for protection as Outstanding Resource Waters (ORWs) under 314 Code of Massachusetts Regulations (CMR) 4.04(3).
Class B	These waters are designated as a habitat for fish, other aquatic life, and wildlife, and for

	primary and secondary contact recreation. Where designated they shall be suitable as a source of water supply with appropriate treatment. They shall be suitable for irrigation and other agricultural uses and for compatible industrial cooling and process uses. These waters shall have consistently good aesthetic value.
Class C	These waters are designated as a habitat for fish, other aquatic life and wildlife, and for secondary contact recreation. These waters shall be suitable for the irrigation of crops used for consumption after cooking and for compatible industrial cooling and process uses. These waters shall have good aesthetic value.

There are five Class A waters in the Massachusetts portion of the watershed, summarized in Table 3.2.1-3. The remainder of the Deerfield River Watershed is classified as Class B cold or warm water fishery. There are no Class C waters in the Deerfield River Watershed.

Table 3.2.1-3: Class A Waters in the Massachusetts Portion of the Deerfield River Watershed (Source: MDEP 2003a)

Water Body	Location/Outlet
Upper Reservoir and Lower Reservoir* (Highland Springs)	Source to outlet in Ashfield and those tributaries thereto
Unnamed Reservoir (Mt. Spring Reservoir, Mountain Brook Reservoir)	Source to outlet in Colrain and those tributaries thereto
Greenfield Reservoir (Glen Brook Upper Reservoir)	Source to outlet in Leyden and those tributaries thereto
Unnamed Reservoir (Fox Brook Upper Reservoir)	Source to outlet in Colrain and those tributaries thereto
Unnamed Reservoir (Phelps Brook Reservoir)	Reservoir outlet in Monroe and those tributaries thereto

*Lower Reservoir no longer exists and will be removed from the list of Class A waterbodies in the next revising of the MWQS.

Note: MDEP has recommended that the Green River and its tributaries from the Vermont border to Greenfield pumping station be reclassified from Class B to Class A in the next revision of the MWQS.

3.2.2 Designated Uses for Massachusetts Waters

The status of certain designated uses as defined in the State Water Quality Standards (SWQS) was assessed recently (MDEP 2003a). The designated uses include: aquatic life, fish consumption, primary and secondary contact recreation and aesthetics. Each use, within a given segment, was individually assessed as 1) Support, 2) Impaired, 3) Alert, and 4) Not Assessed. When too little current or reliable information was available, the use is not assessed; however, if the limited information indicates some evidence of water quality impairment which is not "naturally occurring", the use was identified with an "Alert Status."

For the 30 river segments investigated, sufficient data was available to adequately assess many segments for the five main uses evaluated (i.e., aquatic life, fish consumption, primary, and secondary contact, and aesthetics) (MDEP 2003a). At least one designated use was assessed in 25 river segments. Of those segments that were assessed, two were considered to be "Impaired" for one or more designated uses (Table 3.2.2-1) as a result of mercury contamination and acid mine drainage. Sixteen segments in the watershed were placed on "Alert Status" for aquatic life, primary contact, secondary contact, or aesthetics as a result of flow regulation, erosion and sedimentation, nutrients, high temperature, low dissolved oxygen, bacteria, or illegal waste dumping concerns.

Table 3.2.2-1: River Segment Assessment Summary (Source: MDEP 2003a)

Location	Segment #	Aquatic Life	Fish Consumption	1° Contact	2° Contact	Aesthetics
Deerfield River	MA33-01	S*	NA	S	S	S
Deerfield River	MA33-02	S*	NA	S	S	S
Deerfield River	MA33-03	S*	NA	S*	S	S
Deerfield River	MA33-04	S*	NA	S	S	S*
Pelham Brook	MA33-12	S	NA	NA	NA	S
Cold River	MA33-05	S	NA	S	S	S
Chickley River	MA33-11	S	NA	NA	NA	S
Bozrah Brook	MA33-13	NA	NA	NA	NA	NA*
Davis Mine Brook	MA33-18	NA (1.6 mi), NS (1.7 mi)	NA	I	I	NA (1.6 mi), NS (1.7 mi)
Mill Brook	MA33-14	S*	NA	NA	NA	S
Clesson Brook	MA33-15	S*	NA	S	S	S
Smith Brook	MA33-26	NA	NA	NA	NA	NA
Clark Brook	MA33-16	S	NA	NA	NA	S
East Branch North River	MA33-19	S*	NA	S*	S	S
Foundry Brook	MA33-25	NA	NA	NA	NA	S
West Branch North River	MA33-27	S	NA	NA	NA	NA
Tissdell Brook	MA33-24	NA	NA	NA	NA	S
Taylor Brook	MA33-31	S*	NA	S	S	S
North River	MA33-06	S*	NA	S*	S	S
Bear River	MA33-17	S	NA	NA	NA	S
Drakes Brook	MA33-23	S	NA	NA	NA	S
Dragon Brook	MA33-20	NA	NA	NA	NA	NA
Shingle Brook	MA33-22	NA	NA	NA	NA	NA
South River	MA33-07	S*	NA	S	S	NA
South River	MA33-08	S*	NA	S*	S*	S
Pumpkin Hollow Brook	MA33-32	S*	NA	NA	NA	S
Hinsdale Brook	MA33-21	NA*	NA	NA	NA	NA
Green River	MA33-28	S	NA	NA	NA	S*
Green River	MA33-29	S	NA	S	S	S
Green River	MA33-30	S*	NA	I	S*	S*

Legend: S=Support; NA=Not Assessed; I=Impaired; numbers in parentheses indicate river miles meeting that condition.
**=Alert Status*

A total of 24 lakes and ponds exist in the watershed. Designated uses were assessed at some lakes and ponds based on surveys conducted by MDEP in 1995 and 2000. The 1995 surveys conducted on 13 lakes were cursory in nature and relied on visual rather than quantitative observations. In 2000, more intensive baseline surveys were conducted at two lakes (Pelham Lake and Plainfield Pond).

Bog Pond was placed on "Alert Status" for aquatic life due to an unconfirmed report of non-native species (variable water milfoil) presence and Sherman Reservoir was given an "Alert Status" for aquatic life because of elevated arsenic and copper in the sediment; however, the aquatic life use was not fully assessed in any of the 24 lakes and ponds within the watershed. Sherman Reservoir and Plainfield Pond were determined to be "Impaired" for fish consumption due to mercury contamination. The remaining lakes in the watershed were not assessed for fish consumption. The primary and secondary recreation use was assessed and determined to have "Support" status in North Pond and South Pond. For the remaining lakes and ponds in the watershed, recreational and aesthetic uses were not assessed due to lack of data.

3.2.3 303d Impaired Waters

Section 303(d)[4] of the Clean Water Act, requires that various states identify waterbodies that do not meet standards and requires the development of Total Maximum Daily Loads[5] (TMDLs) for these waterbodies. The waterbodies requiring a TMDL assessment, per the Massachusetts Year 2002 Integrated List of Waters, within the Deerfield River Watershed are illustrated in Table 3.2.3-1.

Table 3.2.3-1: Massachusetts Category 5 Waters-Waters requiring a TMDL (Source: MDEP 2003b)

Name/Segment	Location	Cause of Impairment
Deerfield River/MA33-01	Vermont line/Monroe/Rowe, to confluence with Cold River, Charlemont.	Metals
Deerfield River/MA33-02	Confluence with Cold River, Charlemont to confluence with North River, Charlemont/Shelburne Falls.	Unknown Toxicity, Metals, and Chlorine
Chickley River/MA33-11	Confluence with Tilton and Horsefords brooks, Savoy to confluence with Deerfield River, Hawley.	Pathogens
Davis Mine Brook/MA33-18	Headwaters, just south of Dell Road, Rowe to confluence with Mill Brook, Charlemont.	pH, Other Habitat Alterations
Green River/MA33-09	Vermont line, Colrain to former Greenfield WWTP outfall, Greenfield.	Pathogens, Metals, Cause Unknown
Green River/MA33-10	Former Greenfield WWTP outfall to confluence with Deerfield River, Greenfield.	Unionized Ammonia, Pathogens, Metals, Cause Unknown
North River/MA33-06	From confluence of East and West Branches of the North River, Colrain to confluence with Deerfield River, Shelburne.	Pathogens, Taste, Odor and Color
South River/MA33-08	Emments Road Ashfield to confluence with Deerfield River, Conway.	Pathogens, Other Habitat Alterations, Cause Unknown
Plainfield Pond	Plainfield	Metals, Noxious aquatic plants
Sherman Reservoir	Rowe/Monroe/Whitingham, Vt.	Metals
Tannery Pond	Savoy	Flow Alteration

3.2.4 Water Quality Conditions by Subwatershed

A summary of water quality conditions along the Deerfield River and its major tributaries from Somerset Reservoir to the Connecticut River is provided below.

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[4] The Clean Water Act contains several sections requiring reporting on the quality of waters. Section 303(d) requires, from time to time, a list of waters for which effluent limitations are not sufficient to meet water quality standards. In its regulations implementing Section 303(d), the Environmental Protection Agency has defined "time to time" to mean on April 1 of every even-numbered year.

[5] A TMDL is the total amount of a pollutant that a waterbody may receive from all sources without exceeding water quality standards.

East Branch Deerfield River Subwatershed

Water temperatures within Somerset reservoir support coldwater fish species. Temperature and dissolved oxygen (DO) stratification occurs during the summer months; however, DO levels remain near saturation above the thermocline. The waters downstream of the reservoir are classified as a Class B coldwater fishery by the state of Vermont and temperature/DO levels range from 10ºC to 12ºC (50ºF to 53.6ºF) and 9.1 to 13.0 mg/l, respectively, during July, August, and September (FERC 1997).

North Branch Deerfield River Subwatershed

Approximately four miles downstream of the Searsburg Dam is Harriman Reservoir. The North Branch Deerfield joins the East Branch Deerfield at this location to form the mainstem Deerfield. Aside from snowmaking withdrawals, the North Branch is largely unregulated in terms of streamflow. However, there is a long history of land and instream alterations in the North Branch subwatershed that have impacted water quality conditions. A section of the North Branch and a tributary (Iron Stream) were assigned a “Non-Support” status by VANR due to low flows that resulted from snowmaking withdrawals and high levels of iron from ski area development. Another section of the North Branch and two tributaries (Cold Brook and an unnamed tributary) were assigned a “Partial Support” status due to low flows as a result of snowmaking withdrawals. In addition, a section of the North Branch and a tributary (Beaver Brook) were also assigned a “Non-Support” status due to stream channelization and erosion concerns (VANR 2003). The town of Wilmington holds a NPDES permit to discharge 0.0135 mgd of treated wastewater to the North Branch Deerfield River.

Deerfield River Mainstem-Vermont

Water in the Searsburg Impoundment is classified as Class B by the state of Vermont. Due to the riverine nature of the impoundment, there is little or no stratification during the summer months, and little change from the upstream reaches in water quality. The bypass reach below the Searsburg Dam did not meet minimum state water quality standards before 1997 due to low flow conditions and significant warming of the water (FERC 1997). Water temperatures would rise as much as 3ºC (37.4ºF) before being cooled again at the confluence with the Searsburg powerhouse tailrace. However, the new FERC license for the project issued in 1997 set minimum flow requirements for the bypass reach, which resulted in improved temperature and DO conditions.

Water quality in Harriman Reservoir meets Vermont state water quality standards, but there is evidence that increased housing density, land clearing, and agricultural uses have elevated phosphorus levels. It is important to note that, overall, the reservoir is relatively low in productivity. In addition, historic water quality sampling has shown that water tends to be somewhat acidic with pH ranging from 6.4 to 5.9 and is sensitive to acidic inputs. Thermal stratification occurs during the summer and cooler temperatures at depth support cold-water fish species. The Harriman bypass reach receives well-oxygenated, cold water from the reservoir, which helps support a downstream coldwater fishery. The unregulated West Branch Deerfield River joins the mainstem in the Harriman bypass reach before eventually flowing into the Sherman Reservoir. The Village of Whitingham holds an NPDES permit to discharge 0.012 mgd of treated wastewater into the Harriman Reservoir, while the Town of Readsboro discharges treated wastewater to mainstem below Harriman Reservoir (Table 3.2.4-1).

West Branch Deerfield River Subwatershed

Water quality information within the West Branch Deerfield River Subwatershed is limited; however, high summer water temperatures resulting from a lack of stream shading and summer low flows have been identified as a concern. In addition, waters within the watershed can experience low alkalinity and low pH as well (VANR 2003).

Deerfield River Mainstem-Massachusetts

The Class B waters leaving the Harriman Reservoir enter the Sherman Reservoir, located in Rowe, Massachusetts, at the border of Vermont and Massachusetts. From 1961 to 1992 the Sherman Reservoir received once-through cooling water from the Yankee Atomic Electric Company (YAEC) Rowe Nuclear Powerplant. The most recent NPDES permit issued in 1988 allowed non-contact discharges of up to 225 mgd of cooling water with a maximum allowable temperature rise of 13.1ºC (rise of 23.5ºF) over intake, 10.8 mgd of service water consisting of turbine lubricating oil, cooling water, generator hydrogen cooling water, and the primary plant effluent, and 1.0 mgd of water treatment plant effluent, transformer cooling water, and floor drain water with a maximum allowable temperature rise of 19.4ºC (rise of 35ºF) over intake temperature (Table 3.2.4-1) (MDEP 2003a).

The nuclear plant has been actively decommissioning since February 1992, and a permit has been drafted to authorize discharge of up to 0.22 mgd of wastewater consisting of spent fuel pool heat exchanger, dilution test tank effluent, stormwater, and excavation de-watering during the decommissioning process. The power plant draws its water from a pipe about 70 feet deep and 200 feet offshore in the Sherman Reservoir and discharges via three outfalls back into the reservoir. Additionally, when the plant is preparing for final dismantlement, the spent fuel pool containing 145,000 gallons of water must be drained and rinsed requiring another 20,000 gallons. All water must pass through a purification system to minimize the release of radioactive materials to the environment (MDEP 2003a).

Presently, the Sherman Reservoir is a Class B waterbody and meets both Vermont and Massachusetts surface water quality standards. Temperatures remain under 20ºC (68ºF) below approximately 30 feet of depth during summer stratification and DO levels are good throughout (FERC 1997). Sediment grab samples from the Sherman Reservoir showed elevated levels of arsenic (25.5 ppm, four times the low effects range) and copper (32.3 ppm two times the low effects range) (ESS, Inc. 2002). The Massachusetts Department of Public Health (MDPH) has issued a fish consumption advisory for Sherman Reservoir due to elevated mercury levels (MDPH 2002). As a result, the fish consumption use for this portion of the river was "Impaired" (MDEP 2003a).

Outflow from the Sherman powerhouse (located at the dam) travels about 0.8 miles downstream into the Station No. 5 impoundment. USGen was authorized in September 1997 via NPDES permit MA0034908 to discharge 0.05 mgd of station sump water, and 0.002 mgd of bearing cooling water into the Deerfield River near Mill Street/Monroe Bridge, in Monroe just below the Sherman Reservoir. In addition, the Town of Monroe is authorized (permit number MA0100188) to discharge 0.015 mgd from their wastewater treatment facility at this same location (Table 3.2.4-1). Sampling conducted upstream of the Monroe wastewater facility showed alkalinity and pH ranges of 10 to 20 mg/l and 6.3 to 6.8, respectively (MDEP 2003a).

Water in the Station No. 5 impoundment is classified as Class B by the state of Massachusetts. Temperatures are typically below 20ºC (68ºF) and DO near saturation throughout the impoundment (FERC 1997); however, high summertime temperatures may present problems for coldwater fish species. Water from the impoundment is diverted 3.1 miles downstream to the Station No. 5 powerhouse where it discharges into the Fife Brook Impoundment. The entire flow of Dunbar Brook is also diverted into the power canal in Monroe. USGen is authorized by NPDES permit MA0034894 (issued September 1997) to discharge 0.072 mgd of station sump water with oil floatation, 0.252 mgd of bearing cooling water, 0.0126 mgd of strainer backwash, and <10 gallons per day (gpd) of sump water with oil floatation at the Station No. 5 Dam (Table 3.2.4-1). Water quality and chemistry in the 3.1 mile Station No. 5 bypass reach is good and meets Class B standards for coldwater fish, since the minimum flow of 73 cfs was established in 1997 (MDEP 2003a).

Water from the Station No. 5 impoundment enters the Fife Brook Impoundment via the bypass reach and the tailwater of the Station No. 5 powerhouse. The Fife Brook Impoundment is classified as a Class B waterbody by the state of Massachusetts and supports coldwater fish species. The FERC requires a minimum flow of 125 cfs to be released from the Fife Brook Dam. Water quality sampling conducted a short distance below Fife Brook Dam in the summer of 2000 by MDEP showed DO ranging from 8.5 to 9.8 mg/l, and the maximum recorded temperature reaching 17.0ºC (62.6ºF). The pH and alkalinity at this site ranged from 5.8 to 6.5 and 4 to 5 mg/l, respectively. Turbidity was low, ranging from 1.3 to 2.4 nephlometric turbidity units (ntu) (MDEP 2003a). Fecal coliform counts below the Fife Brook dam near Zoar Gap ranged from 7 to 10 colonies/100 milliliters (DRWA 2002).

The 17-mile stretch of river between the Fife Brook Dam/Powerhouse and the Station No. 4 Impoundment is the longest unimpeded reach of the entire 70.4 miles of the Deerfield River and is used heavily for recreation. This reach is classified as a Class B coldwater fishery. Five significant tributaries enter this river reach; Pelham Brook, Cold River, Chickley River, Mill Brook, and Clesson Brook.

Water quality sampling conducted near the Charlemont USGS gage in the summer of 2000 showed DO ranging from 9.3 to 12.8 mg/l and saturation was not less than 91%. The maximum temperature recorded was 19.7ºC (67.5ºF) (MDEP 2003a). Fecal coliform counts ranged from 10 to 50 colonies/100 milliliters (ESS Inc. 2002). The pH ranged from 6.4 to 6.8 and alkalinity was low (4 to 6 mg/l). Suspended solids measurements were very low ranging between 1.4 to 1.9 mg/l and measurements for turbidity were very low ranging between 0.15 to 1.7 ntu (MDEP 2003a and ESS Inc. 2002).

There is one NPDES permit for wastewater discharge in this mainstem segment. The NPDES permit number MA0103101 issued in September 1997 authorizes the Charlemont Wastewater Treatment Plant to discharge 0.05 mgd of treated wastewater to the Deerfield River just downstream of the confluence with Mill Brook in Charlemont (Table 3.2.4-1). The facility was upgraded in 1999 and effluent toxicity has improved as a result (MDEP 2003a).

The Deerfield River Valley begins to broaden through Charlemont, and temperature, DO, and pH remain at satisfactory levels; however, sediments sampled within the Station No. 3, Station No 2, and Gardners Falls impoundments all showed slightly elevated levels of arsenic (1-3 times greater than low effects ranges) (ESS Inc 2002). Despite these non point sources of pollution, the aquatic life in the Deerfield River is apparently not affected and the water quality meets all MWQS uses (MDEP 2003a).

The Station No. 4 Impoundment is a shallow, riverine impoundment about 1.5 miles long and meets Class B coldwater fishery standards. Sediment grab samples in the No. 4 impoundment found all analyzed chemicals to fall below the low effects range with the exception of arsenic which had a slightly elevated level (12.0 ppm, two times greater than low effects range) (ESS Inc. 2002).

The Station No. 4 Dam diverts water downstream to the powerhouse, where it empties upstream of the Station No. 3 Impoundment in Shelburne Falls. The 1.4-mile bypass reach, below the Station No. 4 Dam makes a wide northern loop before turning south again and entering Shelburne Falls. The North River, the Deerfield's largest tributary, enters the Deerfield 0.8 miles downstream from the Station No. 4 Dam in the bypass reach.

The Deerfield River below the Station No. 4 dam is classified as a Class B warmwater fishery as temperatures in the summer may rise above 20ºC (68ºF). There are no water quality issues in the mainstem from the Station No. 4 powerhouse to the Station No. 3 impoundment. USGen is authorized by

NPDES permit MA0034860 issued in September 1997 to discharge 0.0015 mgd of floor drain water, 0.06 mgd of transformer cooling water, and 0.0216 mgd of bearing cooling water at the Station No. 4 dam (Table 3.2.4-1).

The Station No. 3 Impoundment is classified as a Class B warmwater fishery. Sediment grab samples collected behind the Station No. 3 Dam showed that the arsenic concentration at 10.7 ppm, which is approximately 1.8 times greater than the low effects level (ESS Inc. 2002). The Station No. 3 powerhouse has an NPDES permit (MA0034851) issued September, 1997 to discharge the following volumes: 0.0015 mgd of internal facility drainage, 0.06 mgd of transformer non-contact cooling water, 0.0216 mgd bearing contact cooling water, and 0.0432 mgd of cooling water strainer backwash (Table 3.2.4-1). The 0.4-mile bypass reach has no water quality issues aside from maintenance of a 100 cfs minimum flow. However, a fecal coliform level of 350 colonies/100 milliliters (a violation of state standards is 400 colonies/100 milliliters) was recorded in the glacial potholes below the Station No. 3 Dam (DRWA 2002).

The town of Buckland is authorized to discharge from the Shelburne Falls Wastewater Treatment Facility to the Deerfield River (NPDES permit MA0101044 issued September 1997). The permittee is authorized to discharge 0.25 mgd of treated sanitary wastewater.

Below Station No. 3 the river is quickly impounded again by the Gardners Falls Dam. The impounded waters again are shallow Class B waters supporting a warmwater fishery. Sampling conducted in April 2002 just upstream of the Gardners Falls Dam showed pH, alkalinity, DO, and DO saturation levels of 6.34, 10.30 mg/l, 10.54 mg/l, and 93%, respectively (DRWA 2002). However, sediment grab samples collected behind the Gardners Falls Dam showed the arsenic concentration at 10.3 ppm, which is approximately 1.7 times greater than the low effects level, and the lead concentration at 43.5 ppm, which is approximately 1.4 times greater than the low effects level (ESS Inc. 2002).

The Gardners Falls project is certified by NPDES permit MA0035670 to release 0.00864 mgd of bearing cooling water and 10 gpd of boiler blowdown (max temp 32.2ºC [90ºF]) (Table 3.2.4-1). There is a 0.3-mile bypass reach below the Gardners Falls Dam as the water is diverted along the west bank to the powerhouse. Required minimum flow in the mainstem Deerfield below Gardners Falls Dam is 150 cfs. There are no water chemistry or water quality issues in the 2.5-mile reach between Gardners Falls and the Station No. 2 impoundment; however, in June of 2002, a fecal coliform level of 400 colonies/100 milliliters (a violation of state standards) was recorded in the Wilcox Hollow area below the Gardners Falls Dam (DRWA 2002).

The Station No. 2 Impoundment holds Class B waters, and the Station No. 2 powerhouse is certified (NPDES permit MA0034851 in September 1997) to release 0.0015 mgd of internal facility drainage, 0.06 mgd of non-contact transformer cooling water, 0.0216 mgd of bearing cooling water, and 0.0432 mgd of cooling water strainer backwash (Table 3.2.4-1). Sediment grab samples showed that the arsenic concentration at 16.3 ppm, which is approximately 2.7 times greater than the low effects level (ESS Inc. 2002).

From the tailwaters of the Station No. 2 Dam the Deerfield River flows 13.2 miles to its confluence with the Connecticut River with the South and Green rivers entering in Conway and Greenfield. In June of 2002, a fecal coliform level of 620 colonies/100 milliliters (a violation of state standards) was recorded at the South River confluence, and a level of 740 colonies/100 milliliters was collected a short distance downstream at the Stillwater bridge (DRWA 2002). DO just upstream of the confluence with the Green River in Greenfield ranged from 9.28 to 11.78 mg/l and saturation was not less than 83% during the summer of 2000. The maximum temperature in this segment of the Deerfield River in 2000 was 20.5ºC. The pH ranged from 6.8 to 7.0 (ESS Inc. 2002).

The Town of Deerfield is authorized to discharge from the Old Deerfield Wastewater Treatment Facility to the Deerfield River in Deerfield (NPDES permit MA0101940 issued September 1997). The permittee is authorized to discharge 0.25 mgd of treated sanitary wastewater. In addition, the Greenfield Water Pollution Control Plant located in Greenfield, Massachusetts is authorized by NPDES permit MA0101214 issued in October 2002 to discharge 3.2 mgd of sanitary wastewater to the Deerfield (Table 3.2.4-1). The location of this outfall has recently been moved from the Green River to the Deerfield River, which has resulted in improvements to Green River water quality conditions.

DO measurements taken near the Route 5/10, below the Green River confluence, in Greenfield during 2000 were not less than 8.9 mg/l and were as high as 11 mg/l. Percent saturation ranged from 88% to a high of 95%. The maximum temperature measured in 2000 was 20.2ºC. The pH ranged between 6.8 and 7.0 and alkalinity ranged from 11 to 17 mg/l during the summer of 2000 (MDEP 2003a and ESS Inc. 2002). There have been concerns related sources of elevated phosphorus and occasional high turbidity in this segment (MDEP 2003a).

Pelham Brook Subwatershed

Water quality sampling of fecal coliform bacteria from Pelham Brook was conducted in November and December 1995 and April 1996 by MDEP. Fecal coliform counts ranged from <4 to 74 colonies/100 milliliters. In addition, fish species were collected in this brook, and the presence of multiple age classes of brook trout and Altantic salmon, multiple intolerant species, and the absence of macrohabitat generalists indicated excellent water quality conditions as well as stable flow regimes (MDEP 2003a).

Cold River Subwatershed

The Cold River flows approximately 14 miles southeasterly before entering the Deerfield River in Charlemont, Massachusetts. Sampling conducted in April 2002 by DRWA showed that Cold Brook has pH, alkalinity, DO, and DO saturation levels of 5.59, 5.80 mg/l, 10.06 mg/l, and 87%, respectively. Fecal coliform counts ranged from 0 to 80 colonies/100 milliliters. (DRWA 2002). In addition, fish species were collected in this brook, and the presence of multiple age classes of brook trout and Altantic salmon, multiple intolerant species, and the absence of macrohabitat generalists indicated excellent water quality conditions as well as stable flow regimes (MDEP 2003a).

Chickley River Subwatershed

The Chickley River flows 8.7 miles northeasterly before entering the Deerfield River in Charlemont approximately 2 miles downstream of the Cold River confluence, and is classified as a Class B coldwater fishery. Dissolved oxygen in the Chickley River ranged from 9.3 to 11.6 mg/l and saturation was not less than 90% during the summer of 2000. The maximum temperature recorded in the Chickley River was 15.8ºC (60.4ºF), while pH ranged between 6.9 and 7.2 (ESS, Inc. 2002).

Mill Brook Subwatershed

Davis Mine Brook is a sub-tributary and begins in Rowe before flowing into Mill Brook in Charlemont. This brook has been severely impacted by the now defunct Davis Mine in Rowe, and assigned a "Impaired" status for aquatic life and aesthetic uses (MDEP 2003a). The Davis Mine was a sulfur mine containing pyrite and was active from 1882 to 1910 when it collapsed and groundwater filled the shafts. Since that time, extremely acidic water (pH < 2) has been entering the Davis Mine Brook and has led to the disappearance of fish and many macroinvertebrates. Acid mine drainage is evident in the streambed near the mine as the water is brightly colored due to the colonization of acidophilic microbes. Mill Brook has some potential water quality issues and was placed on Alert Status for aquatic life uses (MDEP 2003a), as it may be affected by Davis Mine Brook's acidic water, or by junkyards/landfills in its watershed.

Clesson Brook Subwatershed

Clesson Brook in Hawley-Buckland met MWQS for a coldwater fishery, but fish sampling conducted by MDEP revealed that there were no salmonids (trout, salmon) present and only one of the fish species collected was considered to be intolerant of pollution. Therefore, it was placed on "Alert Status" for aquatic life use. Water quality samples were collected from Clesson Brook during the summer of 2000. Dissolved oxygen and DO saturation were not less than 11.5 mg/l or 90.6% saturation. The maximum instream temperature was 17.1ºC (62.8ºF), pH ranged from 7.0 to 7.3, and turbidity ranged from 0.08 to 1.92 ntu (ESS, Inc. 2002).

North River Subwatershed

The North River is formed at the confluence of the East and West Branches of the North River in Colrain, Massachusetts and flows 3.3 miles through Shelburne, Massachusetts to its confluence with the Deerfield River. The East and West Branches flow south from their headwaters in Halifax and Whitingham, Vermont through Colrain and Heath, Massachusetts.

The North River and its tributaries are classified as Class B coldwater fisheries and have generally good water quality with the exception of erosion, sedimentation, landfill seepage, and wastewater discharge concerns. Parts of the North River and some of its tributaries have been experiencing significant erosion in localized areas. These erosion sites, combined with upstream road crossing and agricultural runoff, have potential impacts on productivity and nutrient loading. Significant turbidity in the North River and its tributaries was observed during wet weather conditions.

Water quality data collected during the summer of 2000 in the East Branch North River showed DO conditions were not less than 11.2 mg/l or 93.9% saturation. The maximum instream temperature was 19.6ºC (67.3ºF), and pH ranged from 6.9 to 7.4. Turbidity ranged from 0.60 to 41.8 ntu although five of six measurements were less than 1.6 ntu. The elevated turbidity occurred during a wet weather event (ESS, Inc. 2002).

The lower 3.3 miles of the North River (before it enters the Deerfield River) support the MWQS for a Class B coldwater fishery; however, there are several pollution issues. Dissolved oxygen measurements in the North River collected during the summer of 2000 near the BBA Nonwovens facility were not less than 9.3 mg/l and were as high as 13 mg/l. Percent saturation ranged from 89.3 to a high of 110%. The maximum temperature in the North River was 19ºC (66.2ºF). The pH of the North River ranged between 6.5 and 7.8. However, sediment grab samples collected in 2000 showed the arsenic concentration at 12.6 ppm, which is approximately two times greater than the low effects level (ESS Inc. 2002). In 2002, fecal coliform levels ranged from 16 to 236 colonies/100 milliliters just upstream of the BBA Nonwovens facility (DRWA 2002).

BBA Nonwovens is authorized via NPDES permit MA0003697 issued in March 1997 to discharge 1.35 mgd of treated industrial and domestic wastewater and stormwater to the North River (Table 3.2.4-1). Eight of 21 tests conducted from 1997 to 2002 on the wastewater facility effluent did not meet permit requirements. Fecal coliform bacteria counts have been slightly elevated below the facility. In addition, an acid spill to the North River occurred at the BBA Nonwovens facility in September 1999. The spill of approximately 700 gallons of 93% sulfuric acid resulted in extensive fish kill in the 3.3-mile reach from the facility to the confluence with the Deerfield River. Actions were taken to minimize the impact, and a Natural Resource Damage settlement was reached in 2003 for damages incurred.

South River Subwatershed

The South River begins at the outlet of Ashfield Pond in Ashfield and flows northeasterly through Conway to its confluence with the Deerfield River about 4 miles downstream of the Station No. 2 Dam. The water quality is generally good although it was put on the 1998 303d list of impaired waters for unknown causes/habitat alteration and pathogens.

Water quality sampling conducted in 2000, showed that six out of twenty fecal coliform tests conducted at various locations had bacteria counts greater than 200 colonies/100 milliliters and all occurred during wet weather conditions (ESS, Inc. 2002). A sewage treatment system called Solar Aquatics was installed to treat municipal wastewater from the Ashfield town center. This facility has a groundwater discharge (permit # GW-594-0) with a limit of 0.025 mgd.

Dissolved oxygen measurements in the South River collected in the summer of 2000 in the lower portion of the river were not less than 9.3 mg/l and were as high as 13.1 mg/l. Percent saturation ranged from 88.4 to a high of 100. The maximum temperature was 20°C (68°F) (ESS, Inc. 2002).

Green River Subwatershed

The Green River begins in Marlboro, Vermont and flows approximately 33 miles south into the Deerfield River, entering in Greenfield, Massachusetts. The northern portion of the river down to the Greenfield Water Supply Dam in Greenfield (8.3 miles north of the confluence) is classified as a Class A public water supply coldwater fishery and water quality is good. DO measurements in this section taken by MDEP in 2000 were not less than 9.4 mg/l. Percent saturation ranged from 91% to a high of 98%. The maximum temperature was 16°C (61°F), pH ranged between 7.3 and 7.7, alkalinity ranged from 31 to 38 mg/l, and suspended solids were below detection (MDEP 2003a). Despite good water quality the river does have some aesthetic and ecologic quality issues in this northern section. There is a dumping area present along the river in Colrain that contains household appliances, household trash, construction debris, paint cans, and furniture. The area is cleaned up by volunteers on an annual basis. There is also a junkyard located in Guilford, Vermont and the Greenfield Department of Public Works along with the town of Guilford have addressed concerns about vehicles in the floodplain and stormwater best management practices.

The health of the final 3.7-mile reach to the confluence with the Deerfield River is compromised by high fecal coliform counts, limited riparian zones, and one dam in disrepair. Fecal coliform counts are high (range from 80 to 6,870 colonies/100 milliliters) both in the mainstem Green River and in its tributary streams near the confluence with the Deerfield. The high counts occurred during wet weather events in the fall of 2000. Sewage contamination was ruled out as the source of high counts in the Cherry Rum Brook subtributary. High counts in the Arms Brook subtributary are attributed to neighboring cattle fields, high counts in the Maple Brook subtributary are attributed to sewage leakage in Greenfield, and high counts in the Wheeler Brook subtributary could not be explained.

Turbidity and trash along some areas of the riverbank in Greenfield and a petroleum odor from the sediment have been noted (MDEP 2003a). The Greenfield Water Pollution Control Plant discharged treated wastewater to the Green River near the confluence with the Deerfield until 1998 when the discharge was moved to the mainstem Deerfield (Table 3.2.4-1).

Dissolved oxygen measurements in the Green River collected in the summer of 2000 within the lower portion of the river were not less than 8.2 mg/l and were as high as 11.0 mg/l. Percent saturation ranged from 75.0 to a high of 103. The maximum temperature was 20°C (68°F), pH ranged between 7.1 and 7.5, alkalinity ranged from 41 to 46 mg/l, suspended solids ranged from 1.6 to 4.4 mg/l during the 2000 (ESS, Inc. 2002).

3.2.5 Landfills

Fuss and O'Neil (2003) conducted an assessment of the environmental risk posed by current and historic landfills in the Deerfield River watershed. As part of the assessment, all current and historic landfills in the Massachusetts portion of the Deerfield River watershed were identified (Figure 3.2.5-1). These landfills were then prioritized in terms of the likelihood to adversely impact nearby natural resources. Further evaluation of these priority sites, including field reconnaissance and screening level sampling, was then conducted; and recommendations were developed to address identified problems. The results of the landfill assessment are summarized in Table 3.2.5-1. Recommendations from the study included the following.

- Management of the Rowe Landfill along Pelham Brook, including removal of solid waste from Pelham Brook, cleanup of refuse along the base of the landfill, and repair and stabilization of the eroded areas of the landfill side slopes. Additional field investigation may be warranted to further assess the environmental risk posed by the landfill and determine the need for corrective/remedial action.

- Management of the Charlemont Landfill, including removal of the exposed bulky waste adjacent to Tatro Brook, and additional field investigation to further assess the environmental risk from the landfill and determine the need for corrective/remedial action. Inspection and additional field investigation of the former municipal brush dump on Warner Hill Road is also recommended.

- Management of the Colrain Brush landfill/Former Town Dump including; performing additional field investigation to assess environmental risk, identifying and characterizing the extent of any impacts that may be present, and determining the need for corrective action. The report identified significant quantities of exposed refuse within 50 feet of the North River and groundwater seeps hydraulically connected to the North River as major issues of concern.

- Management of the Buckland Wood and Demolition Landfill, additional field investigation is recommended to further assess the environmental risk posed by the landfill, identify and characterize the extent of any impacts that may be present, and determine the need for corrective/remedial action. The investigation should include field measurement of hydraulic conductivity, depth to groundwater, confirmation of groundwater flow rate and direction, and collection of upgradient and downgradient groundwater samples and additional seep samples.

- Management of the Lampson & Goodnow site, additional investigation is recommended to address potential contamination associated with the former process wastewater discharge and identified waste disposal area behind the manufacturing building. The vertical and lateral extent of impacted soils in the area should be delineated, and remedial alternatives should be identified. Additional inspection and sampling of the historical waste disposal area is also recommended to further identify the nature and extent of the waste.

- Management of the former Conway/Buckland Landfill, additional field investigation is recommended to further assess the environmental risk posed by the landfill, identify and characterize the extent of any impacts that may be present, and determine the need for corrective action. Field measurement of hydraulic conductivity, depth to groundwater, confirmation of groundwater flow rate and direction, and collection of upgradient and downgradient groundwater samples and additional seep sampling should be performed.

- Management of the Greenfield tire pile, the tire pile should be removed and the ravine should be stabilized to reduce the potential for erosion and sedimentation in the Deerfield River. This effort should be coordinated with the Greenfield Board of Health and the property owner.

3.2.6 Stormwater Management

Phase I of the National Pollutant Discharge Elimination System (NPDES) stormwater program was established in 1990. It required NPDES permit coverage for municipalities that had populations of 100,000 or more.

Phase II of the NPDES stormwater program was signed into law in December 1999. This regulation builds upon the existing Phase I program by requiring smaller communities, also known as small municipal separate storm sewer systems (MS4s), to be permitted.

Regulated small MS4s must apply for permit coverage by March 2003. Those communities permitted under Phase II are required to develop and implement a comprehensive stormwater management program that includes six minimum measures: (1) public education and outreach on stormwater impacts; (2) public involvement/participation; (3) illicit discharge detection and elimination; (4) construction site stormwater runoff control; (5) post-construction stormwater management for new development and redevelopment; and (6) pollution prevention/good housekeeping for municipal operations.

One way a small MS4 becomes part of the Phase II program is through an automatic designation, which applies to areas designated as an urbanized area by the U.S. Census Bureau. The definition of an urbanized area is any local government or group of local governments that combined have a population of 50,000 and a density of 1,000 people per square mile. Currently, there are no Phase II stormwater communities in the Deerfield River Watershed.

Table 3.2.4-1: NPDES Permit Dischargers in the Deerfield River Watershed (Source MDEP 2003a and VANR 2003)

Company	NPDES Permit #	Issue Date	Discharge Amount (mgd)	Type of Discharge	Receiving Water
* Wilmington WWTF			0.0135	Treated sanitary wastewater	North Branch Deerfield River
* Whitingham WWTF			0.00123	Treated sanitary wastewater	Harriman Reservoir
* Readsboro WWTF			0.0075	Treated sanitary wastewater	Deerfield River mainstem
*Jacksonville WWTF			0.00501	Treated sanitary wastewater	East Branch North River
YAEC	MA0004367	9/1988 (2/1993)	225 10.8 1.0	Condenser cooling water Service water Effluent/floor drain water	Sherman Reservoir
USGen	MA0034908	9/1997	0.05 0.002	Station sump water Bearing cooling water	Sherman Reservoir
Town of Monroe	MA0100188	9/1997	0.015	Treated sanitary wastewater	Sherman Reservoir
USGen	MA0034894	9/1997	0.072 0.252 0.0126 <10 gpd	Station sump water Bearing cooling water Strainer backwash Sump water w/ oil floatation	Fife Brook Impoundment
USGen	MA0034886	9/1997	6.58 0.22	Equipment cooling water/floor drain Strainer backwash	Fife Brook Impoundment
USGen	MA0034878	9/1997	0.07 0.35	Station sump water Bearing cooling water and strainer backwash	Fife Brook Impoundment
Town of Charlemont WWTP	MA0103101	9/1997	0.05	Treated sanitary wastewater	Deerfield River mainstem
BBA Nonwovens	MAR05B746 MA0003697	3/2001	N/A 1.35	Storm water Treated industrial wastewater	North River
USGen	MA0034860	9/1997	0.0015 0.06 0.0216	Floor drain water Transformer cooling water Bearing cooling water	Deerfield River mainstem
Town of Buckland from Shelburne Falls WWTP	MA0101044	9/1997	0.25	Treated sanitary wastewater	Deerfield River mainstem

Company	NPDES Permit #	Issue Date	Discharge Amount (mgd)	Type of Discharge	Receiving Water
Consolidated Edison	MA0035670	9/1997	0.00864 10 gpd	Bearing cooling water Boiler blowdown	Deerfield River mainstem
USGen	MA0034851	9/1997	0.0015 0.06 0.0216 0.0432	Internal facility drainage Non-contact cooling water Bearing cooling water Cooling water backwash	Deerfield River mainstem
Town of Deerfield WWTP	MA0101940	9/1997	0.25	Treated sanitary wastewater	Deerfield River mainstem
Town of Greenfield WPCP (water pollution control plant	MA0101214	10/2002	3.2	Treated sanitary wastewater	Deerfield River mainstem

* Denotes NPDES permits issued by the State of Vermont.

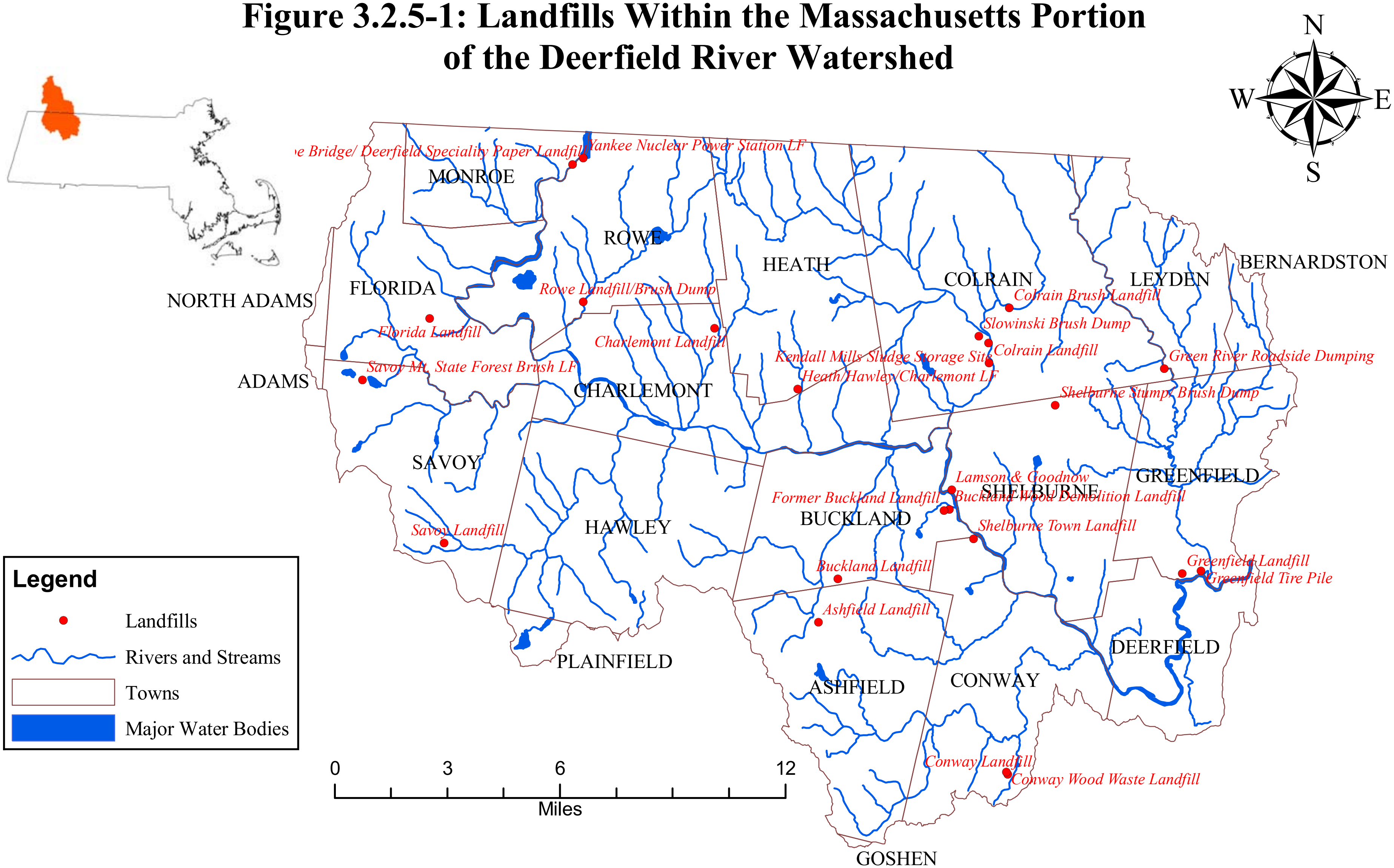
Table 3.2.5-1: Pertinent Results from Deerfield River Watershed Landfill Assessment (Source: Fuss and O'Neil 2003)

Landfill	Dates of Operation	Waste	Status	Monitoring	Nearest Water Body
Florida Landfill	1900-81	Wood, msw*, c/d+, tires	Closed/Capped	N	1,500 ft, Deerfield River
Monroe Bridge /Deerfield Specialty Paper Landfill	1900-84	Msw, paper sludge	Closed/Capped	1995-present	200 ft, Deerfield River
Yankee Nuclear Power Station-construction fill area	1900s-1980s	c/d waste	Inactive/Capped/Lined	1997-present	500 ft, Deerfield River
Rowe Brush Dump	Unknown	Demolition debris	Inactive	N	100 ft, Pelham Brook
Rowe Landfill	Unknown-1978	msw	Inactive	2003	100 ft, Pelham Brook
Savoy Mt. State Forest Brush Landfill	Unknown	Wood waste	Inactive	N	Cold River
Heath/Hawley/Charlemont Landfill	1972-89	msw	Inactive	1987-present	<500 ft. Deerfield River
Savoy Landfill	1959-93	msw	Closed/Partial Cap		1,000 ft, Tilton Brook
Charlemont Landfill	Unknown-1972	msw	Inactive	Recommended in 2002	10 ft, Tatro Brook/Mill Brook
Buckland Landfill	1966-96	Msw, c/d, industrial, sludge (from Shelburne WWTP), bottom ash daily cover	Closed/Capped	1991-present	Clesson Brook
Ashfield Landfill/Demolition/Wood Waste	Unknown-1993	msw and wood waste	Inactive/Capped	2002	2,000 ft, Smith Brook
Colrain Brush Landfill/ Former Town Dump	Unknown-1989	c/d, industrial waste, msw	Closed/Capped	Sampled in 2003	50 ft, North River
Kendall Mills Sludge Storage Site	1970-75	Sludge from Kendall Mills Plant treatment system	Closed	Recommended in 2002	North River
Colrain Landfill	1976-95	msw, industrial waste	Closed/Capped	1987-present	North River
Slowinski Brush Dump	1987	Soil/stumps from road construction	Closed	Test pits in 1987	North River
Buckland Wood Demolition Landfill	1970-84	c/d, asbestos	Closed/Capped	Recommended in 2002	500 ft, Deerfield River

Landfill	Dates of Operation	Waste	Status	Monitoring	Nearest Water Body
Lamson and Goodnow Mfg. Company	Unknown	Never officially recognized as a landfill	Unknown	Sampled in 2003	Deerfield River
Former Buckland Landfill	Unknown-1970s	msw and possibly industrial waste	Inactive	Recommended in 2002	100 ft, Deerfield River
Shelburne Town Landfill	1970-79	msw	Closed/Capped	Recommended in 2002	Deerfield River
Greenfield Landfill	1928-96	Msw, industrial waste (some hazardous), sludge, ash, petroleum, contaminated soils, wood, asbestos	Closed/Lined/Capped	1982-present	Deerfield River
Greenfield Tire Pile	1980-present	3-4,000 tires in a ravine along the river	Inactive	N	Deerfield River
Shelburne Stump/Brush Dump	Unknown-1986	Wood waste, c/d, household appliances, tires, metal	Closed/Capped	N	Deerfield River
Conway Landfill	Unknown-1977	Msw, hazardous waste, liquid waste in 1970's with open burning	Inactive	1994-present	Pumpkin Hollow Brook
Conway Wood Waste Landfill	1977-91	Wood waste	Closed/Capped/Lined	1994-present	Pumpkin Hollow Brook
Green River Roadside Dumping in Colrain	Unknown-present	Not official landfill, household appliances/trash, paint cans, furniture, c/d	Unknown	In works	Green River
Deerfield Landfill	Unknown-1998	Msw and sludge (ceased in 1997)	Closed	N	Deerfield River

* msw = municipal solid waste, + c/d = construction/demolition debris

Figure 3.2.5-1: Landfills Within the Massachusetts Portion of the Deerfield River Watershed



Source Information:
- Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Environmental Affairs

3.3 Fish Communities

3.3.1 Migratory Species

Historically, several fish species migrated into the Connecticut River Basin to utilize its mainstem fish habitat, as well as the fish habitat within its many tributaries, such as the Deerfield River Watershed. Damming, pollution, and other alterations within the Connecticut River Basin caused large declines in fish returns. Efforts continue to restore migratory fish runs to the Connecticut River Basin, and its tributaries.

The Holyoke Dam is the first dam on the mainstem Connecticut River, and is located 87 miles upstream from the rivers mouth. The Holyoke Dam is equipped with fish passage facilities (The Holyoke Dam fish lift). There are no other dams on the Connecticut River between Holyoke Dam and the point where the Deerfield River enters the Connecticut River (a total distance of approximately 32 miles).

On the mainstem Deerfield River, upstream fish migration is currently blocked below Shelburne Falls, Massachusetts at the Station No. 2 Dam. Downstream fish passage is provided at the Station No. 4, 3, 2 and Gardners Falls Dams.

Atlantic Salmon

Historic records suggest that Atlantic salmon used the Deerfield River for spawning at least as far upstream as Shelburne Falls (FERC 1997). The Deerfield River accounts for an estimated 13% of all Atlantic salmon nursery habitat in the entire Connecticut River Basin making it an integral part in the overall success and health of Connecticut River Atlantic salmon populations (FERC 1997). The Massachusetts Division of Fisheries and Wildlife (MDFW) currently stocks fry in several of the Deerfield River tributaries.

Under the terms of USGen's license for the Deerfield River Hydroelectric Project, there are two possible triggers that could initiate construction of permanent upstream fish passage at Station No. 2. One trigger includes documentation of four radio tagged salmon in the Station No. 2 tailwaters over two consecutive years. The other trigger includes documentation of 12 radio tagged salmon at Station No. 2 for two consecutive years with successful trapping of those tagged fish for transport upriver or to a hatchery (USGen 2002).

Since 1998, USGen has conducted radio tagging and monitoring studies to determine the number of adult Atlantic salmon that have migrated to the tailwaters of the Station No. 2 Dam. The study effort consists of capturing adult salmon at the Holyoke Dam fish lift on the Connecticut River, radio tagging, and releasing them to the Connecticut River below the mouth of the Deerfield River.

Adult salmon collected at the Holyoke fish lift are made available for these studies by the Connecticut River Atlantic Salmon Commission (CRASC). Typically, nine of every ten adult salmon collected in the fish lift are retained by the United States Fish and Wildlife Service (USFWS) for use as broodstock; and the tenth salmon is allowed to pass upstream of the Holyoke Dam to continue migration. USGen's radio telemetry monitoring effort has consisted of tagging those adult salmon that are allowed to pass upstream. During the prior four years of radio telemetry monitoring (1998 through 2001), 11%, 22%, 19% and 14% of all returning salmon collected at the Holyoke Dam fish lift were tagged.

Four tracking stations are typically used to monitor use of the Deerfield River. They are located on the Connecticut River below the mouth of the Deerfield River, on the Connecticut River upstream of the

Deerfield River mouth, approximately 4.5 miles upstream in the Deerfield River, and at the Station No. 2 Dam. Four adult salmon, representing 11.8% of the total number (34) of adult salmon trapped at the Holyoke Dam fish lift were tagged in 2002. Of this total, one salmon entered the Deerfield River and moved upstream to the Station No. 2 Dam, two salmon were presumed to have moved further upstream on the Connecticut River, and one salmon was never logged at any monitoring station and was presumed to have migrated back downstream past Holyoke Dam. It is likely that the one salmon that migrated to the Station No. 2 Dam was of upper Deerfield River origin.

Table 3.3.1-1 illustrates the results of past annual monitoring efforts. To date, 1999 represents the only year in which four or more adult salmon have reached the Station No. 2 Dam. USGen's annual radio telemetry evaluations are scheduled to continue until a trigger criterion is met or the CRASC determines that radio tagging is no longer necessary.

Based on the study results thus far, operation of an upstream fishway at Station No. 2 Dam would not occur until, at the earliest, spring 2007. This date is derived given that four or 12 individuals (depending on the trigger approach and interpretation) would have to arrive at the Station No. 2 Dam in the 2003 and 2004 monitoring years to trigger construction of the fishway. Construction of the fishway would be completed within two construction seasons (USGen 2002).

Table 3.3.1-1: Annual Adult Salmon Returns to the Deerfield River (Source: USGen 2002)

Year	# of Radio Tagged Salmon	# of Salmon Migrating into the Deerfield River Mouth	# of Salmon Migrating as Far Upstream as the Station No. 2 Dam
1998	22	4	3
1999	20	11	9
2000	10	4	0
2001	4	3	2
2002	4	1	1

American Shad

American shad historically entered virtually all coastal streams in Massachusetts. However, by the mid-1800s American shad were eliminated from the Massachusetts portions of the Connecticut River. Since the mid-1950's, American shad returns have increased dramatically in the Connecticut River due to newly constructed and improved fish passage facilities (Hartel et al. 2002). In 2003, 286,814 American shad were counted at the Holyoke Dam fish lift (USFWS 2004). Within the Deerfield River, American shad typically range as far upstream as the Station No. 2 Dam (USFWS 1999).

Sea Lamprey

Prior to the 1800s, sea lamprey entered virtually every Massachusetts stream and river that allowed them access to spawning sites. By the mid-1800s newly constructed dams blocked their migration routes and industrial pollution altered their habitat (Hartel et al. 2002). As a result of migratory fish restoration efforts, sea lamprey are now common in the Connecticut River and migrate well into New Hampshire. At the Holyoke Dam fish lift, 53,030 sea lamprey were counted in 2003 (USFWS 2004). Within the Deerfield River, sea lamprey typically range as far upstream as the Station No. 2 Dam (USFWS 1999).

Blueback Herring

Blueback herring are common in Massachusetts and enter numerous coastal streams. Their populations have been reduced or eliminated in some areas by river alterations. Currently, blueback herring are abundant in the Connecticut River where they migrate as far upstream as New Hampshire (Hartel et al. 2002). At the Holyoke Dam fish lift, 1,398 blueback herring were counted in 2003 (USFWS 2004). Blueback herring can range as far upstream as the Station No. 2 Dam on the Deerfield River (USFWS 1999).

American Eel

American eel are abundant along the Massachusetts coast; as well as in ponds, rivers, and in streams which are connected to the ocean (Hartel et al. 2002). In 2002, two juvenile American eels were counted at the Holyoke Dam fish lift, while in 2003 no American eels were counted (USFWS 2004).

During 2002, two American eels were captured in the Green River, above the Mill Street and Wiley & Russell Dams. These dams are not equipped with fish passage facilities; however, American eel are able to ascend smaller dams by climbing wetted margins (Haro 2002).

3.3.2 Fishery Conditions and Occurrence by Subwatershed

A summary of fishery conditions along the Deerfield River and its major tributaries from Somerset Reservoir to the Connecticut River is provided below. Within the Massachusetts portion of the Deerfield River watershed, MDFW annually stocks various species of trout in several areas for recreational fishing (Table 3.3.2-1). Stocking typically occurs during the spring with some limited stocking occurring in the fall as well. Table 3.3.2-2 summarizes the distribution, occurrence, and status of all fish species currently present in the Massachusetts portion of the Deerfield River watershed (Hartel et al. 2002).

Table 3.3.2-1: Trout Stocked Waters in the Deerfield River Watershed (Source: MDFW 2003)

Town	Waterbody
Ashfield	Ashfield Pond, Clesson Brook (Upper Branch), South River
Charlemont	Avery Brook, Chickley River, Maxwell Brook, Pelham Brook, Deerfield River, Cold River
Colrain	North River, North River (W. Branch), Green River
Conway	Bear River, Deerfield River, Poland Brook, South River
Deerfield	Deerfield River
Florida	Deerfield River, North Pond, Cold River
Greenfield	Allen Brook, Green River, Mill Brook
Hawley	Chickley River, Mill Brook
Heath	Avery Brook, Mill Brook, West Branch Brook
Leyden	Green River, Shattuck Brook
Monroe	Dunbar Brook, Sherman Reservoir
Rowe	Pelham Brook, Pelham Lake
Savoy	Chickley River, Cold River
Shelburne	Deerfield River, Dragon Brook

Table 3.3.2-2: Fish Species Present in the Massachusetts portion of the Deerfield River Watershed (Source: Hartel et al 2002)

Species	Distribution	Occurrence	Status
Sea lamprey	Mainstem, Green River	Native	
American eel	Mainstem, Chickley, Mill Brook, Clesson Brook, South River, E. Branch North River, Green River	Native	
Gizzard shad	Mainstem	Native	
Common carp	Mainstem, Green River	Introduced	
Eastern silvery minnow	Mainstem	Native	Special Concern
Golden shiner	Mainstem, Cold River, Pelham Brook, Mill Brook, South River, North River, Green River	Native	
Common shiner	Mainstem, Cold River, Mill Brook, Clesson Brook, South River, North River, Green River	Native	
Bridle shiner	Green River	Native	Special Concern
Mimic shiner	Mainstem	Introduced	
Spottail shiner	Mainstem, Green River	Native	
Northern redbelly dace	Green River	Native	Endangered
Blacknose dace	All	Native	
Longnose dace	All	Native	
Creekchub	All	Native	
Fallfish	Mainstem, Clesson Brook, North River, South River, Green River	Native	
Longnose sucker	Mainstem, Cold River, Pelham Brook, Mill Brook, Clesson Brook, North River, South River	Native	Special Concern
White sucker	All	Native	
Brown bullhead	All	Native	
Channel catfish	Mainstem, South River	Introduced	
Chain pickerel	Cold River, Chickley River, Pelham Brook, North River, South River, Green River	Native	
Northern pike	Mainstem only	Introduced	
Rainbow trout	Mill Brook, Clesson Brook	Introduced (Reproducing populations)	
Rainbow trout	Mainstem, North River	Stocked for summer (non-reproducing)	
Atlantic salmon	Mainstem, Cold River, South River, Green River	Stocked (non-reproducing)	
Brown trout	All	Introduced (some Reproducing and some Stocked only)	
Brook trout	All	Native (some Reproducing and some	

Species	Distribution	Occurrence	Status
		Stocked only)	
Banded killifish	Mainstem	Native	
Slimy sculpin	All	Native	
Rock bass	Mainstem	Introduced	
Redbreast sunfish	Mainstem	Native	
Pumpkinseed	Mainstem, Cold River, Pelham Brook, Chickley River, South River, Green River	Native	
Bluegill	Mainstem, Green River, South River	Introduced	
Smallmouth bass	Mainstem, Cold River, Pelham Brook, Chickley River, North River, South River, Green River	Introduced	
Largemouth bass	Mainstem, Chickley River, South River	Introduced	
Black crappie	Mainstem, Pelham Brook, South River	Introduced	
Tessellated darter	Mainstem, North River, South River, Green River	Native	
Yellow perch	Mainstem, Cold River, Chickley River, North River, South River, Green River	Native	

East Branch Deerfield River Subwatershed

Warmwater species common to Somerset Reservoir include smallmouth bass, rock bass, yellow perch, pumpkinseed, and chain pickerel. Recent FERC license stipulations (1997) limit water surface elevation fluctuations at Somerset Reservoir, to no more than ±1 foot from May 1 to July 31 to protect warmwater fish populations. During that time of year, smallmouth bass and panfish spawn in shallow waters and untimely reductions in water level can reduce or destroy spawning habitat.

The reservoir is managed primarily for a put-and-take brook trout fishery that is not affected by the changing water levels. Minimum flows below the Somerset Dam in the winter and summer are now in place to provide sufficient habitat to sustain a year round population of brook trout. Downstream fish passage is in place at Somerset Reservoir as well.

North Branch Deerfield River Subwatershed

Information on fisheries in the North Branch Deerfield is limited; however, it is likely this stream supports spawning runs of rainbow smelt, as well as brook trout from Harriman Reservoir. Overall, the species present in the North Branch Deerfield are likely similar to those in the East Branch Deerfield.

Deerfield River Mainstem-Vermont

The Searsburg Impoundment, located six miles downstream of Somerset Reservoir, is stocked with brook trout only. Minimum flow requirements to the bypass reach of 35 cfs in the summer and 55 cfs in the winter provide habitat for self-sustaining populations of brown trout and rainbow smelt spawning and incubation. Prior to 1997, there was little or no flow in the bypass reach. The new minimum flow requirements greatly increase the habitat in the bypass reach for brook, rainbow, and brown trout, rainbow smelt, and landlocked salmon stocked in the Harriman Reservoir. The Vermont Department of Fish and Wildlife (VDFW) conducted electrofishing in the Searsburg bypass reach in 2002. Wild brook trout were captured below Searsburg Dam, and further downstream near the powerhouse yearling rainbow trout and young-of-the-year salmonids were caught (VANR 2003).

The VDFW manages Harriman Reservoir as a large salmonid fishery (lake, brown, rainbow, and brook trout as well as landlocked salmon). Rainbow smelt stocking began within Harriman Reservoir in 1954-55 and has produced a self-sustaining population. The 1970's and 1980's met with limited success in establishing a landlocked salmon fishery. A new water level management plan resulting from the 1997 relicensing will protect spawning, incubation, and fry rearing for rainbow smelt and smallmouth bass in addition to increasing littoral habitat for other warmwater fish. Minimum flow requirements in the 4.4-mile bypass reach below the Harriman Reservoir provide a naturally reproducing brook and brown trout fishery. The reach is continuously fed by coldwater releases from Harriman Reservoir and is relatively under-fished due to access requiring hiking in from public highways. In addition, vegetative growth in the bypass combined with significant beaver activity provides abundant cover for salmonids (FERC 1997). Trout population surveys have been completed in this reach annually since 1999. The survey results indicate that brook trout numbers continue to increase and that fish growth is depressed due to coldwater temperatures (VANR 2003).

West Branch Deerfield River Subwatershed

The West Branch Deerfield River enters into the Harriman bypass reach. Information on fishery conditions in the West Branch is limited. Generally, the watershed supports populations of brook, rainbow, and brown trout; however, overall productivity is low (VANR 2003).

Deerfield River Mainstem-Massachusetts

Sherman Reservoir offers an outstanding resource for trophy size brown trout and supports numerous species of warmwater fish. The main forage base in Sherman Reservoir appears to be smelt entrained through the Harriman powerhouse. Overall, water quality and fishery health in the reservoir is expected to have improved since the 1997 relicensing process due to minimum flows increasing upstream habitat quality, as well as the termination of once-through cooling waters released from the Yankee Atomic Electric Facility.

The Station No. 5 Impoundment downstream of the Sherman Dam is not managed for any fish species; however, populations of rainbow trout, smallmouth bass, rock bass, pumpkinseed, and white sucker are present. Current management efforts have concentrated on the bypass reach below the Station No. 5 dam that has historically been known as the "dryway." Minimum flows of 73 cfs are now required to pass at the Station No. 5 Dam providing suitable habitat for self-sustaining populations of brown and brook trout in the 2.6-mile bypass reach. In addition to daily minimum flows, whitewater releases of approximately 1,000 cfs are required to be passed through the Station No. 5 bypass reach 32 times each year from April 1 to October 31. Upramping and down ramping procedures are employed to allow fish to leave areas of potential stranding (FERC 1997).

Below Fife Brook Dam minimum flows of 125 cfs are required. Most of the 17-mile reach that eventually flows into the Station No. 4 Impoundment is managed by MDFW as a valuable catch and release trout fishing area (from Fife Brook Dam to Hoosac Tunnel and from Pelham Brook to the Mohawk Campground, and is typically stocked with rainbow and brown trout. Five significant tributaries (Pelham Brook, Cold River, Chickley River, Mill Brook, and Clesson Brook) enter this mainstem reach of the Deerfield River.

The Station No. 4 Impoundment is not managed for any particular fish species; however, populations of rainbow trout, brown trout, smallmouth bass, rock bass, white sucker, fallfish and spottail shiner have been noted. Size ranges of fish captured in the impoundment suggest that natural reproduction is occurring with the exception of some rainbow and brown trout that likely reached the impoundment from upstream stocking efforts (FERC 1997). Downstream fish passage is installed at the Station No. 4 dam and minimum flow requirements are 100 cfs in the winter and 125 cfs in the summer. The downstream fish passage and minimum flows are in place to support self-sustaining populations of brown trout in the bypass reach.

The Station No. 3, Gardners Falls, and Station No. 2 impoundments all support a variety of fish species including rainbow and brown trout, smallmouth bass, yellow perch, white sucker, and fallfish. The 1997 relicensing effort required the construction of downstream fish passage at all three dams and new minimum flow requirements to improve fish habitat in the bypass reaches. A minimum flow of 200 cfs to the 9-mile riverine reach below Station No. 2 provides nursery habitat for Atlantic salmon and ample habitat for self-sustaining populations of brown trout. The reach below Station No. 2 is managed as a put-and-take fishery with stocking of rainbow and brook trout.

Pelham Brook Subwatershed

Fish sampling was conducted by MDEP at Pelham Brook during September 2000. Fish species captured in order of abundance included slimy sculpin, longnose dace, Atlantic salmon, brook trout, blacknose dace, and brown trout. In addition, longnose sucker were collected by MDFW in Pelham Brook during August 2000 and September 2001. This collection effort also revealed the presence of multiple age classes of both Atlantic salmon and brook trout (MDEP 2003a).

Cold River Subwatershed

Fish species captured during the MDEP September 2000 sampling in order of abundance included Atlantic salmon, blacknose dace, longnose dace, and a brown trout. In addition to these species, MDFW documented slimy sculpin and rainbow trout in the Cold River in August 2000 and September 2001 investigations. This collection effort also revealed multiple age classes of Atlantic salmon (MDEP 2003a). In 2002, bridle shiner, a rare species in Massachusetts, was collected from Tannery Pond (Haro 2002).

Chickley River Subwatershed

September 2000 sampling efforts conducted by MDEP within the Chickley River several species were captured including Atlantic salmon, slimy sculpin, longnose dace, blacknose dace, brown trout and rainbow trout. Multiple age classes of brook trout and Atlantic salmon were documented in the Chickley River during the sampling period (MDEP 2003a).

Mill Brook Subwatershed

Fish species captured during MDEP’s September 2000 sampling effort included in order of abundance Atlantic salmon, brook trout, and blacknose dace. Overall, a small number of fish were collected and species such as slimy sculpin and longnose dace were notably absent. In August 2000, the MDFW documented multiple age classes of both Atlantic salmon and brook trout in Mill Brook upstream of its confluence with Davis Mine Brook (MDEP 2003a).

Clesson Brook Subwatershed

The MDEP conducted fish population sampling in September 1996 at Clesson Brook. Fish collected in order of abundance included: blacknose dace, longnose dace, white sucker, slimy sculpin, and creek chub (MDEP 2003a).

North River Subwatershed

On the East Branch North River within Vermont, wild and stocked brook trout are present on the mainstem, and wild brook trout populations are prevalent throughout the upper watershed. Wild brown trout populations are also present on the mainstem and several tributaries (VANR 2003). In September 2000, fish species captured on the East Branch North River by MDEP in order of abundance included Atlantic salmon, longnose dace, blacknose dace, and one each of yellow bullhead, banded killifish, and tessellated darter (MDEP 2003a).

On the West Branch North River, the MDFW conducted fish population sampling between August 2000 and September 2001. Two locations were sampled and several species were collected including blacknose dace, slimy sculpin, longnose dace, Atlantic salmon, white sucker, brown trout, longnose sucker, eastern brook trout, and one brown bullhead. Multiple age classes of Altantic salmon and brook trout were documented (MDEP 2003a).

In September 2001, the MDFW conducted fish surveys along the mainstem North River. The fish community was dominated by multiple age classes of Atlantic salmon; with one rainbow, brown and brook trout also collected (MDEP 2003a).

South River Subwatershed

The South River was also sampled for fish by MDFW in recent years. Fish species found in the South River during an August 2000 collection consisted of blacknose dace, Atlantic salmon, longnose dace, common shiner, creek chub, eastern brook trout, slimy sculpin, and pumpkinseed (MDEP 2003a).

Green River Subwatershed

September 2000 sampling efforts within the Green River showed that fish communities were comprised of slimy sculpin, brown trout, longnose dace, and blacknose dace (MDEP 2003a). Atlantic salmon were also caught in several tributaries to the Green River. The Vermont portion of the Green River supports populations of wild brook trout as well (VANR 2003a).

During 2002, several locations within the Green River subwatershed were surveyed for rare native fishes. Overall, several species were collected including American eel, fathead minnows, common shiner, tessellated darters, northern redbelly dace, and banded killifish (Haro 2002). Only the northern redbelly dace is considered a rare species in Massachusetts. The fathead minnows collected were the first recorded within Deerfield River watershed. The species was likely introduced by bait bucket releases, as has occurred elsewhere in other western Massachusetts sites (Haro 2002).

3.3.3 Rare Species and Critical Habitats

Rare Species

Past surveys have identified three native minnow species in the Deerfield River watershed that are known to be uncommon or rare in Massachusetts, and have been listed by the state as endangered or of special concern. These species include the eastern silvery minnow (status = special concern), bridle shiner (status = special concern), and the northern redbelly dace (endangered) (Haro 2002).

In Massachusetts, the eastern silvery minnow is only found in the mainstem of the Connecticut River north of the Holyoke Dam and in the lower Deerfield River. Historically, this species was once very common, particularly along the flooded flats of the Connecticut River near Hadley, Massachusetts. The last recorded collection within Deerfield River Watershed was along the lower Deerfield River near Greenfield, Massachusetts in 1959. Recent collection efforts in this same locale did not yield any specimens (Haro 2002). Their decline may be related flow alterations caused by dams, as these water control practices may reduce or change the character of backwaters and spawning sites utilized by the eastern silvery minnow (Hartel et al. 2002).

The bridle shiner was common in Massachusetts until the early 1960's, when populations began to decline. This species had been collected in several locations within the Green River subwatershed in 1962. Recent collections efforts in this subwatershed did not yield any specimens; however, sampling in Tannery Pond located in Savoy, Massachusetts (Cold River Subwatershed) yielded approximately 12 bridle shiners (Haro 2002).

Northern redbelly dace were first found in Massachusetts within the Green River subwatershed in 1940. This represents the only known population of this species in Massachusetts. Since 1979, this species has only been found within Glen Brook, a tributary to the Green River. Recent collections efforts at this site yielded small numbers of this species (Haro 2002).

The state and federally endangered shortnose sturgeon have been known to utilize the lower 2-mile reach of the Deerfield River. Historically a single population of shortnose sturgeon existed in the Connecticut River. Adults most likely spawned in the late spring near the confluence of the Deerfield River then moved downstream, in some cases as far Long Island Sound, to foraging areas, where they remained until fall. In the fall, spawning fish would then undertake the migration upstream to their natal spawning grounds near the Deerfield River. These adults would remain in this area through the winter and spawn the following spring.

The construction of Holyoke Dam in 1848 divided the Connecticut River shortnose sturgeon population. Until very recently, it was believed that the fish above the dam and those below the dam formed essentially discrete populations; however, recent evidence suggests that the downstream population is sustained by outmigrating sturgeon from the upstream group. Successful reproduction occurs within the upstream population when they migrate downstream and are unable to return back up over the dam (UMass 2004). The total number of adults in the Connecticut River is thought to be approximately 1,000 fish (Hartel et al. 2002).

The longnose sucker is a species of special concern in Massachusetts; however, it is fairly common in portions of the Deerfield River Watershed. The longnose sucker is currently listed as a species of special concern due to its decline in the lower Connecticut system (Connecticut mainstem, Westfield, and lower Chicopee rivers) and due to the poor water quality in parts of the Hoosic and Housatonic Watersheds (Hartel et al. 2002).

Critical Habitats

The Natural Heritage and Endangered Species Program (NHESP) recently completed the “Living Waters” project. The goal of the Living Waters project is to promote the protection of freshwater biodiversity in Massachusetts. Water flow manipulations and water quality degradation can threaten freshwater species and their habitat; therefore, NHESP developed the Living Waters project to identify the most critical areas for freshwater biodiversity in the state in order to better protect these resources.

The results of the project were the delineation of Living Waters core habitats and critical supporting watersheds. Core Habitats either represent the lakes, ponds, rivers, and streams that provide habitat for rare freshwater species, or overall exemplary aquatic habitats. The critical supporting watershed identifies the more immediate portion of a core habitat's watershed where conservation efforts should be targeted (NHESP 2003).

Several Living Waters core habitat areas were identified within the Deerfield River Watershed, including several mainstem reaches and tributaries (Figure 3.3.3-1). Significant portions of the Cold River, Pelham Brook, Chickley River, Clesson Brook, North, South, and Green Rivers and their subtributaries were identified as core habitats. In addition, significant portions of the mainstem Deerfield between the Fife Brook and Station No. 4 dams were delineated as core habitats, as well as portions of the Deerfield below Station No. 2 Dam, and its mouth. Roads and agriculture were considered the greatest potential threats to the core habitats within the Deerfield River Watershed (NHESP 2003).

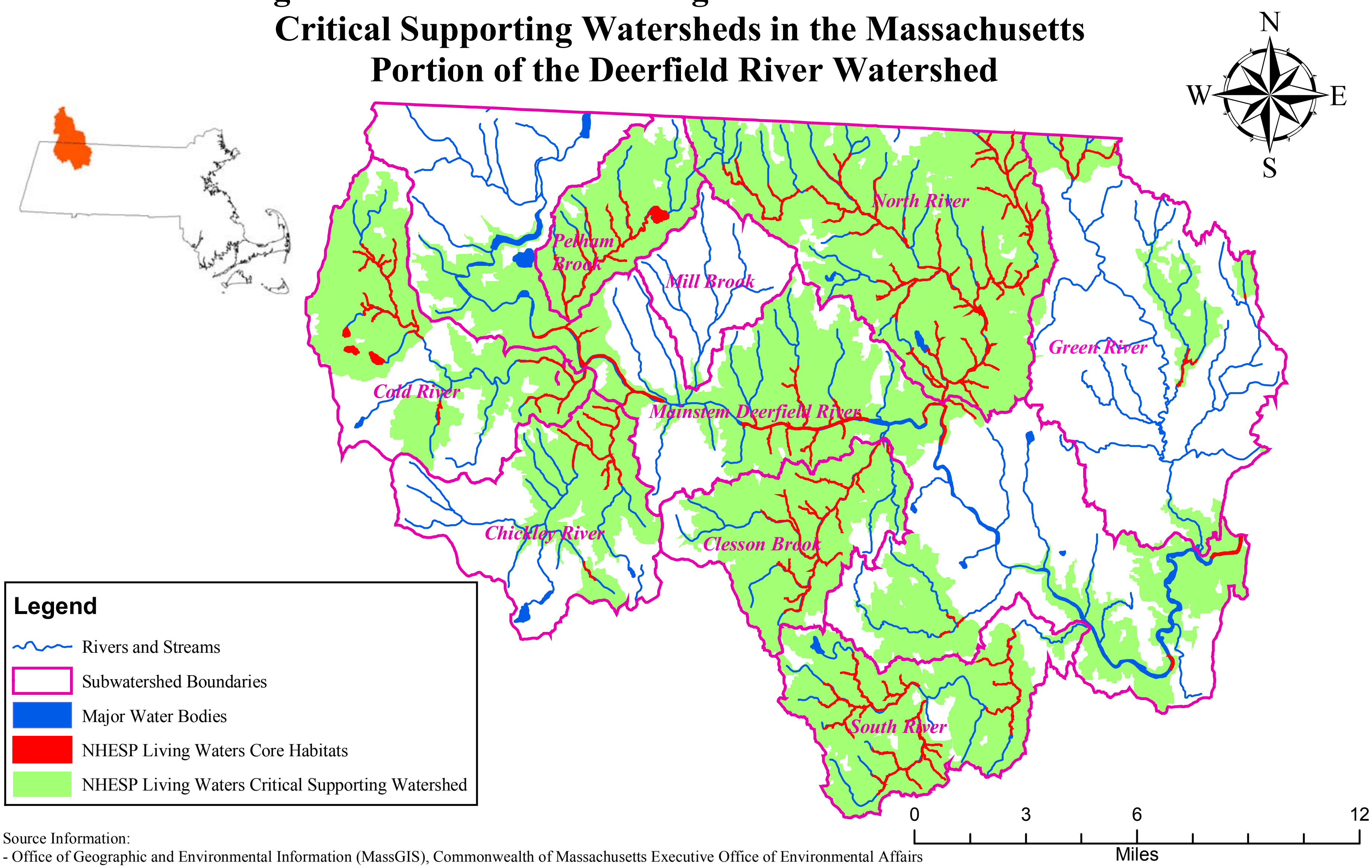
3.3.4 Non-native Fish Species

The majority of non-native fish species introduced in Massachusetts are native to the United States but transplanted outside their native ranges. The most widely recognized methods of freshwater introductions include the annual stocking of game fish, bait bucket introductions, and manmade canals which have allowed the flow of organisms from one waterbody to another (USGS 2004a).

A recent survey for several rare native minnow species uncovered the presence of fathead minnows in the Green River subwatershed. The species was likely introduced by bait bucket releases, as has occurred elsewhere in other western Massachusetts sites (Haro 2002). The potential impacts of this introduction are unknown (USGS 2004a).

Species such rainbow and brown trout are typically stocked in many locations within the Deerfield River Watershed. Rainbow trout, native to the Pacific Coast region, have been know to hybridize with other, more rare trout species, thereby affecting their genetic integrity (USGS 2004a). Brown trout are native to Europe, northern Africa, and western Asia, and can reduce native fish populations (especially other salmonids) through predation and food competition (USGS 2004a).

Figure 3.3.3-1: NHESP Living Waters Core Habitats and Critical Supporting Watersheds in the Massachusetts Portion of the Deerfield River Watershed



Source Information:
- Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Environmental Affairs

3.4 Wildlife and Terrestrial Habitat

3.4.1 Wildlife Species Occurrence

Mammals

Within the Deerfield River Watershed, many species of terrestrial mammals are likely to occur (Table 3.4.1-1) (Lovejoy and Hoagland 2004). Over time, several terrestrial mammal species have been extirpated from the watershed as well. They include elk, mountain lion, timber wolf, wolverine, marten, lynx, and Indiana bat (Lovejoy and Hoagland 2004).

Big game species include white-tailed deer, moose, and black bear. White-tailed deer are the only species requiring special winter habitats known as "deer yards." Studies in Vermont identified approximately 11 deer yards along the Deerfield River and various tributaries in the mid-1990's, while similar studies have not been completed in Massachusetts, it is believed that steep south and west facing slopes hold deer in the winter (FERC 1997).

Black bear populations in the Massachusetts portion of the watershed are relatively extensive. The watershed typically ranks among the highest in terms of annual bear harvest in Massachusetts. Black bear were hunted to near extirpation in the nineteenth century; however changes in land use and a reduction in hunting pressure have increased bear populations. Currently the population is increasing at approximately 8 to 10% annually and is expanding eastward into more densely populated areas (MDFW 2000a).

Moose are known to inhabit the Green Mountain region of the upper watershed. There have also been anecdotal sightings of moose in the eastern part of the Massachusetts portion of the watershed.

Furbearing species in the watershed include red fox, beaver, mink, muskrat, and otter with coyote and bobcat present in the upland areas. There have been anecdotal reports of fisher sightings in the Green River subwatershed.

Several mammal, as well as bird, species associated with early-successional habitats have declined throughout the region since the 1950's in response to the limited availability of these habitats. Even-aged forests characterize the Massachusetts landscape (see Section 3.4.4) and likely result from historic land use practices and farm abandonment (Litvaitis 1993).

The New England cottontail rabbit, the region's only native cottontail, was once common throughout all of Massachusetts. Prior to 1930, the New England cottontail was the only cottontail species occurring in Massachusetts; however, during the last 25 to 50 years New England cottontail populations have decreased dramatically. Recently, efforts have been underway to list the New England cottontail as a federally endangered species. The reasons for the population decline are attributed to shrinkage of favorable habitat and to competition with the non-native Eastern cottontail, which were first introduced to the region in the 1930s (MDFW 2004a).

The New England cottontail typically prefers early-successional habitats, such as dense understory vegetation associated with gaps in the forest, regenerating forest stands in disturbed areas, stream corridors, and shrubby woodlands. These habitat types have decreased throughout New England over the past century, with a coincident decrease in New England cottontail populations (Litvaitis 1993). Studies indicate that the New England cottontail population declines may be countered by a forest management program that increases early-successional habitat (Litvaitis et al 1996).

Fragmenting of these habitats can make species such as the New England cottontail more susceptible to predation as well. During winter, New England cottontails occupying small patches of habitat (<3 hectares) can experience food shortages, which necessitates movement to areas with more food supply and potentially less escape cover. These New England cottontails are killed by predators at approximately twice the rate as those on large patches of habitat (Barbour and Litviatis 1993).

Early-successional habitats are important to predatory mammal species as well. Species, such as bobcat, require a mix of young and old growth forest habitats to provide high densities of preferred prey sources (early successional areas) as well cover (late successional areas) (Litvaitis 1993). Habitat fragmentation put these species at risk as well. As a result of scattered prey populations, these species may be required to make frequent road crossings making them susceptible to vehicle collisions and other sources of mortality. A study in Maine determined that vehicle collisions were the second most frequent source of mortality among a group of transmitter equipped bobcats (Litvaitis et al 1987)

Table 3.4.1-1: Terrestrial Mammals Likely to Occur in the Deerfield River Watershed (Source: Lovejoy and Hoagland 2004)

Common Name	Species Name	Status
Opossum	Didelphis virginiana	Common
Short-tailed shrew	Blarina brevicauda	Common
Masked shrew	Sorex cinereus	Uncommon
Smoky shrew	Sorex fumeus	Uncommon
Water shrew	Sorex palustris	Uncommon
Star-nosed mole	Condylura cristata	Common
Hairy-tailed mole	Parascalops breweri	Uncommon
Big brown bat	Eptesicus fuscus	Common
Silver-haired bat	Lasionycteris noctivagens	Uncommon
Red bat	Lasiurus borealis	Uncommon
Northern long-eared bat	Myotis keenii	Common
Little brown bat	Myotis lucifugus	Common
Eastern pipistrelle	Pipistrellus subflavus	Rare
Coyote	Canis latrans	Common
Gray fox	Urocyon cinereoargenteus	Uncommon
Red fox	Vulpes vulpes	Common
Black bear	Ursus americanus	Common
Raccoon	Procyon lotor	Common
River otter	Lontra canadensis	Uncommon
Fisher	Martes pennanti	Uncommon
Skunk	Mephitis mephitis	Common
Short-tailed weasel	Mustela erminea	Uncommon
Long-tailed weasel	Mustela frenata	Uncommon
Mink	Mustela vison	Common
Bobcat	Lynx rufus	Common
Moose	Alces alces	Rare
White-tailed deer	Odocoileus virginianus	Common
Porcupine	Erethizon dorsatum	Common
Northern flying squirrel	Glaucomys sabrinus	Uncommon

Common Name	Species Name	Status
Southern flying squirrel	Glaucomys volans	Common
Woodchuck	Marmota monax	Common
Gray squirrel	Sciurus carolinensis	Common
Eastern chipmunk	Tamias striatus	Common
Red squirrel	Tamiastriatus hudsonicus	Common
Beaver	Castor canadensis	Common
Red-backed vole	Clethrionomys gapperi	Common
Meadow vole	Microtus pennsylvanicus	Common
Pine vole	Microtus pinetorum	Common
Muskrat	Ondatra zibethicus	Common
Southern bog lemming	Synaptomys cooperi	Uncommon
House mouse	Mus musculus	Common
White-footed mouse	Peromyscus leucopus	Common
Deer mouse	Peromyscus maniculatus	Common
Norway rat	Rattus norvegicus	Common
Woodland jumping mouse	Napaeozapus insignis	Uncommon
Meadow jumping mouse	Zapus hudsonicus	Uncommon
Snowshoe hare	Lepus americanus	Uncommon
Eastern cottontail	Sylvilagus floridanus	Common
New England cottontail	Sylvilagus transitionalis	Uncommon

Reptiles and Amphibians

Reptile and amphibian species likely to occur in the watershed are illustrated in Table 3.4.2-2 (MDFW 2004b). Snakes potentially occurring in the watershed include the green snake, brown snake, black rat snake, eastern ribbon snake, redbelly snake, garter snake, milk snake, ringneck snake, water snake, black racer snake, and hognosed snake.

The black rat snake is listed as endangered in Massachusetts (MDFW 2004b). In addition, black racer snake populations have been declining in recent times due to a lack of early-successional habitats for which they rely on for various stages of their life cycles (MDFW 2004c). The nonvenomous black racer inhabits shrublands and thickets, and grows up to six feet in length.

Several salamander and turtle species likely inhabit the watershed as well (Table 3.4.2-2). The Jefferson salamander, four-toed salamander, and spring salamander are listed as species of special concern in Massachusetts, while the marbled salamander is listed at threatened. The spotted turtle, wood turtle, and eastern box turtle are species of special concern. This blandings turtle is listed as threatened, and recent records of its occurrence in the watershed are limited (MDFW 2004b).

Recent studies (DRWA 2003a) were conducted by inventorying calling amphibians in the Massachusetts portion of the Deerfield River Watershed. The three most common and widely-distributed species of calling amphibians in the watershed were the spring peeper, green frog, and gray treefrog, which were found in a variety of wetland habitats. Intermediate in occurrence and distribution were the bullfrog and wood frog. Bullfrogs were only observed in wetlands with areas of open water, while wood frogs were found predominantly in seasonally flooded areas. The occurrence of wood frogs was positively associated with the amount of tree cover at a given site. The least frequently encountered amphibians were the American toad, pickerel frog, and northern leopard frog. Habitat preferences for these species could not be determined by the study. Fowler's toad and the spadefoot toad were not observed during the study. The Fowler's toad is more common in eastern Massachusetts, and the spadefoot toad is listed as threatened in Massachusetts. The study concluded that on-road vehicle kills are probably a major cause of mortality to amphibian populations. Preservation of wetlands diversity and prevention of habitat fragmentation were deemed critical components of the long-term health of amphibian populations.

Table 3.4.1-2: Reptiles & Amphibians in the Deerfield River Watershed (Source: MDFW 2004b)

Common Name	**Scientific Name**
Jefferson Salamander	*Ambystoma jeffersonianum*
Spotted Salamander	*Ambystoma maculatum*
Marbled Salamander	*Ambystoma opacum*
Eastern Newt	*Notophthalmus viridescens*
Northern Dusky Salamander	*Desmognathus fuscus*
Eastern Red-backed Salamander	*Plethodon cinereus*
Four-toed Salamander	*Hemidactylium scutatum*
Spring Salamander	*Gyrinophilus porphyriticus*
Northern Two-lined Salamander	*Eurycea bislineata*
Eastern Spadefoot	*Scaphiopus holbrookii*
American Toad	*Bufo americanus*
Fowler's Toad	*Bufo fowleri*
Spring Peeper	*Pseudacris crucifer*
Gray Treefrog	*Hyla versicolor*
American Bullfrog	*Rana catesbeiana*
Green Frog	*Rana clamitans*
Pickerel Frog	*Rana palustris*
Northern Leopard Frog	*Rana pipiens*
Wood Frog	*Rana sylvatica*
Snapping Turtle	*Chelydra serpentina*
Eastern musk turtle	*Sternotherus odoratus*
Painted Turtle	*Chrysemys picta*
Spotted Turtle	*Clemmys guttata*
Wood Turtle	*Clemmys insculpta*
Eastern Box Turtle	*Terrapene carolina*
Black Racer Snake	*Coluber constrictor*
Ringnecked Snake	*Diadophis punctatus*
Black Rat Snake	*Elaphe obsoleta*
Hognosed Snake	*Heterodon platirhinos*
Milk Snake	*Lampropeltis triangulum*
Water Snake	*Nerodia sipedon*
Green Snake	*Opheodrys vernalis*
Brown Snake	*Storeria dekayi*
Redbellied Snake	*Storeria occipitomaculata*
Eastern Ribbon Snake	*Thamnophis sauritus*
Garter Snake	*Thamnophis sirtalis*

Birds

The North American Breeding Bird Survey is a long-term, large-scale, avian monitoring program initiated in 1966 to track the status and trends of North American bird populations. During each bird breeding season, trained participants collect bird population data along roadside survey routes. The data collected provides an index of population abundance that can be used to estimate population trends and relative abundances at various geographic scales. (USGS 2004b). Surveys have been conducted near Cummington, Massachusetts, slightly south of the Deerfield River Watershed, since the mid-1960's. During that time, approximately 110 different species of birds have been identified (Table A-1 located in Appendix A).

Data collected from the many eastern survey routes show declines among bird species that prefer early-successional habitats (e.g., abandoned fields, grasslands, and shrublands). Overall, 12 of 16 shrubland birds exhibited declining populations, including golden-winged warbler (endangered in Massachusetts), prairie warbler, and field sparrow, whose populations decreased by more than 2% annually. Other shrubland birds such as ruffed grouse and woodcock have declined by approximately 4% annually. In addition, five of six birds commonly associated with grasslands exhibited dramatic declines. Three of these species, the upland sandpiper, vesper sparrow, and grasshopper sparrow, are either threatened or endangered in Massachusetts (MDFW 2004c).

Recent studies also documented various marshbirds in the watershed (DRWA 2003a). Four of the eight target species of marshbirds were documented during the study. Three of the four species never observed, Pied-billed grebe, common moorhen, and sedge wren, rarely breed in Massachusetts. The fourth species, the king rail, is at the northernmost edge of its breeding range in Massachusetts.

American bitterns were identified at seven (29%) of the wetlands inventoried and five of the seven sites range in size from 15 to 23 acres. The least bittern was the rarest marshbird of the four target species observed, occurring at only one wetland. Species scarcity was attributed to their tendency to avoid high altitude-freshwater wetlands and unstable water regimes. Virginia rails were identified at 46% of wetlands surveyed, which made it the most frequently observed marshbird. This species was found in wetlands ranging from 8 to 33 acres. American and least bittern are listed as endangered species in Massachusetts.

Soras were rarely detected, as they were found at 13% of the wetlands surveyed. Soras typically occur at sites with greater amounts of cattails and increasing edge between aquatic bed/open water and emergent vegetation. Several wetlands appeared to contain appropriate habitat for breeding soras; however, no birds were detected at these sites. The study recommended that similar inventories be conducted in the future to determine whether changes have occurred in marshbird distribution and abundance.

Common loons have been observed on Somerset Reservoir in Vermont since 1977. Common loons nested on Somerset Reservoir during 13 of 17 years from 1977 to 1994 and were successful (young survived through August 31) in seven of those years accounting for 6% of the known common loon production in Vermont. Common loons set up breeding territories on large lakes. The common loon has reduced mobility on land and, therefore, its nest building is restricted to the waters edge. Due to its nest location and lack of mobility on land, common loon nesting success is sensitive to water level fluctuations and human disturbance. As this is the southernmost location of breeding loon pairs in Vermont, it represents a value of special significance to agencies, non-governmental organizations and to the general public. The water level management plan within Somerset Reservoir, adopted as part of the 1997 relicensing, will allow loons to more successfully nest on natural sites and enhance shoreline feeding habitat (FERC 1997).

Wild turkeys are relatively prevalent in the watershed, with the general area typically yielding the highest annual turkey harvests (MDFW 2004d).

3.4.2 Rare Species and Critical Habitats

The NHESP has identified locations of estimated habitats of rare wildlife and uses the information to assist in the enforcement of wetlands, endangered species, and forest management regulations. Figure 3.4.2-1 delineates the approximate geographical extent of these habitats of state protected rare wildlife. In the Massachusetts portion of the Deerfield River watershed, more than 38 estimated habitats have been identified by the NHESP.

Current data indicates that at least 67 vascular plants (Table 3.4.2-1) species of special concern occur in the watershed (NHESP 2003).

Table 3.4.2-1: List of Endangered, Threatened and Special Concern Vascular Plant Species Likely Occurring in the Massachusetts Portion of the Deerfield River Watershed (Source: NHESP 2003)

Common Name	Scientific Name	Status
Adder's-Tongue Fern	Ophioglossum pusillum	Threatened
Autumn Coralroot	Corallorhiza odontorhiza	Special Concern
Bailey's Sedge	Carex baileyi	Endangered
Barren Strawberry	Waldsteinia fragarioides	Special Concern
Bartram's Shadbush	Amelanchier bartramiana	Threatened
Black Maple	Acer nigrum	Special Concern
Boreal Wormwood	Artemisia campestris ssp borealis	Endangered
Bristly Black Currant	Ribes lacustre	Special Concern
Broad Waterleaf	Hydrophyllum canadense	Endangered
Canadian Sanicle	Sanicula canadensis	Threatened
Climbing Fern	Lygodium palmatum	Special Concern
Climbing Fumitory	Adlumia fungosa	Threatened
Crooked-Stem Aster	Symphyotrichum prenanthoides	Threatened
Downy Arrowwood	Viburnum rafinesquianum	Endangered
Dwarf Mistletoe	Arceuthobium pusillum	Special Concern
Dwarf Rattlesnake-Plantain	Goodyera repens	Endangered
Dwarf Scouring-Rush	Equisetum scirpoides	Special Concern
Farwell's Water-Milfoil	Myriophyllum farwellii	Endangered
Few-Flowered Sedge	Carex pauciflora	Endangered
Fragile Rock-Brake	Cryptogramma stelleri	Endangered
Frank's Lovegrass	Eragrostis frankii	Special Concern
Gattinger's Panic-Grass	Panicum gattingeri	Special Concern
Giant St. John's-Wort	Hypericum ascyron	Endangered
Green Dragon	Arisaema dracontium	Threatened
Green Rock-Cress	Arabis missouriensis	Threatened
Hairy Beardtongue	Penstemon hirsutus	Endangered
Hitchcock's Sedge	Carex hitchcockiana	Special Concern
Hooded Ladies'-Tresses	Spiranthes romanzoffiana	Endangered
Intermediate Spike-Sedge	Eleocharis intermedia	Threatened
Large-Leaved Goldenrod	Solidago macrophylla	Threatened
Large-Leaved Sandwort	Moehringia macrophylla	Endangered

Common Name	Scientific Name	Status
Leafy White Orchis	Platanthera dilatata	Threatened
Linear-Leaved Milkweed	Asclepias verticillata	Threatened
Long-Styled Sanicle	Sanicula odorata	Threatened
Low Bindweed	Calystegia spithamaea	Endangered
Many-Fruited False-Loosestrife	Ludwigia polycarpa	Endangered
Michaux's Sandwort	Minuartia michauxii	Threatened
Michaux's Sedge	Carex michauxiana	Endangered
Mountain Alder	Alnus viridis ssp crispa	Threatened
Mountain Firmoss	Huperzia selago	Endangered
Muskflower	Mimulus moschatus	Endangered
Nodding Pogonia	Triphora trianthophora	Endangered
Northern Bog Violet	Viola nephrophylla	Endangered
Northern Mountain-Ash	Sorbus decora	Endangered
Pale Green Orchis	Platanthera flava var herbiola	Threatened
Purple Clematis	Clematis occidentalis	Special Concern
Purple Milkweed	Asclepias purpurascens	Endangered
Purple Needlegrass	Aristida purpurascens	Threatened
Putty-Root	Aplectrum hyemale	Endangered
Red Mulberry	Morus rubra	Endangered
Roundleaf Shadbush	Amelanchier sanguinea	Special Concern
Sandbar Cherry	Prunus pumila var depressa	Threatened
Sandbar Willow	Salix exigua	Threatened
Shore Sedge	Carex lenticularis	Threatened
Slender Cottongrass	Eriophorum gracile	Threatened
Snowberry	Symphoricarpos albus var albus	Endangered
Spiked False Oats	Trisetum triflorum ssp molle	Endangered
Thread Rush	Juncus filiformis	Endangered
Threadfoot	Podostemum ceratophyllum	Special Concern
Tradescant's Aster	Symphyotrichum tradescantii	Threatened
Tuckerman's Sedge	Carex tuckermanii	Endangered
Tufted Hairgrass	Deschampsia cespitosa ssp glauca	Endangered
Upland White Aster	Solidago ptarmicoides	Endangered
Wall-Rue Spleenwort	Asplenium ruta-muraria	Threatened
White Adder's-Mouth	Malaxis brachypoda	Endangered
Wild Senna	Senna hebecarpa	Endangered
Woodland Millet	Milium effusum	Threatened

As a companion to the estimated habitats of rare wildlife information, NHESP also identified locations of priority habitats of rare species. This information consists of habitats for rare plant and animal populations that are protected under the Massachusetts Endangered Species Act regulations. There is typically substantial overlap between locations of estimated and priority habitats, there are also significant differences as well. In the Massachusetts portion of the Deerfield River Watershed, more than 80 priority habitats have been identified (Figure 3.4.2-1).

The NHESP completed the BioMap project to identify areas in need of protection in order to preserve native biodiversity, which is defined as the variety of life and its processes. The project focuses on state-listed rare species and significant natural communities. Maps were created through an evaluation of over 7,000 site-specific records of rare plants, animals, and natural communities. The maps delineate the most viable rare species habitats and natural communities (i.e., core habitat), as well as large minimally-fragmented supporting natural landscapes that protect the core habitats. The goal of the BioMap project is to promote strategic land protection by identifying areas that provide suitable habitat for the maximum number of terrestrial and wetland plant and animal species and natural communities.

Significant concentrations of core habitats and supporting natural landscapes in the Deerfield River Watershed (Figure 3.4.2-2) occur within portions of the Savoy and Mohawk Trail state forests, in areas adjacent to Clesson Brook, the North, South, and Green Rivers, as well as along the Deerfield River below Station No. 2. Smaller core habitat areas occur in other portions of the watershed as well.

3.4.3 Vernal Pools and Wetlands

There are several wetlands in the Vermont portion of the watershed mostly located on the plateau east of the Green Mountain peaks. These include a 70-acre emergent marsh around Billings Pond in Searsburg, a 100-acre marsh around Red Mill Pond in Woodford, the 250-acre Beaver Meadows wetland complex in Woodford, the 200-acre Camp Meadows wetland complex in Woodford, the 50-acre Castle Meadows wetland complex in Glastonbury, and a number of 30-40 acre wetlands in the remaining parts of the watershed. Despite the apparent abundance of wetlands in Vermont, wetland habitat has been significantly reduced since the 19th century due to logging and agricultural land clearing. It is estimated that Vermont and Massachusetts have lost approximately 35% and 28%, respectively, of their wetlands in the last 200 years. This reduction of wetlands is primarily due to major changes in land use. Since 1880, over 1.7 million acres of farmland in Vermont have been reverted back to forest but wetland loss continues at a rate of about 120 acres annually (FERC 1997).

Vernal pools are small, shallow ponds characterized by periods of dryness. Vernal pool habitat is extremely important to a variety of wildlife species including some amphibians that breed exclusively in vernal pools, and other organisms, which spend their entire life cycles confined to vernal pool habitat. Many additional wildlife species utilize vernal pools for breeding, feeding, and other important functions (MassGIS 2003).

According to MassGIS data, there are 11 certified vernal pools (Figure 3.4.3-1) in the Massachusetts portion of the Deerfield River Watershed. These vernal pools were certified by the Natural Heritage and Endangered Species Program (NHESP) according to the Guidelines for Certification of Vernal Pool Habitat (5/88, MDFW). In most cases, certified vernal pools are offered protections under the state wetlands protection act regulations, as well as the state water quality certification, state Title 5, and forest cutting practices act regulations.

NHESP staff also identified locations of potential vernal pools by aerial photograph interpretation. However, in some instances, not all potential vernal pools were identified due to unfavorable conditions in the landscape topography, pool physiography and/or photograph quality. Furthermore, vernal pool habitats occur in a wide variety of landscape settings, including forested swamps, bogs, and other wetlands. Vernal pools within these settings were not typically interpreted, but are nonetheless legitimate and valuable vernal pools (MassGIS 2003).

Within the Massachusetts portion of the Deerfield River Watershed, over 450 potential vernal pools were identified as part of the NHESP effort (Figure 3.4.3-1). In order for a vernal pool to be officially certified, specific information must be collected in the field and presented to the NHESP. Potential vernal pools do not receive protection under state wetlands protection act regulations, or any other state or federal wetlands protection laws.

3.4.4 Forests

Approximately 83% of the entire Deerfield River Watershed is covered by forest. Detailed forest inventories have been completed for Vermont and Massachusetts. Many of the resulting statistics from the inventories were grouped by county (USDA 1998). Northern hardwood forests are the most common forest type within the watershed, accounting for approximately 66% of the forest area. This forest type is characterized by sugar maple, beech, yellow birch, and black cherry species. White/red pine forests cover approximately 19%, while oak/hickory forests cover approximately 12% of the watershed (USDA 1998). White/red pine forests consist principally of eastern white and red pine, with associated species including jack pine, aspen, birch, and maple. The oak/hickory forest type principally includes northern red oak, white oak, bur oak, or hickories, singly or in combination, as well as jack pine, beech, yellow-poplar, elm, and maple (USDA 1998).

In 1998, tree size classifications for all forest lands in the watershed were determined (USDA 1998). Sawtimber[6] sized trees comprise approximately 76% of forest lands area in the watershed, while poletimber[7] size trees and seedlings/saplings[8] comprise 18% and 5%, respectively. Similar size distributions were exhibited for the entire state of Massachusetts.

Within Massachusetts as a whole, in 1985 trees sizes were distributed more evenly across the sawtimber and poletimber classifications. Sawtimber stands covered 41%, while poletimber stands accounted for 51%. Seedling/sapling stands accounted for 8%. Relative to the 1998 inventory data, this represented a 51% decrease in poletimber stands while sawtimber stands increased by 48% (USDA 1998). This statewide trend is most likely exhibited within the Deerfield River Watershed as well. The trend is indicative of overall forest maturation, and a corresponding loss in early-successional forests (MDFW 2004c).

Forest growing stock is the total volume of all the trees in a forest. Net annual growth describes the increase in the volume of trees during a specified year. Components of net annual growth include the increment of net volume of trees at the beginning of the specified year that survive to the year's end, plus the net volume of trees reaching the minimum size class, minus the volume of trees that died. Growing stock removals are defined as the volume removed from poletimber and sawtimber trees in a forest. Within the Massachusetts portion of the watershed, between 1984 and 1997, the net annual growth of forest growing stock was approximately 2.2 times greater than the average annual removal rate. However, approximately 50% of this average annual removal is related to timber harvests on land in forest use, the remainder comes from conversion of forestland to residential and commercial development (MDFW 2000b).

Rates of growth to removals of growing stock volume vary with tree species. Within Massachusetts, red maple is growing 2.5 times faster than it is being removed, either by harvest or by land-use change, while northern red oak, the species with the highest amount of total growing-stock removals, has a growth to removals ratio of 0.8 (USDA 1998). Efforts are underway by the state of Massachusetts to reverse both the proliferation of red maple and the trend in regeneration failure of red oak (Wickersham 2000).

Several tree species in the region have been impacted by invasive pathogens. For example, oaks and other hardwoods have been stressed by the gypsy moth. The American chestnut has been rendered an

[6] Sawtimber sized trees are defined as trees containing at least one 12-foot saw log or two noncontiguous saw logs, each at least 8 feet long. Softwoods must be a least 9.0 inches in diameter at breast height and hardwoods at least 11.0 inches in diameter at breast height.
[7] Poletimber sized trees are at least 5.0 inches in diameter at breast height and smaller than sawtimber size.
[8] Seedlings/saplings are trees less than 5.0 inches in diameter at breast height.

understroy tree or shrub by the chestnut blight. Beech bark disease has greatly reduced numbers of large American beech. Currently, the hemlock wooly adelgid is causing mortality of eastern hemlock (DeGraaf and Miller 1996).

The MDCR oversees forest management practices in Massachusetts. Regulations require a landowner to file a cutting plan if more than 25,000 board feet (or >50 cord) of wood is proposed to be harvested. Development of the cutting plan requires a forester to visit the proposed site to evaluate potential impacts to streams and wetlands, as well as soil erosion prevention measures. If the harvest area falls within an estimated habitat of rare wildlife or priority habitat of rare species, the cutting plan is screened by NHESP to determine if the logging will have any negative impacts on these areas of special significance. NHESP will make recommendations to minimize any adverse impacts, if necessary.

If the plan complies with the state regulations, then it is approved and logging can commence. Interim checks by a licensed forester are conducted throughout the cutting process to ensure compliance with the plan. After cutting is completed, the site is visited by a licensed forester who submits a summary report to MDCR.

For the period 2001 to 2003, an annual average of 2,399 acres of land was logged in the Massachusetts portion of the Deerfield River Watershed. This logging activity required a total 203 stream crossings.

3.4.5 Exotic/Invasive Plant Species

Approximately 45% of all vascular plant species in Massachusetts are exotic (Sorrie and Somers 1999). Invasive exotic plants are quick colonizers of disturbed areas. The faster growing rates of invasive plants, coupled with efficient seed dispersal mechanisms, and tolerance for a wide range of environmental conditions often allow invasive exotics to out-compete native species. Japanese knotweed is native to Southeast Asia and was introduced into the United States during the late 1800s. Due to its rapid growth rate, ability to tolerate a wide range of environmental conditions, and difficulty in removal, Japanese knotweed is considered to be a highly threatening and invasive species. Field surveys for Japanese knotweed were completed on eight tributaries (Table 3.4.5-1) to the Deerfield River (DRWA 2003b).

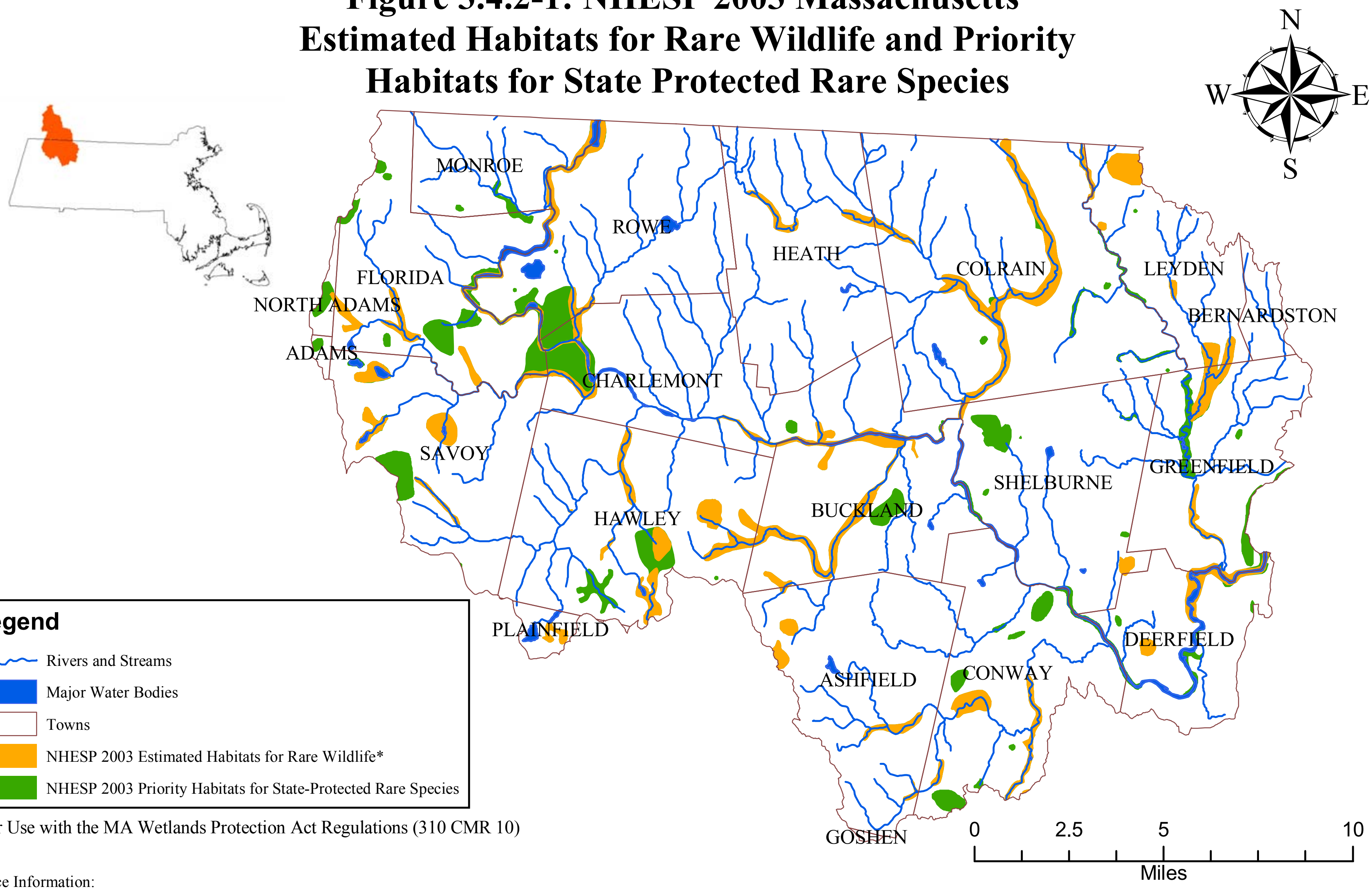
Table 3.4.5-1: Deerfield River Tributaries Surveyed for Japanese Knotweed (Source: DRWA 2003b)

Tributary Name	Proportion of Stream Surveyed
Avery Brook	93%
Bear River	23%
Chickley River	32%
Clesson Brook	70%
Green River	49%
Sanders Brook	47%
South River	46%
Tannery Brook	100%

Overall, Japanese knotweed infestations are relatively extensive along the tributaries surveyed and can be found on seven of the eight tributaries surveyed. Clesson Brook and the Chickley, Green, and South rivers have the most severe infestations of Japanese knotweed, while Avery Brook and Bear River have a moderate level of infestation. Tannery and Sanders Brook have little or no infestation (DRWA 2003b).

In general, knotweed infestations were more abundant in riparian areas that were adjacent to roads due to favorable growth conditions created by increased streambank disturbance and increased light levels (DRWA 2003b).

Figure 3.4.2-1: NHESP 2003 Massachusetts Estimated Habitats for Rare Wildlife and Priority Habitats for State Protected Rare Species



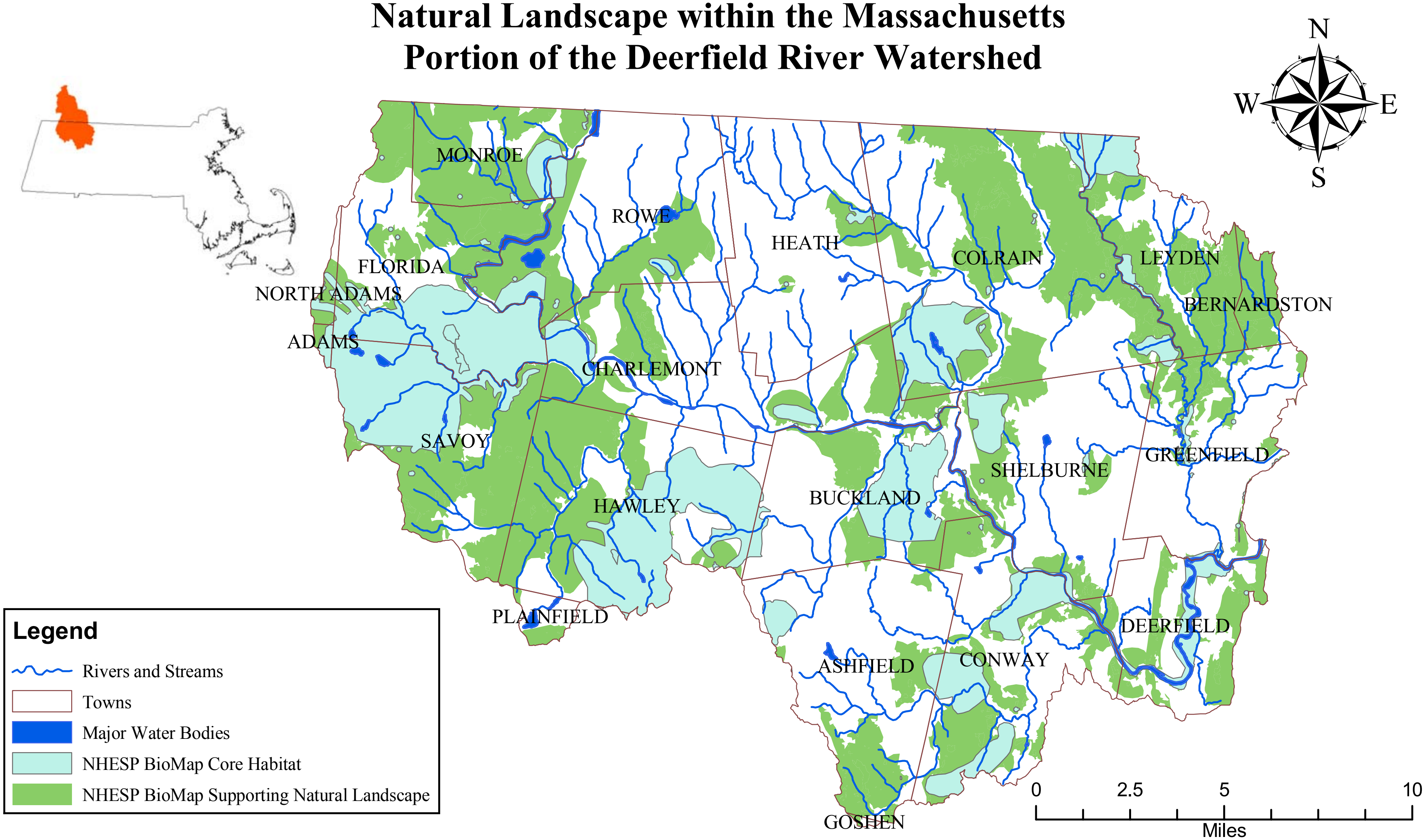
Legend

- Rivers and Streams
- Major Water Bodies
- Towns
- NHESP 2003 Estimated Habitats for Rare Wildlife*
- NHESP 2003 Priority Habitats for State-Protected Rare Species

* For Use with the MA Wetlands Protection Act Regulations (310 CMR 10)

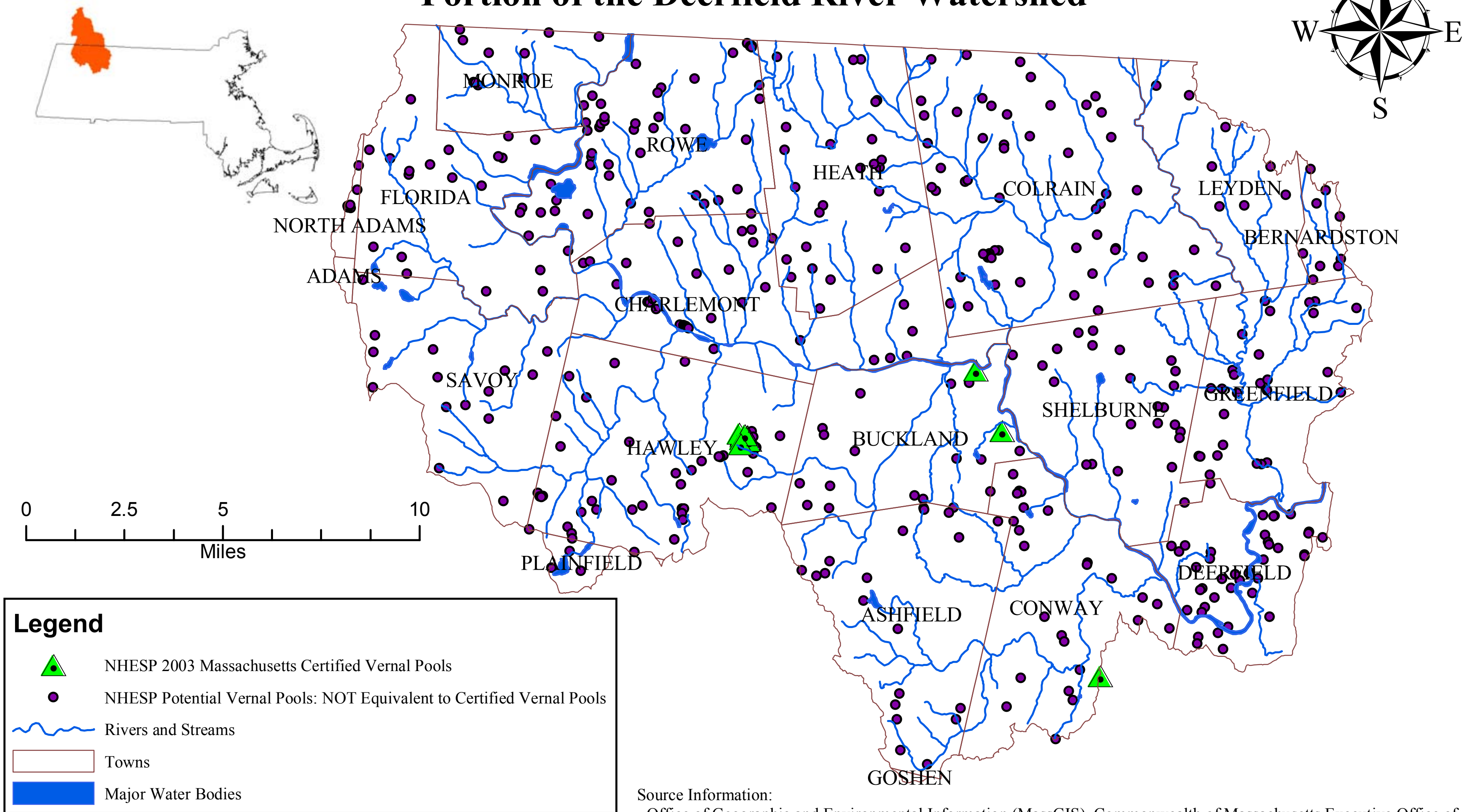
Source Information:
- Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Environmental Affairs

Figure 3.4.2-2: NHESP BioMap Core Habitat and Supporting Natural Landscape within the Massachusetts Portion of the Deerfield River Watershed



Source Information:
- Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Environmental Affairs

Figure 3.4.3-1: NHESP 2003 Massachusetts Certified and Potential Vernal Pools within the Massachusetts Portion of the Deerfield River Watershed



Source Information:
- Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Environmental Affairs

3.5 Open Space

Franklin Regional Council of Governments (FRCOG) recently completed an effort to develop an open space and recreation plan for the Deerfield River Watershed (FRCOG 2004). The plan contained several actions to protect and manage community growth, without losing valued open space and recreational assets.

3.5.1 Land Use Patterns and Changes

The majority of the watershed is heavily forested with farmland typifying the eastern portion. Development has been documented in distinct areas of the watershed, particularly in the towns of Greenfield and Shelburne. Industrial development is common along major rivers and commercial development in village centers and along the Mohawk Trail. Large residential subdivisions are uncommon in the watershed (FRCOG 2004).

Land use for the Vermont portion of the watershed consists of 86% forested, 5% water/wetland, 5% agriculture, and 4% residential (VANR 2003). Figure 3.5.1-1 depicts land use in the Deerfield River Watershed. The Massachusetts portion of the watershed is largely undeveloped and classified as approximately 81% forested, 9% agriculture, 5% urban/residential, and 1.5% water/wetland with most of the urban land in the southernmost portions of the watershed (Table 3.5.1-1).

Table 3.5.1-1: Land Use in the Massachusetts Portion of the Deerfield River Watershed (Source: MassGIS 2003)

Land Use Type	Percent	Description
Forest	80.6%	Forest
Cropland	5.7%	Intensive agriculture
Residential	4.5%	Multi-family; smaller than 1/4 acre lots; 1/4 - 1/2 acre lots; larger than 1/2 acre lots
Pasture	3.1%	Extensive agriculture
Open Land	2.4%	Abandoned agriculture; power lines; areas of no vegetation
Water	0.9%	Fresh water; coastal embayment
Woody Perennial	0.7%	Orchard; nursery; cranberry bog
Recreation	0.6%	Golf; tennis; playgrounds; skiing; stadiums; racetracks; fairgrounds; drive-ins; beaches; marinas; swimming pools
Wetland	0.5%	Nonforested freshwater wetland
Urban Open	0.3%	Parks; cemeteries; public & institutional greenspace; also vacant undeveloped land
Commercial	0.3%	General urban; shopping center
Transportation	0.3%	Airports; docks; divided highway; freight; storage; railroads
Mining	0.1%	Sand; gravel and rock
Industrial	0.1%	Light & heavy industry
Waste Disposal	0.02%	Landfills; sewage lagoons

Agricultural land in the watershed includes land growing feed crops to support dairy and beef farms, pasture for grazing, fruit tree orchard plantings, and sugar maple stands that are tapped to produce maple syrup. Within the watershed, agricultural fields are most prevalent in the areas east of the North River in Colrain, and Clesson Brook in Buckland. The amount of agricultural land varies by town:

- Monroe, Florida, Savoy, Hawley, and Rowe have 5% or less of their land in agriculture;
- Ashfield, Conway, Buckland, Charlemont, and Heath have between 9 and 11% of their land in agriculture; and,
- Colrain, Shelburne, Greenfield, Deerfield, and Leyden have between 12 and 23% of their land in agriculture.

Since 1985, there have been significant changes in land use within the Massachusetts portion of the watershed. Specifically, large lot residential development has resulted in the loss of forest and farmland. Between 1985 and 1999, the watershed experienced reductions in cropland (10%), pastureland (22%), and forest (1%), with a 58% increase in large-lot residential development. This development typically occurred via construction of single-family homes on lots along existing roadways (FRCOG 2004).

It is likely that land use in the watershed will follow a similar pattern in the foreseeable future. However, the population within the watershed is projected to increase at a faster rate than previously experienced; therefore, changes in land use patterns are expected to be more pronounced (FRCOG 2004).

3.5.2 Population Growth and Projections

Table 3.5.2-1 illustrates the population trends between 1970 and 2000 for towns within the Massachusetts portion of the watershed (FRCOG 2004). Significant increases in population (>10%) were experienced in 11 of the 15 towns located within the watershed. Overall, the Massachusetts portion of the watershed experienced a growth rate of 14.4%, while population in Massachusetts as a whole increased 11.6%.

Table 3.5.2-1: Population Trends (1970-2000) of Towns within the Massachusetts Portion of the Deerfield Watershed (Source: FRCOG 2004)

	1970 Population	2000 Population	Percent Change 1970-2000
Savoy	322	705	118.9%
Heath	383	805	110.2%
Leyden	376	772	105.3%
Conway	998	1,809	81.3%
Charlemont	897	1,358	51.4%
Hawley	224	336	50.0%
Ashfield	1,274	1,800	41.3%
Colrain	1,420	1,813	27.7%
Rowe	277	351	26.7%
Deerfield	3,873	4,750	22.6%
Shelburne	1,836	2,058	12.1%
Buckland	1,892	1,991	5.2%
Florida	672	676	0.6%
Greenfield	18,116	18,168	0.3%
Monroe	216	93	-56.9%
Deerfield River Watershed	**32,776**	**37,485**	**14.4%**
Massachusetts	**5,689,377**	**6,349,097**	**11.6%**

The FRCOG and the Berkshire Regional Planning Commission (BRPC) project populations for the majority of towns to increase by approximately 7,300 people by 2025, an increase of 19.5% (FRCOG 2004).

Build-out analyses provide another measure of the potential for future growth. Such analyses were completed for all towns within the Massachusetts portion of the watershed during 2001. The effort was sponsored by the Massachusetts Executive Office of Environmental Affairs (EOEA). The results of those analyses show the potential for significant growth and demand for services in the watershed's communities under maximum build-out conditions (Table 3.5.3-1).

Table 3.5.3-1: Results of Build-Out Analyses for Massachusetts Portion of the Deerfield River Watershed (Source: EOEA 2004)

Town	Additional Developable Land Area (acres)	Additional Residents	Additional Water Demand at Build-out (gallons/day)	Additional Solid Waste (tons/yr)
Ashfield	18,860	22,407	1,908,497	11,494
Buckland	8,212	10,310	887,017	5,289
Charlemont	8,336	13,917	1,110,250	15,169
Colrain	16,174	28,355	2,225,301	14,546
Conway	14,256	13,195	991,986	6,769
Deerfield	12,000	18,624	2,272,093	9,554
Greenfield	5,796	18,883	1,849,865	9,686
Hawley	6,965	8,057	604,241	4,113
Heath	11,011	13,942	1,104,264	7,152
Leyden	7,926	9,798	855,734	5,026
Monroe	3,080	3,403	300,567	1,745
Rowe	5,694	2,923	500,667	1,499
Shelburne	6,117	7,405	763,930	3,799
Florida	4,338	5,856	439,198	2,635
Savoy	6,954	6,027	451,994	2,712
Watershed	**135,719**	**183,102**	**16,265,604**	**101,188**

For all towns combined, build-out analyses indicate a significant future growth rate. In terms of infrastructure and space needs, these increases could result in an additional 135,719 acres being developed, almost 16 million gallons per day of additional water demand, and more than 101,188 additional tons/year of solid waste generation to serve the 183,102 additional residents.

The probability that maximum build-out conditions would occur in the watershed is low; however, if 20% of the watershed's open space were developed, significant alteration to watershed's character could be expected. Under these build-out conditions the population within the watershed would be expected to grow to approximately 70,000 (FRCOG 2004).

The potential for significant future growth means that substantial pressure will likely be placed on the natural resources of the watershed – particularly water and land resources – to meet the needs of expanding populations. This pressure will necessitate careful planning to reduce the environmental impacts of growth, including the protection of significant natural resources.

3.5.3 Protected Lands

Efforts by government agencies and private conservation organizations have resulted in a significant amount of protected land in the watershed. This includes permanently protected land owned by private landowners, municipal, state, and nonprofit organizations, and utilities (Figure 3.5.3-1), as well other areas with less stringent land protections. Overall, approximately 63.1 square miles of the watershed are considered "protected open space" (Table 3.5.3-1), representing approximately 18.2% of the watershed. Other open space lands with less stringent land protections also comprise significant parts of the watershed.

Table 3.5.3-1: Protected Open Space Lands in the Massachusetts Portion of the Deerfield River Watershed (Source: MassGIS 2003)

Category	Square Miles	% of Total
Protected in Perpetuity[9]	63.1	18.2
Temporary[10]	68.4	19.7
Limited[11]	1.8	0.5
None[12]	5.7	1.6

Temporarily protected parcels are those that are enrolled in the Massachusetts Chapter 61 tax abatement programs (Table 3.5.3-2). These programs offer landowners a reduction in their property taxes if the landowner agrees that the predominant use of the land will not change during a specified time period. Lands are protected for ten years under Chapter 61 and 61B, and one year under the Chapter 61A designation, which assists farmers by reducing taxes while land is maintain in agricultural use. The Chapter 61 designation provides incentives for owners of actively managed forestland, while landowners with a Chapter 61B designation receive lower property taxes in exchange for keeping land in open space for ten years.

Table 3.5.3-2: Chapter 61 Lands in Massachusetts Portion of the Deerfield River Watershed (Source: MassGIS 2003)

Category	Square Miles	% of Total
Chapter 61 (Forestry)	43.4	57.1
Chapter 61A (Agricultural)	10.0	13.2
Chapter 61B (Recreation)	22.6	29.7

In addition to the aforementioned watershed open space and recreation plan currently being conducted by FRCOG, several towns within the Massachusetts portion of the watershed have completed their open space plans. Table 3.5.3-3 depicts that status of each town's open space planning.

[9] Legally protected in perpetuity and recorded as such in a deed or other official document.
[10] Legally protected for less than perpetuity (e.g. short term conservation restriction or Chapter 61 lands), or temporarily protected through an existing functional use.
[11] Protected by legal mechanisms other than those above, or protected through functional or traditional use.
[12] Totally unprotected by any legal or functional means. This land is usually privately owned and could be sold without restriction at any time for another use (e.g. scout camps, private golf course, and private woodland).

Table 3.5.3-3: Status of Open Space Plan with Massachusetts Portion of the Deerfield River Watershed (Source: FRCOG 2004)

Town	Open Space Plan Status
Ashfield	Plan to be completed by June 2004
Buckland	Plan to be completed by June 2004
Charlemont	Plan to be completed by June 2004
Colrain	Plan to be completed by June 2004
Conway	Plan Complete
Deerfield	Plan Complete
Florida	Draft Plan Complete
Greenfield	Plan Complete
Hawley	No Plan
Heath	Plan Complete
Leyden	Plan to be completed by June 2004
Monroe	No Plan
Rowe	Plan Elements to be completed by June 2004
Savoy	Plan Complete
Shelburne	Plan to be completed by June 2004

3.5.4 Zoning

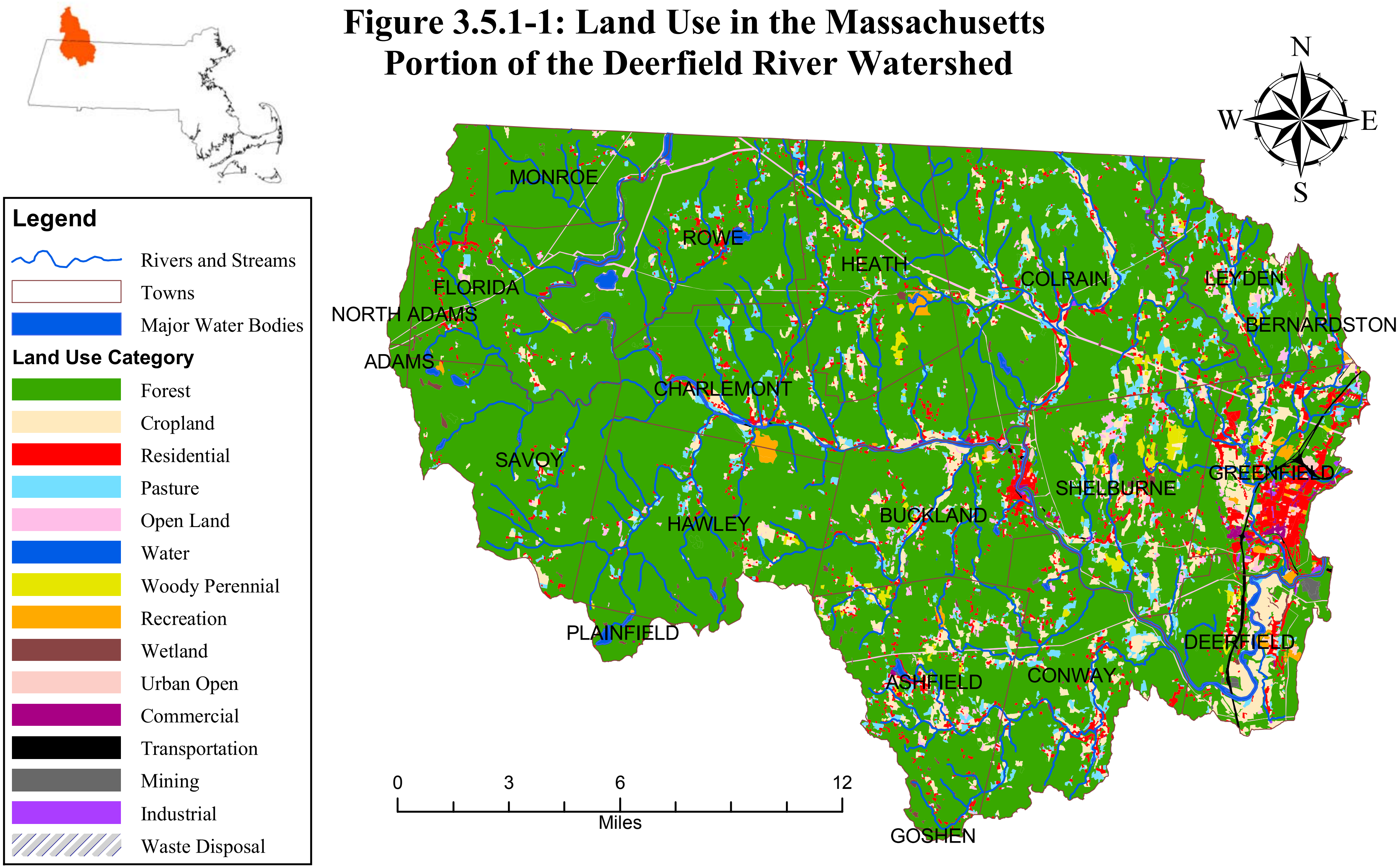
Communities use a variety of planning tools including local by-laws and ordinances to control or otherwise guide growth. The most widespread zoning district in the watershed is the Residential-Agricultural designation (Table 3.5.4-1). Buckland, Colrain, Deerfield, Greenfield, and Shelburne have commercial districts. Industrial zones are delineated in Buckland, Colrain, Conway, Deerfield, Greenfield, Rowe, and Shelburne.

Table 3.5.4-1: Zoning Districts within Deerfield River Watershed Communities (Source: EOEA 2004)

Town	Zoning Districts
Ashfield	Rural-Residential and Agriculture
Buckland	Industrial Commercial Residential with sewer/water Residential without sewer/water
Charlemont	Residential/Agricultural
Colrain	Industrial Commercial Residential /Agriculture
Conway	Residential / Rural Agricultural Light Industrial
Deerfield	Small Business Commercial Industrial Central Village Residential Planned Industrial Residential -Agricultural Water Protection
Florida	Agricultural/Residence

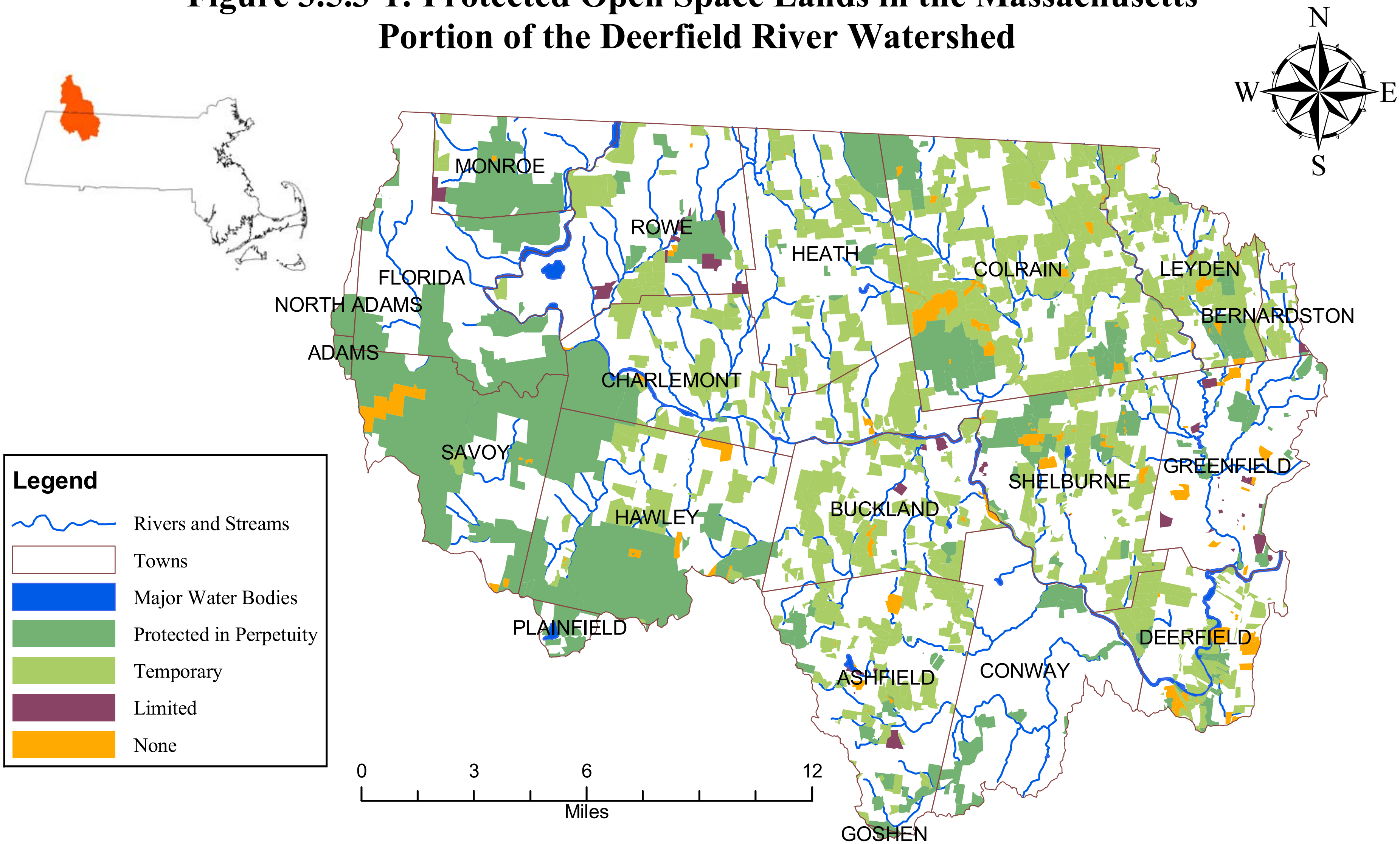
Town	Zoning Districts
Greenfield	Central Commercial General Commercial General Industry Health Service Limited Commercial Office Planned Industry Urban Residential Suburban Residential Rural Residential Semi-Residential
Hawley	Rural
Heath	Primarily Agriculture and Residential Residential/Recreational Mohawk Estates Floodplain Town Center Water Supply
Leyden	Central Village Residential Residential/Agricultural
Monroe	Rural Residential
Rowe	Residential-Agricultural District Industrial
Savoy	Agricultural/Residential
Shelburne	Commercial Industrial Residential Village Residential

Figure 3.5.1-1: Land Use in the Massachusetts Portion of the Deerfield River Watershed



Source Information:
- Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Environmental Affairs

Figure 3.5.3-1: Protected Open Space Lands in the Massachusetts Portion of the Deerfield River Watershed



Source Information:
- Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Environmental Affairs

3.6 Recreation

The Deerfield River is one of the most heavily used recreational rivers in the New England Region, with the most favored activities being whitewater boating and angling (FERC 1997). Several commercial whitewater outfitters offer raft, canoe, and kayak trips within the watershed. These companies include Crabapple Whitewater Outfitters, North American Whitewater Expeditions, Wilderness Plus Rafting, and Zoar Outdoors. Individual recreational users are also attracted to the area for rafting, canoeing and kayaking, although kayak trips are somewhat more common (USGen 2000). Other activities within the watershed include angling, hiking, downhill skiing, cross-country skiing, camping, picnicking, swimming, snowmobiling, off-road recreational vehicles, foliage and wildlife viewing, and hunting.

3.6.1 Whitewater Boating

Due to its proximity to population centers and the predictability of its flows, the Deerfield River is one of the premier whitewater boating locations in the region. Whitewater boating has developed steadily along the river due to designated whitewater boating flows provided at several hydroelectric dams currently owned by USGen. Since 1991, USGen has provided scheduled flow releases suitable for whitewater boating at the Station No. 5 and Fife Brook dams. The availability of water from storage at Harriman Reservoir makes whitewater boating available at Station No. 5 and below Fife Brook at times of the year and on a predictable schedule that nature could not provide.

Overall, the Deerfield River provides opportunities for Class[13] I through Class V whitewater boating within a 15-mile radius of Charlemont. Whitewater boating primarily occurs in two stretches in Massachusetts: a 2.6-mile stretch in the Station No. 5 bypass (the Monroe Bridge Section or Dryway) and a 17-mile stretch between the Fife Brook Dam and the Station No. 4 Dam (the Fife Brook Section).

The Monroe Bridge Section is one of only four Adventure Class (at least Class IV) whitewater stretches offering commercial boating in New England. As a result of the recent FERC relicensing, USGen constructed a boat slide and launching ramp at the Monroe Bridge put-in site. The Dunbar Brook Picnic Area is used as a take-out point for this section (Banks 2001).

The Fife Brook Section consists of three distinct boating segments. The first segment starts below Fife Brook Dam and extends downstream approximately 5 miles to Zoar Gap, where the only Class III rapid exists in the entire section. This segment is frequented by commercial rafting companies, canoers, and kayakers. The middle segment extends from Zoar Gap to Shunpike Picnic Area, which caters to tubers and novice canoers, as well as more highly skilled boaters. The lower segment extends from Shunpike Picnic Area to the Station No. 4 Dam. Tubers, novice canoers, and persons who are on unguided commercial trips primarily use this area (Banks 2001).

During higher flow conditions, boaters occasionally float six miles of Class I and II whitewater along the East Branch Deerfield River from the Somerset Reservoir to the Searsburg Impoundment. In addition, Class II whitewater opportunities are available below the Station No. 2 Dam when the hydroelectric project is generating. A boat slide and stairs are currently planned for construction at the Station No. 2 Dam, which will likely result in increased boating activity. Currently due to limited access, boating activity between Station No. 3, Gardners Falls and Station No. 2 dams is sparse (Banks 2001). An 8-mile stretch of the Green River upstream of West Leyden, Massachusetts is largely Class II whitewater, with some Class III whitewater at high flows.

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[13] Based on the International Scale of River Difficulty, which defines six difficulty classes of whitewater: Class I-easy, Class II-novice, Class III-intermediate, Class IV-advanced, Class V-expert, and Class VI-extreme.

There are several locations along the Deerfield River with public access for canoes, boats, and kayaks. USGen recently constructed a boat slide and launching ramp at the Monroe Bridge put-in site below the Station No. 5 Dam that is typically used by whitewater paddlers. The Dunbar Brook picnic area located approximately 2.5 miles downstream is used as a take-out point in this river reach. Below Fife Brook Dam in the town of Florida, there is popular access point frequently used by whitewater paddlers. The Zoar Gap Picnic Area, located in Charlemont, also represents a popular river access point for whitewater paddlers. Further downstream, the Shunpike Picnic Area, located in western Charlemont, also provides good access to the river. This site is owned by the Massachusetts Highway Department. There is another put-in site approximately one mile from the Buckland/Charlemont border that is not particularly well marked. Slightly west of this site, USGen owns and operates an access point that also has picnic tables. Wilcox Hollow is a river access point located near the Gardners Falls Dam in Shelburne. The site is owned and maintained Consolidated Edison. A boat slide and stairs are currently planned for construction at the Station No. 2 Dam.

3.6.2 Angling

Both lake and river angling opportunities abound within the Deerfield River Watershed. Warmwater and coldwater species inhabit the impoundment and riverine portions of the Deerfield River. In particular, Somerset Reservoir, largely surrounded by the Green Mountain National Forest, supports an excellent brook trout fishery. Harriman Reservoir has the highest amount of summer angler use in the watershed. This reservoir as well as the remaining Deerfield River impoundments also provides significant ice fishing opportunities. Harriman is stocked with landlocked salmon, lake trout, brook trout, brown and rainbow trout. There is also an abundance of warmwater species such as smallmouth bass, yellow perch, and rainbow smelt. The VDFW stocked the Harriman bypass reach in order to establish a brook trout population. This has presumably resulted in a self-sustaining brook trout population, which will likely increase angler usage.

Angling is particularly popular below Fife Brook Dam, as well, where the MDFW manages a highly valued catch and release trout fishing area (from Fife Brook dam to Hoosac Tunnel and From Pelham Brook to the Mohawk Campground). The MDFW typically stocks rainbow and brown trout in these areas. In the spring and fall, fly-fishing is very popular below the Station No. 4 Dam near the confluence with the North River (Banks 2001). Excellent trout fishing opportunities are also available below the Station No. 2 Dam, where anglers typically focus effort near Bardwell Ferry Bridge. This is due in part to the remote nature of the Station No. 2 reach. Major tributaries to the Deerfield, such as the Cold River, also provide angling opportunities.

3.6.3 Hiking

The Mohawk Trail of western Massachusetts, also known as state highway Route 2, was one of the earliest Scenic Byways in New England (FRCOG and BRPC 2002). Large portions of the trail follow the Deerfield River and the Mahican-Mohawk Trail, a former Native American trail linking the Hudson and Connecticut River Watersheds. This original trail is currently being reestablished as a recreational trail in the Deerfield River Watershed.

In addition, there is a vast network of trails throughout the watershed and particularly within the state forest lands (Section 3.6.5). These trails offer opportunities for hiking, horseback riding, and cross-country skiing.

3.6.4 Downhill and Cross Country Skiing

Commercial downhill ski areas located in the Deerfield River Watershed include the Berkshire East Ski Area in Charlemont, Massachusetts and the Mt. Snow Ski Area in Dover, Vermont. Cross Country skiing opportunities are also available via a network trails within state forest lands (Section 3.6.5) as well as in various other portions of the watershed, such as Highland Pond in Greenfield, which maintains 19 miles of cross country ski trails.

3.6.5 State Forests and Parks

The Green Mountain National Forest encompasses approximately 40% of the Deerfield River Watershed within the state of Vermont (VDEC 1992). In addition, the MDCR manages a number of lands and facilities in the watershed, including several state forests, and state parks (Figure 3.6.5-1).

The Mohawk Trail State Forest, located just west of Charlemont, encompasses approximately 6,457 acres, and is considered to be one of the most scenic woodland areas in Massachusetts (FRCOG and BRPC 2002). The forest includes much of the last remaining old growth forests in Massachusetts, as well as a swimming area in the Cold River and a day use picnic area. There are also 56 campsites and six overnight log cabins in the forest. In addition, several original Native American trails, including the Mahican-Mohawk Trail, are available for hiking.

The 11,118-acre Savoy Mountain State Forest is located slightly west of the Mohawk Trail State Forest. This forest consists of several miles of wooded trails with the very scenic North and South Ponds offering fishing, picnicking, and swimming opportunities. There are 45 campsites and four log cabins located within the forest. Significant natural features within the forest include Bog Pond, with its floating bog island, and Tannery Falls, with cascading waterfalls.

The Kenneth Dubuque Memorial State Forest encompasses 7,882 acres, and consists of 47 miles of snowmobile trails, 35 miles of horse trails, six miles of hiking trails and a one mile interpretive trail. The Monroe State Forest is a 4,321-acre forest encompassing southern and central Monroe, and extending into Florida. The forest includes a lookout platform on the side of Hunt Hill, more than five miles of streams supporting native brook trout, and several miles of trails for hiking and horeseback riding. Hunting and winter activities are also available. Catamount State Forest is located on 1,125 acres in southwestern Colrain and eastern Charlemont. A 27-acre lake and nearby streams are stocked with trout. The area offers hiking and bridle trails, as well as the opportunity for various winter activities. H. O. Cook State Forest is located in the northwestern Colrain and northeastern Heath, just south of the Vermont state line. Its 1,620 acres offer hunting, fishing, hiking and horseback riding trails and winter activities. The more than five miles of streams support native brook trout.

The Conway State Forest, a 1,946-acre forest in southern Conway, provides hiking and horseback trails, and more than four miles of streams for trout fishing. It also offers hunting and winter activities. Nearby, the South River State Forest encompasses 500 acres in Conway and provides picnic tables along the South River to its confluence with the Deerfield River, plus several primitive campsites. Fishing is available in the South, Bear, and Deerfield Rivers.

Other state forest lands in the watershed include the D.A.R State Forest, Florida State Forest, Leyden State Forest, Buckland State Forest, and the Shelburne State Forest.

3.6.6 Snowmobiling

Snowmobiling is allowed within several state forests including Savoy Mountain State Forest, Monroe State Forest, Kenneth Dubuque State Forest, and Mohawk Trail State Forest. A major regional trail connects the Savoy Mountain State Forest and the Monroe State Forest. This trail also connects an extensive system of trails location in the upper Massachusetts portion of the Deerfield River Watershed. There are several snowmobile clubs in the watershed including the Buckland Riders Snowmobile Club, Indian Head Snowmobile Club, and the Snowmobile Association of Massachusetts (FRCOG and BRPC 2002).

3.6.7 Hunting

The MDFW manages a Wildlife Management Area within the watershed. The Poland Brook Wildlife Management Area is located in Conway, Massachusetts along Poland Brook, a tributary to the South River. Most of the 664-acre site was used as a dairy farm prior to acquisition by MDFW. Many of the farm fields are maintained either via mowing by MDFW personnel or via cooperative farm agreements with local farmers. One of primary activities at this site is pheasant hunting.

Big and small-game hunting are very popular throughout other portions of the watershed. The undeveloped nature of the watershed coupled with excellent wildlife habitats present many opportunities for recreational hunting. White-tailed deer and black bear populations are quite extensive in the watershed and the area typically ranks among the highest in terms of annual bear harvest in Massachusetts.

3.6.8 Swimming

Swimming uses are common throughout the Deerfield River Watershed. Within Vermont, the following lakes are popular for swimming and are known to receive fairly significant use. Adams Pond in Woodford, Vermont has two designated swim beaches, Grout Pond in Stratton, Vermont has one designated swim beach, and Lake Raponda in Wilmington, Vermont has a popular swim beach. Swimming also occurs at several locations on Harriman Reservoir including the south and north beaches, and swimmers typically use the public access area at Somerset Reservoir. In addition, there are popular swimming spots located near waterfall areas on the West Branch Deerfield and the East Branch of the North River. The Green River also has two notable swimming areas in the Vermont portion (VANR 2003).

Within the Massachusetts portion of the watershed, there was a high degree of informal recreational use directly below the Station No. 3 Dam. This site, known as the “potholes”, is an area of exposed bedrock with glacial potholes. Access to the area was provided by stairs from downtown Shelburne Falls, and the site was used for swimming and sunbathing. The site is no longer publicly accessible as it was closed in 2002. During a typical summer day, hundreds of individuals would recreate at this site (Banks 2001). There is a similar setting near the confluence of the North River and the Deerfield River, although overall use is not as high. A large pool at this confluence below exposed bedrock and cascades attracts swimmers, sunbathers, and tubers (FERC 1997).

MDEM manages a swimming area at Mohawk State Park along the Cold River in Charlemont, Massachusetts. The Greenfield Swimming Pool Dam located on the Green River is popular public swimming area. The dam is about 2 feet high, and flashboards are used to raise the pool behind the dam during the swimming season (MDEP 2003a).

3.6.9 Passive Recreation

The rural/undeveloped nature of the watershed along with its established network of trails and conservation lands present opportunities for more passive types of recreation such as bird watching, nature photography, and winter animal tracking. The High Ledges Wildlife Sanctuary, owned by the Massachusetts Audubon Society, has a variety of flowering plants and a network of trails. The GTD Griswold Conservation Area in Greenfield consists of 200 acres of conservation land providing nature study and bird watching activities. Other passive recreation areas in the watershed include Greenfield Energy Park and Poet's Seat Tower. These facilities offer recreation activities including sightseeing, wildlife viewing, and picnicking.

3.6.10 Instream Recreation Safety

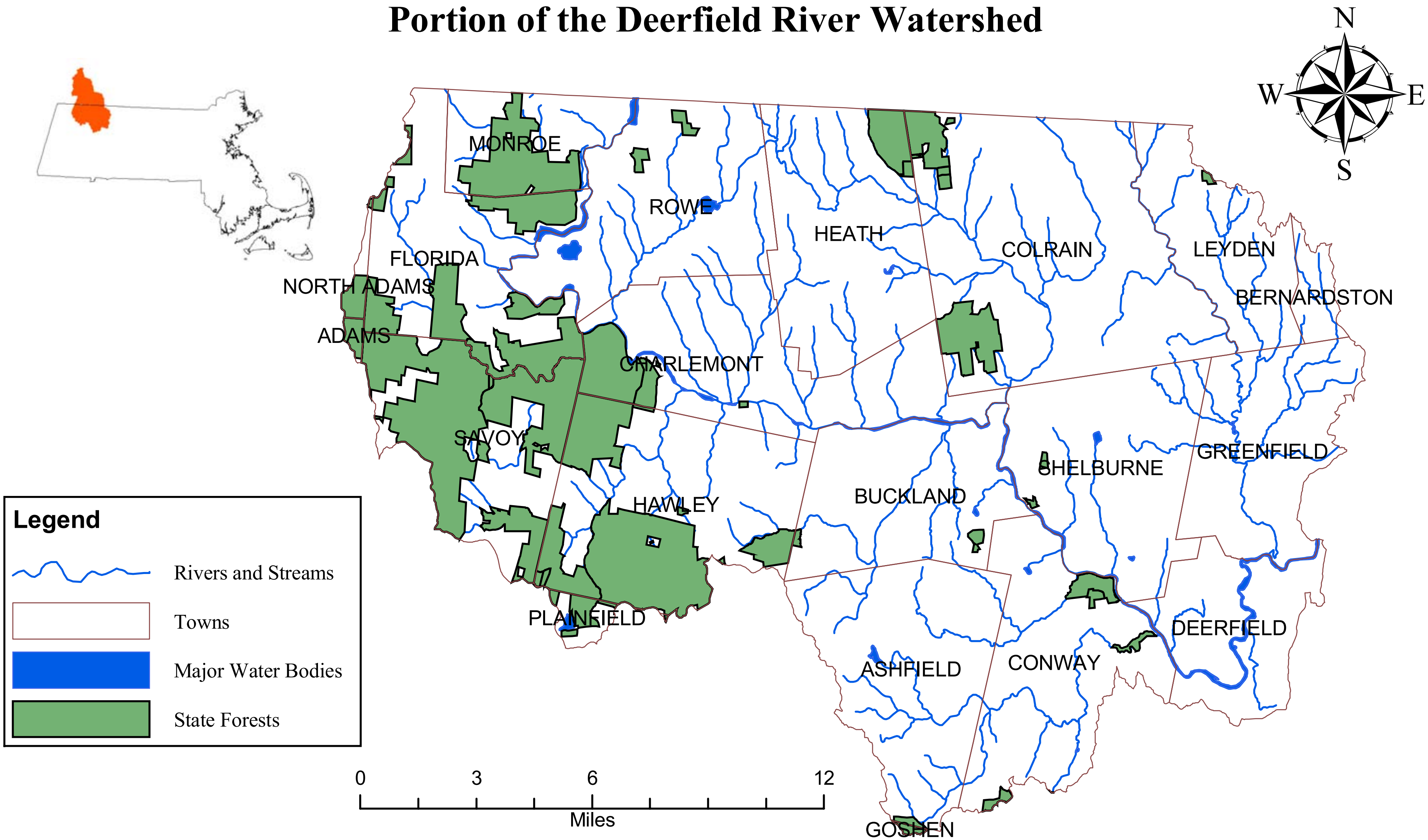
To assist water-based recreationalists, USGen maintains a river flow information phone (Flo-fone). The Flo-fone is a toll-free public service announcement that river users can access to determine flow release schedules from the hydroelectric projects for an upcoming 24-hour period. The Flo-fone is updated daily, at a minimum, to reflect current and anticipated flow release (generation) conditions.

An assessment of recreational safety issues within the watershed (Banks 2001) identified several issues related to the Flo-fone system. Since the advent of deregulation (1998), project operators have found it increasingly difficult to predict changes in flow. Competitive marketing of electricity can result in requests to generate electricity almost immediately resulting in rapid and previously unplanned increases in water level. This situation has been a source of frustration for many recreationists, who often arrive at the river to find water levels above or below those posted on the Flo-fone. The study also suggested a rating and definition system to accompany the Flo-fone. This system would allow users to understand the technical skills necessary to negotiate a given river flow.

A recent study (USGen 2000) conducted by USGen recommended several enhancements to the Flo-fone system. In general, when interviewed regular recreational users were familiar with the Flo-fone system; however occasional or first time recreational users were not as familiar with the system. The Flo-fone system is advertised in several publications and on the Internet. The study recommended that signs with the Flo-fone number also be posted within the project area to acquaint first time users with the system. In addition, occasional and first time users were found to be unfamiliar with the various projects names. Therefore, it was recommended to post the names of the dams with the Flo-fone number. Lastly, there is a public phone in Monroe Bridge near the Station No. 5 Dam, and it was recommended that directions be provided to it on any signs describing the Flo-fone system.

The USGen study also recommended several safety enhancements related to recreation use at several projects. Specifically, these enhancements include the placement of interpretive and informational signs at the whitewater boating put-in and take-out points below Station No. 5 Dam and near the Bardwell Ferry area below the Station No. 2 Dam.

Figure 3.6.5-1: State Forest Lands within the Massachusetts Portion of the Deerfield River Watershed



Source Information:
- Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Environmental Affairs

4 Key Areas of Concern and Assessment Needs

Based on the information and data described in Section 3, existing needs or areas of concern within the Deerfield River have been identified below.

4.1 Water Quantity

- Electric utility deregulation has resulted in flow related concerns by some river users, particularly anglers. The market-based bidding process used to determine when power generation occurs, has resulted in frequent and unscheduled high flow releases below several hydroelectric facilities on the mainstem Deerfield River. These conditions have raised access and river safety concerns for several river users (e.g., swimmers, anglers).
- Assess groundwater resources to identify protection measures and sustainable yield.

4.2 Water Quality

- Independent monitoring of wastewater treatment plant outfalls to ensure discharges are in compliance with NPDES permit standards.
- Detailed study of non-point pollution sources within the watershed, including sources related to landfills, junkyards and illegal garbage dumping areas, stormwater runoff from urban areas and rural dirt roads, road salt and herbicide/pesticide application, runoff from the East Deerfield railroad yard, petroleum spills, hazardous material spills, sewage contamination from failing private septic systems and municipal sewage infrastructure, streambank erosion, and agricultural runoff.
- Implementation of recommendations from the Fuss and O'Neil (2003) landfill assessment study.
- Assessment of lakes and ponds within the watershed to determine presence and extent of invasive plant species.
- Complete TMDLs for impaired waterbodies, per the Massachusetts Year 2002 Integrated List of Waters. (i.e., assessment of maximum amount of pollution a waterbody can accommodate before water quality standards are violated).
- MDEP acceptance of volunteer monitoring data.
- Water quality assessment for lakes and ponds in the watershed.
- Additional water quality data collection within the watershed.

4.3 Fish Communities

- Protection of Living Waters core habitats and critical supporting watersheds.
- Comprehensive assessment to identify impediments (i.e., dams, culverts) to fish passage and wildlife movement within tributaries of the Deerfield River.
- Collection of data to describe aquatic habitat conditions and biotic diversity in the Deerfield River mainstem.

4.4 Wildlife and Terrestrial Habitat

- Protection of BioMap core habitats and supporting natural landscapes in the Deerfield River Watershed.
- Increase early successional habitats, as well as overall terrestrial habitat diversity through forest and land management practices.
- Assessment and implementation of control measures to combat the infestation and spread of invasive terrestrial plant species (i.e., Japanese knotweed).
- Additional surveys of marshbirds and calling amphibians
- Assess the extent and condition of wetlands, as well as protection of existing resources, including vernal pools.

4.5 Open Space

- Implement land use and development patterns that manage growth and preserve scenic, rural character, open space, and water resources, and agricultural and forested lands.
- Protect existing agricultural lands in the watershed.
- Identify and conserve parcels with conservation, wildlife, and recreation interest.
- Coordination with state, regional, and local entities to maximize protection of joint open space resources.

4.6 Recreation

- Increased recreational boating safety in the watershed through greater enforcement of regulations and public outreach/education.
- Enforcement of regulations to control littering and trespassing associated with increased recreational use.
- Expand public river access sites along the mainstem Deerfield for recreational users.
- Promote and provide access to existing and new recreational trail networks for type of users on public and private lands.

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APPENDIX A

Table A-1: Bird Species Identified During North American Breeding Bird Surveys (1966-2003)

Species	Scientific Name
Green Heron	*Butorides virescens*
Turkey Vulture	*Cathartes aura*
Canada Goose	*Branta canadensis*
Mallard	*Anas platyrhynchos*
Sharp-shinned Hawk	*Accipiter striatus*
Cooper's Hawk	*Accipiter cooperii*
Northern Goshawk	*Accipiter gentilis*
Red-shouldered Hawk	*Buteo lineatus*
Broad-winged Hawk	*Buteo platypterus*
Red-tailed Hawk	*Buteo jamaicensis*
American Kestrel	*Falco sparverius*
Ring-necked Pheasant	*Phasianus colchicus*
Ruffed Grouse	*Bonasa umbellus*
Killdeer	*Charadrius vociferus*
Spotted Sandpiper	*Actitis macularia*
Upland Sandpiper	*Bartramia longicauda*
Common Snipe	*Gallinago gallinago*
American Woodcock	*Scolopax minor*
Rock Dove	*Columba livia*
Mourning Dove	*Zenaida macroura*
Black-billed Cuckoo	*Coccyzus erythropthalmus*
Yellow-billed Cuckoo	*Coccyzus americanus*
Great Horned Owl	*Bubo virginianus*
Barred Owl	*Strix varia*
Chimney Swift	*Chaetura pelagica*
Ruby-thr. Hummingbird	*Archilochus colubris*
Belted Kingfisher	*Ceryle alcyon*
Sapsucker (3 species)	*Sphyrapicus spp.*
Downy Woodpecker	*Picoides pubescens*
Hairy Woodpecker	*Picoides villosus*
Pileated Woodpecker	*Dryocopus pileatus*
Olive-sided Flycatcher	*Contopus cooperi*
Eastern Wood-Pewee	*Contopus virens*
Yellow-bell. Flycatcher	*Empidonax flaviventris*
Willow/Alder Flycatcher	*Empidonax spp.*
Least Flycatcher	*Empidonax minimus*
Eastern Phoebe	*Sayornis phoebe*
Grt. Crested Flycatcher	*Myiarchus crinitus*

Species	**Scientific Name**
Eastern Kingbird	*Tyrannus tyrannus*
Yellow-throated Vireo	*Vireo flavifrons*
Blue-headed Vireo	*Vireo solitarius*
Warbling Vireo	*Vireo gilvus*
Red-eyed Vireo	*Vireo olivaceus*
Blue Jay	*Cyanocitta cristata*
American Crow	*Corvus brachyrhynchos*
Common Raven	*Corvus corax*
Tree Swallow	*Tachycineta bicolor*
N. Rough-winged Swallow	*Stelgidopteryx serripennis*
Bank Swallow	*Riparia riparia*
Cliff Swallow	*Petrochelidon pyrrhonota*
Barn Swallow	*Hirundo rustica*
Black-capped Chickadee	*Poecile atricapillus*
Tufted Titmouse	*Baeolophus bicolor*
Red-breasted Nuthatch	*Sitta canadensis*
White-breasted Nuthatch	*Sitta carolinensis*
Brown Creeper	*Certhia americana*
House Wren	*Troglodytes aedon*
Winter Wren	*Troglodytes troglodytes*
Golden-crowned Kinglet	*Regulus satrapa*
Eastern Bluebird	*Sialia sialis*
Veery	*Catharus fuscescens*
Swainson's Thrush	*Catharus ustulatus*
Hermit Thrush	*Catharus guttatus*
Wood Thrush	*Hylocichla mustelina*
American Robin	*Turdus migratorius*
Gray Catbird	*Dumetella carolinensis*
Northern Mockingbird	*Mimus polyglottos*
Brown Thrasher	*Toxostoma rufum*
European Starling	*Sturnus vulgaris*
Cedar Waxwing	*Bombycilla cedrorum*
Blue-winged Warbler	*Vermivora pinus*
Nashville Warbler	*Vermivora ruficapilla*
Yellow Warbler	*Dendroica petechia*
Chestnut-sided Warbler	*Dendroica pensylvanica*
Magnolia Warbler	*Dendroica magnolia*
Black-thr. Blue Warbler	*Dendroica caerulescens*
Yellow-rumped Warbler	*Dendroica coronata*
Black-th. Green Warbler	*Dendroica virens*

Species	**Scientific Name**
Blackburnian Warbler	*Dendroica fusca*
Prairie Warbler	*Dendroica discolor*
Black-and-white Warbler	*Mniotilta varia*
American Redstart	*Setophaga ruticilla*
Ovenbird	*Seiurus aurocapillus*
Northern Waterthrush	*Seiurus noveboracensis*
Louisiana Waterthrush	*Seiurus motacilla*
Mourning Warbler	*Oporornis philadelphia*
Common Yellowthroat	*Geothlypis trichas*
Canada Warbler	*Wilsonia canadensis*
Scarlet Tanager	*Piranga olivacea*
Eastern Towhee	*Pipilo erythrophthalmus*
Chipping Sparrow	*Spizella passerina*
Field Sparrow	*Spizella pusilla*
Vesper Sparrow	*Pooecetes gramineus*
Savannah Sparrow	*Passerculus sandwichensis*
Song Sparrow	*Melospiza melodia*
Swamp Sparrow	*Melospiza georgiana*
White-throated Sparrow	*Zonotrichia albicollis*
Dark-eyed Junco	*Junco hyemalis*
Northern Cardinal	*Cardinalis cardinalis*
Rose-breasted Grosbeak	*Pheucticus ludovicianus*
Indigo Bunting	*Passerina cyanea*
Bobolink	*Dolichonyx oryzivorus*
Red-winged Blackbird	*Agelaius phoeniceus*
Eastern Meadowlark	*Sturnella magna*
Common Grackle	*Quiscalus quiscula*
Brown-headed Cowbird	*Molothrus ater*
Baltimore Oriole	*Icterus galbula*
Purple Finch	*Carpodacus purpureus*
House Finch	*Carpodacus mexicanus*
Pine Siskin	*Carduelis pinus*
American Goldfinch	*Carduelis tristis*
Evening Grosbeak	*Coccothraustes vespertinus*
House Sparrow	*Passer domesticus*

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