## *Basin 7 Assessment Information (from Report dated February 2001)*

**River & Stream Use Support Status**

The Lamoille River mainstem is recognized and named as beginning in the northwest corner of Wheelock, along the east side of Vermont Route 16, at the outlet of Horse Pond. It flows 84.9 miles in a generally westerly direction until it empties into outer Malletts Bay of Lake Champlain ten miles north of Burlington. It is a pool-riffle gravel bottom river for the majority of its length although there are smaller reaches of dune-ripple sand bottom and plane-bed cobble-boulder bottom. From its headwaters to the mouth, the river descends approximately 1,200 feet and drains a 706 square mile watershed, which is 7.5 percent of Vermont's land area. The basin occupies the major part of Lamoille and lesser parts of Franklin, Chittenden, Orleans, Washington, and Caledonia Counties.

Of the 611.1 miles identified to date in the Lamoille River watershed, 35% of the miles (216) fully support aquatic biota and habitat with no threats identified, 4% (27 miles) fully support this use but threats are known, 32% of the miles (197) have not been assessed, and 28% (172 miles) do not fully support aquatic biota/habitat. As discussed below, sediment and habitat alterations are the major causes of the habitat problems. Loss of riparian vegetation, streambank erosion, and channel instability result in the sediment and physical alterations that affect aquatic habitat through much of the Lamoille watershed.

*Table 1. Use Support Status of Basin 7 Rivers and Streams*.

| Use | Miles of full support | Miles threatened | Miles of partial support | Miles of non-support | Miles not assessed |
|---|---|---|---|---|---|
| Overall | 215.7 | 27.2 | 155.5 | 16.3 | 196.8 |
| Aquatic biota/habitat | 215.7 | 27.2 | 155.5 | 16.3 | 196.8 |
| Contact recreation | 198.8 | 74.3 | 39.3 | 0.9 | 297.8 |
| Secondary contact recreation | 210.7 | 65.9 | 78.9 | 13.5 | 242.1 |
| Aesthetics | 230.2 | 35.9 | 133.2 | 7.3 | 204.5 |
| Drinking water supply | 62.1 | 1.8 | 0 | 0.9 | 546.3 |
| Agriculture water supply | 0 | 0 | 0 | 0 | 611.1 |
| Fish consumption | 0 | 602.6 | 8.5 | 0 | 0 |

*E. coli* or other bacteria data needed to determine if swimming is supported is limited, and, therefore, 49% of the miles (298) are not assessed for "contact recreation". Thirty-two percent (199) of the miles fully support swimming with no identified threats, 12% (74 miles) fully support swimming with threats identified, and about 7% (40 miles) do not fully support swimming. Failing

septic systems, manure runoff, high turbidity, severe siltation, and lack of flow are the reasons that the swimming use is partially to non-supported.

Secondary contact reaction, primarily fishing, is fully supported with no known threats for 34% (211) of the river miles. This use is fully supported but threatened on 11% (66) of the miles. Fishing is partially or not supported on 15% (92) of the miles. Forty percent of the miles were not assessed for this use. Fishing was not fully supported where there were habitat alterations, sedimentation, flow alterations, and temperature modification.

Fish consumption is considered threatened statewide because there is a "health alert" that recommends that people limit consumption of fish caught in Vermont waters. Where there is waterbody-specific fish tissue data showing high levels of mercury or PCBs then the miles of river or stream containing the contaminated fish are listed as partial or non-support. In the Lamoille River watershed, 99% (603) of the miles are considered threatened for fish consumption and 1% (8.5 miles) are partially supported because of mercury in walleye that were sampled at the mouth of the Lamoille.

Thirty-eight percent of the river miles are fully supported (230 miles) and 6% (36 miles) are fully supported but threatened for aesthetics. Twenty-three percent of the river miles do not fully support aesthetics and 33% of the miles were not assessed for this use. Physical alterations to the stream channel, streambank erosion, low flow, turbidity, and excessive algae all affect the support status of aesthetics.

**Causes and Sources of Impacts & Threats**

The major causes of impacts to the Lamoille River and its tributaries are sediment and habitat alteration/channel instability, which are integrally connected. Nutrients and thermal modifications affect the third and fourth greatest number of miles. See Table 2 below for the cause (a pollutant or condition) and the number of miles affected by each cause.

Riparian vegetation removal, streambank erosion, floodplain encroachments, floods, and agricultural land uses are the five top sources that affect the water quality and aquatic habitat of the Lamoille River (Table 3). Again these sources are integrally related. Agricultural land use in the productive floodplain of the Lamoille resulted in some riparian vegetation removal. The lack of vegetation along, and back from, the riverbank is often a major contributing factor to streambank erosion and channel instability. The habitat alteration and flood damage was greatly exacerbated by the unstable condition of the river and the lack of riparian vegetation along the Lamoille and some of its tributaries such as the Wild Branch. The dams and impoundments for hydro-electric production on the Lamoille also alter the river's condition by degrading water quality, substrate composition and thermal regime from flow fluctuations, drawdowns, and desilting.

*Table 2. Causes of River Impacts and Threats in the Lamoille Watershed.*

| Cause or Pollutant | Miles of high impact | Miles with moderate impact | Total miles of impact | Miles threatened |
|---|---|---|---|---|
| Sediment | 64.9 | 91.1 | 156.0 | 25.0 |
| Habitat alteration | 77.7 | 69.7 | 147.4 | 17.9 |
| Nutrients | 2.5 | 83.3 | 85.8 | 9.5 |
| Thermal modifications | 0 | 82.2 | 82.2 | 5.0 |
| Flow alterations | 20.5 | 17.9 | 38.4 | 5.0 |
| Turbidity | 0 | 33.8 | 33.8 | 0 |
| Pathogens | 0 | 31.8 | 31.8 | 48.0 |
| Low dissolved oxygen | 0 | 8.5 | 8.5 | 0 |

*Table 3 . Sources of River Impacts and Threats in the Lamoille Watershed.*

| Source | Miles of high impact | Miles with moderate impact | Total miles of impact | Miles threatened |
|---|---|---|---|---|
| Riparian vegetation removal | 15.0 | 111.5 | 126.5 | 6.5 |
| Streambank erosion | 61.3 | 48.8 | 110.1 | 11.2 |
| Floods | 26.8 | 80.2 | 107.0 | 0.4 |
| Habitat modification* | 58.9 | 46.5 | 105.4 | 11.9 |
| Agriculture | 8.5 | 92.3 | 100.8 | 26.0 |
| Flow modification - hydro | 9.7 | 21.0 | 30.7 | 5.0 |
| Road/bridge runoff | 0 | 30.2 | 30.2 | 8.2 |
| Land development | 0 | 26.9 | 26.9 | 7.0 |
| Upstream impoundment | 0.9 | 24.2 | 25.1 | 5.0 |
| Urban runoff | 0 | 15.7 | 15.7 | 0 |
| Road/bridge construction | 15.5 | 0 | 15.5 | 1.5 |

*Habitat modification - sum of channel instability, floodplain encroachments, and past instream work that has led to current channel adjustment.

**Assessment of Lakes and Ponds in the Lamoille River Basin**

The Lamoille River Basin is characterized by having numerous lakes. There are 79 lakes and ponds in

the basin, comprising 4,268 acres. Forty-eight of these lakes (4,144 acres) are tracked in VDEC's Lake Assessment Database. Of these 4,144 acres, 3,739 are monitored (24 lakes) while 405 are evaluated (24 lakes).

**Overall and Individual Use Support, Causes, and Sources of Impacts to Lakes in the White River Basin**

Overall, there are 1,493 lake acres in Basin 7 which only partially support one or more uses, and 115 acres where one or more uses are precluded. All designated uses are fully supported on 2,507 assessed lake and pond acres in Basin 7. Table 4 provides an accounting of lake acres where designated uses are supported, threatened, or not fully supported.

*Table 4. Designated use support for lakes in the Lamoille River Basin.*

| Use | Acres fully supporting uses | Supporting acres with uses threatened | Acres partially supporting uses | Acres not supporting uses | Acres not assessed |
|---|---|---|---|---|---|
| Overall Uses | 459 | 2048 | 1493 | 115 | 29 |
| Aesthetics | 3195 | 805 | 0 | 114 | 30 |
| Aquatic Life Use Support | 459 | 2048 | 1607 | 1 | 29 |
| Agricultural Water Supply | 0 | 0 | 0 | 0 | 4144 |
| Drinking Water Supply | 27 | 0 | 0 | 0 | 24 |
| Fish Consumption | 3344 | 0 | 760 | 0 | 40 |
| Filtered Water Supply | 27 | 0 | 0 | 0 | 4117 |
| Industrial Water Supply | 0 | 0 | 0 | 0 | 4144 |
| Secondary Contact Uses | 3012 | 695 | 293 | 114 | 30 |
| Swimming Uses | 3153 | 847 | 0 | 114 | 30 |

The principal cause of impairment to lakes in the Lamoille River Basin is flow alteration (drawdown of water levels) which affects aquatic life uses on several lakes as discussed in section III (below) for a total of 1,607 acres. Mercury contamination in fish tissue impairs 760 acres. Critically low pH in a tiny pond impairs aquatic life uses on one lake acre, but an additional 899 acres are threatened by low buffering capacity, which could lead to episodic low pH events. Siltation impairs aquatic life uses in the 194 acre Hardwick Lake and is noted as a threat to uses on 295 additional acres, though some reassessment of this threat is warranted (see section IV below). The consequences associated with existing or potential infestations of exotic species impair 114 acres, and threaten an additional 434 lake acres. Table5 provides an accounting of the causes of impacts to lakes in this basin.

*Table 5. Causes of impacts to lakes in the Lamoille River Basin.*

| Cause of impact | Acreage by magnitude of impact | | | Total acres not fully supporting | Total acres threatened |
|---|---|---|---|---|---|
| | High | Moderate | Minor | | |
| 0500 Metals | 0 | 760 | 0 | 760 | 0 |
| 0560 Mercury | 0 | 760 | 0 | 760 | 0 |
| 0900 Nutrients | 0 | 0 | 0 | 0 | 421 |
| 1000 pH | 1 | 0 | 0 | 1 | 899 |
| 1100 Siltation | 0 | 145 | 0 | 145 | 295 |
| 1200 Organic enrichment - DO | 0 | 0 | 0 | 0 | 100 |
| 1500 Flow alteration | 1607 | 0 | 0 | 1607 | 1470 |
| 2200 Noxious aquatic plants - Native | 0 | 0 | 0 | 0 | 25 |
| 2210 Noxious aquatic plants - Algae | 0 | 0 | 0 | 0 | 163 |
| 2600 Exotic Species | 114 | 0 | 0 | 114 | 434 |

The most important source of impairment to Lamoille River Basin lakes is flow regulation which impairs 1,607 lake acres due to habitat modification and partial loss of aquatic life uses. Atmospheric deposition is largely the source of mercury found in fish tissue, and this impairs fish consumption uses on 760 lake acres. Atmospheric deposition is also responsible for the critical acidification of one lake acre, and threatens an additional 899 acres. Some of these waterbodies may also exhibit natural sensitivity to acidification, which explains some of the 861 threatened acres attributable to natural sources. Boating traffic ('in-water releases') among waterbodies is assumed to be the primary vector for Eurasian watermilfoil (Myriophyllum spicatum) introduction to lakes. This impairs 114 lake acres and threatens an additional 395 acres. Boating traffic also threatens an additional 194 acres due to shoreline erosion. Finally, general land development and construction threatens 364 lake acres with sedimentation and/or organic enrichment. Table 6 provides an accounting of the sources of impairment and threats to lakes in the Lamoille River Basin.

*Table 6. Sources of impacts to lakes in the Lamoille River Basin.*

| Source of impact | Acreage by magnitude of impact | | | Total acres not fully supporting | Total acres threatened |
|---|---|---|---|---|---|
| | High | Moderate | Minor | | |
| 1000 AGRICULTURE | 0 | 0 | 0 | 0 | 64 |
| 1100 Nonirrigated Crop Production | 0 | 0 | 0 | 0 | 21 |
| 1800 VT-Animal holding/management area | 0 | 0 | 0 | 0 | 42 |
| 2000 SILVICULTURE | 0 | 0 | 0 | 0 | 35 |
| 2100 Harvesting, Restoration, Residue Management | 0 | 0 | 0 | 0 | 35 |
| 3000 CONSTRUCTION | 0 | 0 | 0 | 0 | 364 |
| 3200 Land Development | 0 | 0 | 0 | 0 | 364 |
| 4000 URBAN RUNOFF/STORM SEWERS | 0 | 0 | 0 | 0 | 153 |
| 4300 Other Urban Runoff | 0 | 0 | 0 | 0 | 148 |
| 4500 Highway/Road Bridge Runoff | 0 | 0 | 0 | 0 | 5 |
| 5000 RESOURCE EXTRACTION | 0 | 0 | 0 | 0 | 15 |
| 5100 Surface Mining | 0 | 0 | 0 | 0 | 15 |
| 7000 HYDROMODIFICATION | 1607 | 0 | 0 | 1607 | 515 |
| 7400 Flow Regulation/Modification | 1607 | 0 | 0 | 1607 | 436 |
| 7900 MARINAS AND RECREATIONAL BOATING | 114 | 0 | 0 | 114 | 589 |
| 7910 In-Water releases | 114 | 0 | 0 | 114 | 395 |
| 8100 ATMOSPHERIC DEPOSITION | 1 | 760 | 0 | 761 | 899 |
| 8300 HIGHWAY MAINTENANCE AND RUNOFF | 0 | 0 | 0 | 0 | 211 |
| 8600 NATURAL SOURCES | 0 | 1 | 0 | 1 | 861 |

## *Basin 11 Assessment Information (from Report dated November 2001)*

**River & Stream Use Support Status**

The Basin 11 planning unit includes three watersheds: the West, Williams, and Saxtons Rivers watersheds. Basin 11 is located in the southeastern corner of Vermont and drains the eastern slope of the Green Mountains. It covers approximately 395,520 acres. The rivers and their tributaries flow down from the mountains through the foothills and across the Vermont Piedmont to the Connecticut River Valley where they join the Connecticut River. The Williams River joins the Connecticut River in Rockingham, the Saxtons River joins the Connecticut River in Bellows Falls, and the West River joins it in Brattleboro. There are approximately 431.8 river miles total assessed for Basin 11.

*Table 1. Use Support Status of Basin 11 Rivers and Streams.*

| Use | Miles of full support | Miles threatened | Miles of partial support | Miles of non-support | Miles not assessed |
|---|---|---|---|---|---|
| Overall | 235.4 | 72.2 | 120.5 | 3.7 | 0 |
| Aquatic biota/habitat | 235.4 | 82.7 | 110.0 | 3.7 | 0 |
| Contact recreation | 364.3 | 51.0 | 14.0 | 2.5 | 0 |
| Secondary contact recreation | 291.8 | 22.6 | 114.9 | 2.5 | 0 |
| Aesthetics | 320.0 | 70.0 | 39.3 | 2.5 | 0 |
| Drinking water supply | 46.9 | 0.1 | 0 | 2.5 | 382.3 |
| Agricultural water supply | 15.9 | 0.1 | 0 | 2.5 | 413.3 |
| Fish consumption | 0 | 431.8 | 0 | 0 | 0 |

The designated use most affected by pollution or undesirable conditions is secondary contact recreation (fishing and the fishery) with aquatic habitat/biota closely following in terms of miles having impacts. Water temperature data showed that a number of stretches in all three watersheds of the basin had high temperatures that affect the health and sustainability of the fishery and its habitat. Sedimentation and physical habitat alterations also affected the aquatic habitat and its inhabitants.

Aesthetics is the third most affected designated use. The loss of riparian vegetation, physical alterations to the channel, streambank erosion and the resulting sedimentation all have an impact on, or threaten, aesthetics.

There were not as many miles where contact recreation was not in full support. Impacts to this use

are listed where *E. coli* data indicate potential pathogen problems or where physical alteration to the river or stream diminished the opportunity for swimming.

The miles of full support, threatened, partial support, and non-support for each use for each river segment or tributary watershed (waterbody) are given in tables in the individual waterbody reports in Appendix E. A narrative is also given in these individual reports that explains the causes and sources responsible for the lack of full support or the threats.

**Causes and Sources of River Impacts & Threats**

Causes are the pollutants or conditions that threaten or have an impact on the aquatic biota, the aquatic habitat, swimming, fishing, the fishery, boating, drinking water supply, fish consumption or other "uses" of the river or stream. The top causes of riverine water quality or aquatic habitat problems in Basin 11 are listed in Table 2 below along with the miles of river or stream that they affect. These are discussed in more detail below.

*Table 2. Causes of River Impacts and Threats in Basin 11.*

| Cause or pollutant | Miles of high impact | Miles with moderate impact | Total miles of impact | Miles threatened |
|---|---|---|---|---|
| Thermal modification | 76.2 | 30.8 | 107.0 | 36.0 |
| Sedimentation | 3.0 | 54.8 | 57.8 | 97.0 |
| Physical habitat alteration | 0 | 44.3 | 44.3 | 39.5 |
| Flow alteration | 21.9 | 12.0 | 33.9 | 12.5 |
| Nutrients | 0.5 | 10.5 | 11.0 | 13.5 |
| pH | 0 | 8.4 | 8.4 | 0 |
| Pathogens | 0 | 7.0 | 7.0 | 17.0 |
| Metals | 0.5 | 0 | 0.5 | 8.6 |

Sources are the land uses, human activities, or occurrence of conditions responsible for the causes named above and that are the origin of the impacts on river or stream water quality or aquatic habitat. Table 3 below lists the primary sources of river and stream impacts and threats in the basin.

*Table 3. Sources of River Impacts and Threats in Basin 11.*

| Source | Miles of high impact | Miles with moderate impacts | Total miles of impact | Miles threatened |
|---|---|---|---|---|
| Riparian vegetation removal | 26.5 | 69.0 | 95.5 | 36.0 |
| Streambank destabilization | 0.5 | 44.8 | 45.3 | 65.5 |
| Flow regulation/modification | 33.9 | 1.3 | 35.2 | 18.0 |
| Channelization | 7.0 | 14.5 | 21.5 | 33.3 |
| Road/bridge runoff | 0 | 20.8 | 20.8 | 57.0 |
| Upstream impoundment | 20.4 | 0 | 20.4 | 6.0 |
| Land development | 2.5 | 14.5 | 17.0 | 37.0 |
| Agricultural activities | 0 | 12.5 | 12.5 | 8.0 |
| Recreational activities | 1.0 | 10.0 | 11.0 | 6.5 |

The cause of most river or stream miles with impacts is thermal modification or water temperatures that are too high to fully support a coldwater fishery. Removal of the riparian trees and shrubs, which is the source affecting the most river miles, results in these higher temperatures. Dams and the resulting impoundment of water also results in higher downstream water temperatures. Much of the Williams River and West River as well as the lower half of the Saxtons River have high temperatures in the summer, which have an impact on the coldwater fishery.

Sedimentation is the second greatest cause of impacts to the rivers and streams in this basin. It is also the largest threat to aquatic habitat, biota, and other uses of these waters. Sources of sediment include streambank erosion, land development and road runoff among others.

Physical habitat alterations are a result of flow regulation, channelization/instream modification, road and bridge work, and channel instability. Other pollutants or conditions affecting the rivers or streams in this basin include flow alteration primarily from the two Army Corps of Engineers flood control dams, nutrients primarily from agricultural land activities, low pH as a result of acid rain and pathogens possibly from failed septic systems.

**Assessment of Lakes and Ponds in the West, Williams, and Saxton's River Basins**

West, Williams, and Saxton's River Basins are characterized by having relatively few lakes. There are 49 lakes and ponds in the three basins, comprising 1,030 known acres. Twenty-nine of these lakes (1,005 acres) are tracked in VDEC's Lake Assessment Database. Of these 1,005 acres, 775 are monitored (11 lakes), while 230 are evaluated (18 lakes).

**Overall and Individual Use Support, Causes, and Sources of Impacts to Lakes in the West, Williams, and Saxton's River Basins**

Overall, there are 360 lake acres in the Basins which only partially support one or more uses, and 21 acres where one or more uses are precluded. All designated uses are fully supported on 624 assessed lake and pond acres. Table 4 provides an accounting of lake acres where designated uses

are supported, threatened, or not fully supported.

*Table 4. Designated use support for lakes in the West, Williams, and Saxton's River Basins.*

| Use | Acres fully supporting uses | Supporting acres with uses threatened | Acres partially supporting uses | Acres not supporting uses | Acres not assessed |
|---|---|---|---|---|---|
| Overall Uses | 88 | 536 | 360 | 21 | 0 |
| Aesthetics | 746 | 66 | 193 | 0 | 0 |
| Aquatic Life Use Support | 88 | 543 | 353 | 21 | 0 |
| Agricultural Water Supply | 0 | 0 | 0 | 0 | 1005 |
| Drinking Water Supply | 101 | 0 | 0 | 0 | 0 |
| Fish Consumption | 1005 | 0 | 0 | 0 | 0 |
| Filtered Water Supply | 101 | 0 | 0 | 0 | 904 |
| Industrial Water Supply | 0 | 0 | 0 | 0 | 1005 |
| Secondary Contact Uses | 939 | 66 | 0 | 0 | 0 |
| Swimming Uses | 939 | 66 | 0 | 0 | 0 |

The two principal causes of impairment to 193 acres in these watersheds, flow alteration and siltation, are both related to operation of two flood control reservoirs, which affects aquatic life uses. The critically low pH exhibited by several ponds impairs aquatic life uses on 181 lake acres. An additional 533 acres are threatened by acidification due to their low buffering capacity, which renders lakes susceptible to episodic low pH events. Table 5 below provides an accounting of the causes of impacts and threats to lakes in these basins.

*Table 5. Causes of impacts and threats to lakes in the West, Williams, and Saxton's River Basins.*

| Cause of Impact | Acreage by Magnitude of Impact | | | Total Acres Not Fully | Total Acres |
|---|---|---|---|---|---|
| 0900 Nutrients | 0 | 0 | 0 | 0 | 10 |
| 1000 pH | 181 | 0 | 0 | 181 | 533 |

| | | | | | |
|---|---|---|---|---|---|
| 1100 Siltation | 85 | 108 | 0 | 193 | 41 |
| 1200 Organic enrichment - DO | 0 | 0 | 0 | 0 | 15 |
| 1300 Salinity - TDS - chlorides | 0 | 0 | 0 | 0 | 9 |
| 1500 Flow alteration | 193 | 0 | 0 | 193 | 7 |
| 2200 Noxious aquatic plants - Native | 0 | 0 | 0 | 0 | 25 |

The most important source of impairment to lakes in the West, Williams, and Saxton's River Basins is hydromodification, which impairs 193 lake acres due to habitat modification and partial loss of aquatic life uses. Shoreline destabilization, related to flow modification, impairs 85 acres on one flood control impoundment. Atmospheric deposition has critically acidified 181 lake acres, and presently threatens an additional 533 acres. Some of these acid-threatened waterbodies may also exhibit natural sensitivity to acidification, which explains the 533 threatened acres attributable to natural sources. Finally, general land development, construction, and associated shoreline destabilization threatens 41 lake acres. Table 6 provides an accounting of the sources of impairment and threats to lakes in the West, Williams, and Saxton's River Basins.

*Table 6. Sources of impacts to lakes in the West, Williams, and Saxton's River Basins*.

| Source of impact | Acreage by magnitude of impact | | | Total acres not fully supporting | Total acres threatened |
|---|---|---|---|---|---|
| | High | Moderate | Minor | | |
| 3000 CONSTRUCTION | 0 | 0 | 0 | 0 | 41 |
| 3200 Land Development | 0 | 0 | 0 | 0 | 41 |
| 7000 HYDROMODIFICATION | 193 | 0 | 0 | 193 | 7 |
| 7400 Flow Regulation/Modification | 193 | 0 | 0 | 193 | 7 |
| 7550 HABITAT MODIFICATION (OTHER THAN HYDROMOD) | 0 | 85 | 0 | 85 | 0 |
| 7600 Removal of Riparian Vegetation | 0 | 85 | 0 | 85 | 0 |
| 7700 Streambank Modification/Destabilization | 0 | 85 | 0 | 85 | 41 |
| 8100 ATMOSPHERIC DEPOSITION | 181 | 0 | 0 | 181 | 533 |
| 8300 HIGHWAY MAINTENANCE AND RUNOFF | 0 | 0 | 0 | 0 | 9 |
| 8600 NATURAL SOURCES | 9 | 96 | 76 | 181 | 533 |

## *Partial Basin 16 Assessment Information (from Draft Report July 2001)*

**Nulhegan River Watershed**

The Nulhegan River, one of several river waterbodies in Basin 16, originates east of Spectacle Pond in the town of Brighton. It flows in an easterly/southeasterly direction through a wide, flat valley of shrub swamp for much of its 16 mile length. The drainage area of the Nulhegan is 151 square miles. The four major tributaries to the Nulhegan are the East Branch (13 miles long), the Black Branch (12 miles), the Yellow Branch (10 miles), and the North Branch (12 miles).

The streams that were sampled in the Nulhegan River watershed in summer 2000 are fairly dilute with specific conductances of 14-60 Fmhos. The total variation in pH among the sites sampled was 5.45-7.68. The three sites on the Yellow Branch of the Nulhegan River had the lowest pH values and alkalinities (pH 5.45 - 5.83, and alkalinity 2- 4.5mg/l ). These values represent summer flows and likely are considerably lower during spring snow melt events, which often bring the highest acidities of the year. As a result, the pH values and alkalinity in the Yellow Branch will be limiting to sensitive fish and macroinvertebrate taxa especially in the orders Ephemeroptera, Bivalvia, and Gastropoda. Other stream reaches that also had low alkalinity and therefore probably undergo a period of low pH in the spring are: Tuffield-Willey and Bluff Mountain Brooks. The low pH and alkalinity of these two streams indicates that other, very high elevation (greater than 600 meters) streams with small watersheds, most likely undergo a period of very low pH and alkalinity.

Fish Assemblages

Twelve sites from eight streams and rivers were sampled within the Silvio Conte lands of the Nulhegan drainage. A total of 450 fish from 16 species were collected. The Vermont Department of Fish & Wildlife collected an additional two species and a total of 31 Atlantic salmon, two brook trout, one brown trout and one rainbow trout at river mile 1.8 of the Nulhegan in 2000. The 18 species collected during this survey can be compared to the 30 species actually collected historically from Vermont waters of the Connecticut River drainage. There are seventy-nine species native to Vermont, with potentially 39 occurring in Vermont waters of the Connecticut drainage. All 18 species collected in 2000 had already been recorded in Vermont waters of the Connecticut drainage. Species richness per site ranged from 1-9.

There were no state or federally-listed species collected during 2000, nor have any been reported in past surveys. Sixteen of the species collected were classified with “common or “widespread” distributions. The burbot and lake chub have “uncommon” distributions across the Vermont. Only two species collected, rainbow and brown trout, are non-native to Vermont.

IBI values could be generated from only three of 12 sites in the Silvio Conte Refuge (SCR). The three sites scored 36 (rating of “very good”), 39 (“excellent”) and 9 (“poor”). Five of the sites were classified as low gradient . No IBI has been developed as yet for this assemblage type. Two sites supported only brook trout and consequently did not provide enough information to calculate an IBI. Three sites were qualitatively sampled and did not provide data of suitable quality to calculate an IBI.

The “poor” evaluation given the Yellow Branch-Nulhegan site (river mile 7.6) may have been due to natural limitations of that river reach. The site was located immediately downstream from an open-canopied low-gradient section of stream. Summer water temperatures may have been elevated in this area to an extent where coldwater species were excluded . This was not evident, however, in the water temperature recorded at the time of sampling (12 $^{0}$C, at 1225 on August 21). A pH of 5.45 is potentially limiting for some species at this site. Brook trout or slimy sculpin, however, are both more resistant to low pH than blacknose dace, which dominated this section. Additional nearby stream sections should be re-sampled to clarify the condition of the fish assemblage of this reach.

Macroinvertebrate Assemblages

A total of 223 taxa were identified from the 17 stream sites sampled within the SCR lands of the Nulhegan River watershed. Aquatic insects were the dominant macroinvertebrate class with 195 taxa, broken down by insect order as follows: 81 Diptera (58 Chironomidae), 44 Trichoptera, 19 Coleoptera, 18 Ephemeroptera, 17 Plecoptera,, 9 Odonata, 2 Megaloptera, and 4 Hemiptera. The remaining taxa were mainly from the class Mollusca, Gastropoda (eight), and Bivalvia (six). This by no means should be considered even close to a complete taxa list of the macroinvertebrate species from running waters within the SCR lands of the Nulhegan River watershed. It is, however, a good representation of the taxa groups found in the stream during the late summer. None of the taxa collected are listed as threatened or endangered in Vermont or the United States. Most of the taxa collected are common in Vermont running waters, and all of the taxa collected are considered native to Vermont. The Trichopteran, *Palaegapetus celsus* is uncommon, found from only 17 other locations in Vermont, and highly associated with small acidic montane streams with liverwort present, which it uses to build its case. The Coleopteran, *Ancyronyx variegata* has only been collected from six other stream sites by the VDEC . This may however be due to its habitat of burrowing under bark of decaying logs, making it difficult to collect with the methods typically employed.

The macroinvertebrate assemblage integrity was evaluated from 12 of the 17 stream reaches sampled for macroinvertebrates. The stream reaches from the SCR were assigned into an assemblage type based on stream size, elevation and alkalinity. Nine of the reaches were evaluated under the Small High Gradient category and three the Medium High Gradient category. The remaining reaches were considered low gradient meandering streams that could not be quantitatively assessed using the above protocols. Eight of the 12 stream reaches were rated as either very good or excellent. These streams would be considered very near reference condition compared to other streams from a similar category in Vermont. The four other streams were rated good condition; moderately altered from the natural condition, but still considered to be meeting their Class B water quality management designation. Two of these streams were comparatively lower in EPT richness, one in density, and one in PPCS-f. Two of these streams had moderately elevated Bio Index values. The low EPT and density values are probably an effect of the low pH stress in Tuffield-Willey and Yellow Alder Brook. The elevated Bio Index and PPCS-f from the North Branch Nulhegan River (river mile10.5) and Yellow Branch Nulhegan River (river mile 7.6) may be due to the extensive wetlands upstream of these sites. It may also be due to the extensive logging that has historically occurred in these watersheds. Overall, all the stream reaches were of good quality or better with no impaired reaches identified within the Silvio Conti National Refuge.

**Paul Stream watershed & Wheeler Stream watershed**

The stream sites from the Paul Stream watershed and the Wheeler Stream watershed ranged in watershed size from 3.5 to 113 $km^2$, and at elevations from 286 to 628 m above sea level. The data indicate the waters of these drainages are somewhat soft with specific conductances ranging from 26-41 Fmhos, and alkalinities from 6.2- 21.3 mg/l. Measured pH was near neutral and ranged between 6.51-7.52. Within the Paul Stream watershed, the smaller streams generally had lower alkalinities (less than 10 mg/l). Dennis and Notch Pond brooks had significantly higher alkalinity than all the other stream sites.

Fish Assemblages

A total of 1,763 fish from 20 species were collected from the ten stream sites. In addition to this, a collection conducted by the Vermont Department of Fish & Wildlife on lower Paul Stream (river mile 3.1) tallied 124 Atlantic salmon and 10 brook trout and an undetermined number of non-game species. Of the 79 fish species native to Vermont, there is potential for up to 39 species to occur in the Vermont waters of the Connecticut valley. Thirty native species were *actually* recorded, historically from this drainage. All twenty species collected in 2000 had already been recorded in the Connecticut drainage. Species richness per site ranged from 1 to13.

Three non-native species were recorded; two brown trout from two sites and a single bluntnose minnow from one site. For all collections made in 2000, blacknose dace, white sucker and brook trout were the most common species, occurring at nine, seven and seven sites respectively. Other common species included longnose dace and creek chub, recorded at six and five sites each respectively. No state or federally listed species were collected in the West Mountain WMA. No listed species have been historically reported from this drainage. Species state-wide occurrence is categorized here as "abundant", "common", "uncommon" or "rare", based on the 9000-record VT ANR database. No rare fishes were collected. Finescale dace and burbot were the least common species, being rated as "uncommon". Ten species were regarded as "common" and nine were considered as having a "wide-spread"state distribution.

Of the 10 sites sampled in the West Mountain WMA, six could be evaluated for biological integrity using one of the two IBIs. The North Branch Paul Stream site supported only brook trout (to apply the CWIBI there must be at least two species). Two sites on Paul Stream were Type 4 - low gradient- sand bottom sites (no appropriate IBI has yet designed to apply to this type of site). One site was only sampled qualitatively for species presence and therefore the data were not of sufficient quality to generate a score. Where IBI scores could be calculated, scores ranged widely for the six sites: 31 ("good") to 45 ("excellent") . All sites where an IBI was calculated met the State Water Quality Standard biocriteria for fish assemblages of Class B waters.

Macroinvertebrate Assemblages

A total of 147 taxa were identified from the seven stream sites sampled within the West Mountain WMA. Aquatic insects were the dominant macroinvertebrate class with 131 taxa, broken down by Insecta order as follows: 52 Diptera (37 Chironomidae), 31 Trichoptera, 16 Ephemeroptera, 15 Plecoptera, 7 Coleoptera, 6 Odonata, 2 Megaloptera, and 2 Hemiptera. The remaining taxa were mainly from the Gastropoda (5) and Bivalvia (4). This should be by no means considered even close to a complete taxa list of the running waters from the West Mountain WMA. It is however, a good representation of the taxa groups found in these streams during the late summer. None of the taxa collected are listed as threatened or endangered in Vermont, or the United States. Most of the taxa collected are common in Vermont running waters, and all of the taxa collected are considered native to Vermont. The Coleopteran, *Microcylloepus pusillus* is somewhat uncommon being found in only seven rivers in the VDEC Biomonitoring database. It was found in Dennis Pond Brook and may be somehow connected to streams below ponds or wetlands.

The integrity of the macroinvertebrate assemblage was evaluated from six of the seven stream reaches. The stream reaches from the Paul Stream drainage were assigned into an assemblage

type based on stream size, elevation and alkalinity. Three of the stream reaches were considered to be Small High Gradient streams, and three Medium High Gradient streams. The seventh, Paul Stream rm 12.8, is a slow, meandering stream that appears to be of good biological integrity, however it could not be quantitatively evaluated using the protocols in the above document. The biological integrity from two of the Small High Gradient streams was rated as excellent or within the range of natural condition. Dennis Pond Brook was rated as very good or exhibiting only a minor change from the expected condition. This evaluation was due to a lower then expected number of EPT taxa and a slightly elevated Bio Index value and may have been a result of the natural influence of significant wetlands and a pond immediately upstream from the reach sampled. The macroinvertebrate assemblage was also somewhat atypical for a SMT in that a number of warm water taxa were present, including *Chimarra atterima*, and *Stenelmis sp*.