A Survey of the Fish and Macroinvertebrate Communities of the Silvio Conte National Wildlife Refuge Lands in the Nulhegan Drainage and the West Mountain Wildlife Management Area

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INTRODUCTION

During 1998, the State of Vermont and the U.S. Fish and Wildlife Service (USF&WLS) acquired a vast tract of land in Northeastern Vermont from the Champion International Corporation through purchasing agreements with the Conservation Fund of Arlington, Virginia. The USFWLS formed the 26,000 acre Nulhegan Basin Division of the Silvio O. Conte National Fish and Wildlife Refuge. The State-managed West Mountain Wildlife Management Area was created from a 22,000 acre parcel in the Paul and Wheeler basins. At that time, little biological survey information existed from the several ponds and numerous rivers and streams in these newly-acquired areas. Fish community information was limited to data collected by Vermont Department of Fish and Wildlife (VTFW) from six locations in the Nulhegan drainage and six from Paul Stream. Lake fish data was dated and incomplete. The Vermont Department of Environmental Conservation (VTDEC) provided historical river macroinvertebrate community data from only two locations in the Nulhegan and one on Paul Stream. Lake macroinvertebrate data was limited to a single lake in the Wheeler stream drainage.

Management plans are currently being developed by the USFWLS for the Silvio Conte National Refuge and by the Vermont Agency of National Resources (VTANR) for the West Mountain Wildlife Management Area. Both of these plans will stress the importance of conserving and protecting existing biological resources. Considerably more information was needed from surface waters in these areas so that management plans could properly address the distribution of aquatic species and natural communities present.

A biological survey of fish and macroinvertebrates was conducted in lakes and rivers within the Silvio Conte National Refuge and West Mountain Wildlife Management Area during the summer of 2000 to address this need. In conjunction with the biological survey, a limited amount of physical and chemical data were collected. The field collections were conducted cooperatively by the VTDEC, the VTFW and the USFWS-Sunderland Office of Fisheries Assistance. All data analysis was conducted by the VTDEC.

Specifically this report presents the results from the following :

1. A fish species inventory of running and standing waters.

2. An analysis of these data indicating an estimate of existing running-water fish assemblage types using a modification of the classification presented in *The Classification of the Aquatic Communities of Vermont* (the Aquatic Classification Workgroup 1998);

3. An evaluation of fish assemblage health as measured by the VTDEC protocols (through use of Indexes of Biotic Integrity) for each wadeable hard-bottomed stream site;

4. Estimates of Atlantic salmon parr and smolt production in the Nulhegan River and Paul Stream sub-basins;

5. A macroinvertebrate assemblage survey of running waters.

6. An analysis of these data indicating an estimate of existing running-water macroinvertebrate assemblage types as presented in *The Classification of the Aquatic Communities of Vermont* (the Aquatic Classification Workgroup 1998).

7. An evaluation of the macroinvertebrate assemblage health or biological integrity as measured by the VTDEC protocols (through use of community-level biometrics) for each wadeable "riffle" stream site;

8. An inventory of the macroinvertebrate Molluscan fauna, from both flowing and standing waters.

METHODS

Fish Community

Running waters

In selecting fish collection sites, attention was given to include variety of habitat types, stream sizes and gradients. Sampling was completed between August 21, and September 21, 2000. Fish were collected with the use of backpack electrofishing gear. One or more electrofishing passes were completed for each site. Where multiple runs were conducted, a removal population estimate method was calculated for each species. Block nets were used on the up-stream end of a section if there was no physical barrier to constrain fish from fleeing the electric field. All stunned fish were collected and identified to species. Lengths and weights were collected from salmonid species. Stream sections selected for sampling were representative of the physical habitat in the surrounding river reach. Lengths of the sampled sections ranged from 40 to 208 m, and were, in most cases, proportional with mean stream width. Twelve sites from eight streams were sampled on the Conte refuge and 10 sites on seven streams were sampled on the West Mountain WMA.

The VTDEC has developed two indices of biological integrity based on fish assemblage characteristics: the Cold Water Index of Biotic Integrity (CWIBI) and the Mixed Water Index of Biotic Integrity (MWIBI). These indices are used by VTDEC to evaluate the aquatic life use status of moderate to high gradient, wadeable streams in Vermont (VTDEC 2001). Both IBI's include several individual population parameters, or metrics. Each metric is given a numeric score associated with one of the three categories of excellent, fair and poor. The individual metric scores are summed resulting in a final IBI score of 9 (poor) to 45 (excellent).

A physical habitat assessment was conducted at each sampling site. This evaluation included a minimum of mean section width, section length, substrate composition (pebble count methods-VTDEC), embeddedness, canopy coverage and bank condition. Water temperature was also taken .

Standing waters

Fish communities in nine ponds in the West Mountain Wildlife Management Area were sampled at a reconnaissance level with a variety of gear types between August 23 and September 8, 2000. Sampling gear types included electroshocker, gill nets, trap nets and minnow traps. Only a very limited use of gill nets and electrofishing was employed. Gill nets, trap nets and minnow traps were set one day, fished overnight and retrieved the following day. Gill nets were *experimental* type; sinking monofilament; 150 foot by 6 foot and made up of six 25-foot panels with graduating in mesh size from 1.5 to 4 inch stretched measure. Trap nets consisted of six square hoops, 4 feet by 4 feet at the orifice with 10-foot long wings. The trap nets did not include a center leader. Minnow traps were of standard commercial manufacture, made of one-quarter inch mesh galvanized hardware cloth, 18 inches long by 8 inches in diameter with a 1-inch diameter orifice at each end. Minnow traps were baited with dry and canned cat food. Electrofishing employed a gasoline-powered DC generator set at 500 volts DC, 1.0 amp maximum output. The generator was placed in a 14 foot jonboat. Electrofishing was accomplished from the boat using a single hand-held electrode and a hand-held dip net.

Gill nets only were used on two ponds. Normally just trout were measured, weighed, and if dead, eviscerated to determine gender. Scales and otoliths were removed from dead trout for age determination. Live fish were released. Fish captured in trap nets were identified, enumerated by species and in some instances measured, weighed and released. In cases were identification was uncertain, one or more specimens was vouchered. Fish captured in minnow traps typically were enumerated by species. In some instances the largest and smallest specimens of a species were measured. In cases were identification was uncertain, one or more specimens was vouchered. Fish were netted selectively during electrofishing , mainly to document species. No effort was made

to quantify the number of fish seen or captured.

Macroinvertebrate Assemblages

Macroinvertebrate stream reaches were selected to include at least one representative site for each potential assemblage type presented by the Aquatic Classification Workgroup (1998). Specifically sites were selected based on watershed size, stream gradient, elevation, and background alkalinity. All sampling was conducted during the index period between August 30 and September 7 by VTDEC Biomonitoring and Aquatic Studies Section staff.

Moderate to high gradient "riffle" reaches were sampled using a standardized "kick net" methodology (VTDEC 1989). Samples are collected using an 18 inch wide x 12 inch high D-frame net with a 500 Φ mesh size. The net is placed in the riffle at an appropriate location and the area immediately upstream of the net is thoroughly disturbed by hand, ensuring that all pieces of substrate are moved and rubbed clean of attached organisms. Moving in an upstream direction, this is repeated at four locations within the riffle section. Selected sampling locations represent a range of velocity and substrate type characteristic of that riffle. Low gradient "slow winder" stream reaches were sampled by sweeping thru the upper sediments, woody debris dams and root-wads, and macrophyte beds when present. All samples were preserved in the field with 75 % ethyl alcohol. Samples were processed in the VTDEC R.A. La Rosa Laboratory, Waterbury following standard sub-sampling procedures as described in VTDEC (1989). This procedure requires at least one-quarter, and possibly the entire, sample to be processed. All animals were identified to the lowest practical taxonomic level usually genus or species when possible. All animals have been archived in the VTDEC laboratory. A number of stream physical characteristics were recorded at each site including: stream "bank full" width; depth; substrate composition (using visual methods or the Pebble Count Method- VTDEC); substrate embeddedness (riffle sites only); canopy cover; and periphyton cover. Additional observations on bank stability, weather, temperature and flow were also recorded.

Macroinvertebrate taxa and counts for each sample were entered into an Access database, from which a number of biometrics were calculated, as well as per cent composition of the major orders, and functional feeding groups. Eight metrics and community compositional data were then used to determine the biological integrity of each community following VTDEC guidelines (VTDEC 2001). Macroinvertebrate stream assemblage type determinations were arrived at through professional biologist judgment by interpretation of a Two-Way Indicator Species Analysis (TWINSPAN) of the dominant taxa for each site, by assessing the relationship between the dominant taxa and a number of physical chemical parameters using Canonical Correspondence Analysis (CCA), following the methods of Aquatic Classification Workgroup (1998). The VTDEC has developed procedures to assess the biological integrity of three macroinvertebrate stream types: Small Mountain Streams (), Medium Mountain Streams (MHG) and Warm Water, Moderate-Gradient Streams and Rivers (WWMG).

Mollusca Survey

Gastropods, and bivalves were collected in a qualitative manner using a large sweep net with a 500 Φ mesh size. All collections were made in the littoral zone of lakes by sweeping through muck, leaf matter, and macrophyte beds. Additionally animals were rinsed from large woody debris and cobble substrates. An attempt was made to sample all available macro-habitats found within the littoral zone of each lake. Approximately two hours were spent sampling each lake. Mollusca were also sampled from running waters qualitatively at the Nulhegan River-river mile (RM) 4.5, and Paul Stream RM10.2 (Ferdinand Bog). The Mollusca from all other running water sites were collected as described above for all macroinvertebrates. All samples were preserved in the field with 75 % ethyl alcohol. Samples were processed in the VTDEC Laboratory in Waterbury. All gastropods and bivalves were picked out of the each sample. All animals were identified to the lowest practical taxonomic level usually

species when possible and were archived in the VTDEC laboratory. Collections were conducted between August 16 and September 20.

Water Chemistry

Water chemistry parameters were collected during biological sampling. Water temperature was taken with a hand-held thermometer, pH was measured in the field with portable meters and dissolved oxygen was determined using the Winkler titration method. Specific conductance, total alkalinity, calcium, magnesium, sodium and potassium were all determined using USEPA approved methods contained in the VTDEC Laboratory Quality Assurance Plan (1999). All laboratory samples were analyzed at the VTDEC laboratory.

RESULTS AND DISCUSSION

Running Waters

West Mountain Wildlife Management Area

Sampling location information for both fish and macroinvertebrate assemblages appears in Table 1 and Figure 1. The stream sites drained watersheds ranging in size from 3.5 to 113 km^2, with at site elevations of 286 to 628 m. Physico-chemical data collected from the stream sites are found in Table 2. The data indicate that the waters of these drainages are "soft" with specific conductances from 26 to 41Φmhos, and alkalinities from 6.2 to 21.3mg/l. The pH's were near circumneutral, ranging between 6.51-7.52. Within the Paul Stream watershed, the high-elevation smaller streams generally had lower alkalinities (<10mg/l). Dennis Pond Brook had higher alkalinity than the other stream sites.

Fish Assemblages

The fish collection raw data are presented in Appendixes 1 and 2. A total of 1,763 fish from 20 species were collected from the ten stream sites. In addition to this, a 2000 collection conducted by the VTFW on lower Paul Stream (RM 3.1) tallied 124 Atlantic salmon and 10 brook trout and an undetermined number of non-game species. Three species not recorded in 2000 from Paul Stream that have been historically collected by the VTFW are brown trout, rainbow trout and yellow perch.

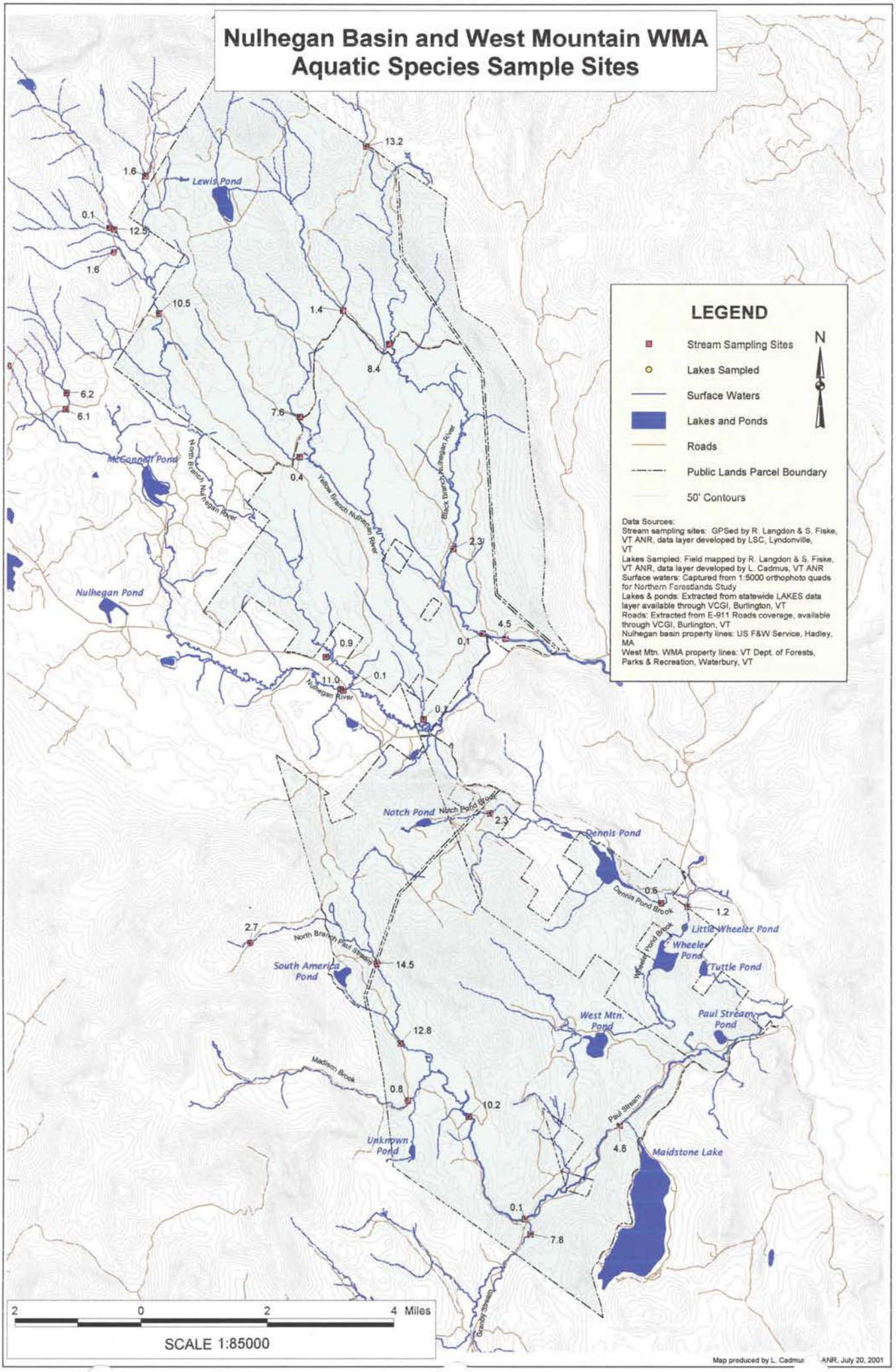
There are potentially 39 native fish species in the Connecticut River drainage of Vermont. Thirty have actually been historically reported, twenty of which were collected during the current effort. For the 2000 collections species richness per site ranged from 1 to 13.

Blacknose dace, white sucker and brook trout were the most common species observed in 2000, 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 (Table 3). Three specimens non-native to the Connecticut drainage were recorded; two were brown trout and the third, a bluntnose minnow.

Table 1. Site location parameters and community sampled for Paul and Wheeler Stream drainage sites in the West Mountain Wildlife Management Area ,sampled in August - September 2000. M-macroinvertebrates, F-fish

Location and river mile from mouth		Community Sampled	Latitude - Longitude	Elevation (meters)	Drainage Area at site (km^2)
			Paul Stream Drainage		
North Branch Paul Stream	2.7	M, F	444248 714626	628	3.5
Paul Stream	14.5	F	444230 714400	466	19.1
Paul Stream	12.8	M, F	444124 714334	450	30.4
Madison Brook	0.8	M, F	444037 714326	457	16.0
Paul Stream	10.2	F	444023 714216	445	53.6
Paul Stream	7.8	M	443858 714120	367	60.8
Granby Stream	0.1	M, F	443858 714110	366	41.2
Paul Stream	4.8	M	444014 713922	352	113.0
Paul Stream	3.1	F	444107 713820	337	
			Wheeler Stream Drainage		
Notch Pond Brook	2.3	F	444433 714148	373	3.5
Dennis Pond Brook	0.6	M, F	444318 713832	297	25.0
Wheeler Stream	1.2	F	444314 713803	286	18.0

Nulhegan Basin and West Mountain WMA Aquatic Species Sample Sites



Map produced by L. Cadmus ANR, July 20, 2001

Table 2. Physico-chemical data from the 12 sites sampled for fish and macroinvertebrates from the Paul and Wheeler drainages within the West Mountain Wildlife Management Area during August 2000. Stream sites are listed in order from top to bottom of watersheds.

Location and river mile from mouth	Water Temp (°c), Time	Dissolved Oxygen (mg/l)	Specific Cond. (Φmhos)	pH (std units)	Alkalinity (mg/l)	Calcium (mg/l)	Magnesium (mg/l)	Potassium (mg/l)	Sodium (mg/l)	Turbidity NTU's
Notch Pond Brook 2.3	13@1230	8.2	40	7.39	15.9	6.57	1.07	1.17	1.53	0.37
Dennis Pond Brook 0.6	22@1220	7.9	40	7.49	21.3	7.04	1.11	0.88	1.91	0.49
Wheeler Pond Brook 1.2	22@1000	7.5	28	7.52	7.8	3.98	0.64	0.55	1.27	0.98
North Branch Paul Stream 2.7	14@1145	8.9	34	6.51	9.3	4.21	0.78	0.92	1.53	0.20
Paul Stream 14.5	15@1245	-	41	7.12	15.9	5.72	1.00	1.01	1.72	0.57
Paul Stream12.8	14@1000	7.2	39	6.82	15.6	5.57	0.98	1.00	1.65	1.09
Madison Brook 0.8	14@1430	8.2	28	6.62	6.2	3.36	0.74	0.91	1.33	0.52
Paul Stream 10.2	16@1430	7.7	35	6.63	12.1	4.64	0.86	0.83	1.42	0.34
Paul Stream 7.8	12@1415	-	34	7.16	9.5	4.1	0.80	0.74	1.33	-
Granby Stream 0.1	16@1430	7.3	26	6.99	7.8	3.37	0.71	0.61	1.47	0.72
Paul Stream 4.8	9@1430	-	35	-	7.1	4.11	0.82	0.70	1.38	-
Paul Stream 3.1	14@0950	-	20	-	-	-	-	-	-	-

Table 3. Occurrence of fishes collected from streams and rivers in the West Mountain Wildlife Management Area during 2000.

		As	Bt	Br	Cp	Bm	Bd	Cc	Cs	Ff	Fd	Gs	Ph	Ld	Rd	Ls	Ws	Bb	Bu	Ss	Ps	Yp
West Mountain WMA																						
Notch Pond Brook	*2.3*		x				x															
Wheeler Pond Brook	*1 .2*			x	x		x	x	x	x		x		x	x		x				x	x
Dennis Pd. Brook	*0.6*			x		x	x	x	x	x				x	x		x	x	x		x	x
No Br. Paul Stream	*2.7*		x																			
Paul Stream	*14.5*		x				x									x	x			x		
Paul Stream	*12.8*		x				x	x	x						x	x	x					
Madison Brook	*0.8*		x				x							x			x			x		
Paul Stream	*10.2*						x	x	x		x	x	x	x	x	x	x					
Granby Stream	*0.1*	x	x				x	x						x			x			x		
Paul Stream	*3.1*	x	x				x							x		x				x		

Abbreviations for common and scientific names.

As	*Atlantic salmon*	*Salmo salar*	*Ph*	*Finescale x Redbelly dace*	*Phoxinus Sp. hybrid*
Bt	*Brook trout*	*Salvelinus fontinalis*	*Ld*	*Longnose dace*	*Rhinichthys cataractae*
Br	*Brown trout*	*Salmo trutta*	*Rd*	*No. Redbelly dace*	*Phoxinus eos*
Cp	*Chain pickerel*	*Esox niger*	*Ls*	*Longnose sucker*	*Catostomus catostomus*
Bm	*Bluntnose minnow*	*Pimephales notatus*	*Ws*	*White sucker*	*Catostomus commersoni*
Bd	*Blacknose dace*	*Rhinichthys atratulus*	*Bb*	*Brown bullhead*	*Ameiurus nebulosus*
Cc	*Creek chub*	*Semotilus atromaculatus*	*Bu*	*Burbot*	*Lota lota*
Cs	*Common shiner*	*Luxilus cornutus*	*Ss*	*Slimy sculpin*	*Cottus cognatus*
Ff	*Fallfish*	*Semotilus corporalis*	*Ps*	*Pumpkinseed*	*Lepomis gibbosus*
Fd	*Finescale dace*	*Phoxinus neogaeus*	*Yp*	*Yellow perch*	*Perca flavescens*
Gs	*Golden shiner*	*Notemigonus crysoleucas*			

Common and scientific names of fish species collected from both management areas are listed in Table 4. No state or federally listed species were collected in the West Mountain WMA. Species state-wide occurrence is categorized here as "wide-spread ", "common", "uncommon" or "rare" (Table 4). These designations are based on the 9000+ record VTANR database. No state-listed endangered or threatened species were recorded from this drainage. 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.

A 1998 document (Aquatic Classification Workgroup 1998) made an initial attempt to classify Vermont's aquatic communities. Among those addressed were fishes of running waters. The document listed seven assemblage types based on species similarity. Among the workgroup's recommendations was the need to generate more information from the upper Connecticut Valley so that additional assemblage types may be developed . The addition of data from this study to the VTDEC fish database consequently did allow the generation of an additional proposed assemblage type. Specifically a new classification type, the low gradient, soft-bottomed stream type (Type 4), represented by three subtypes, is proposed here. The classification presented by the Aquatic Classification Workgroup (1998) is thereby modified to include 10 assemblage types (Appendix 3). Table 5 shows the classification of the West Mountain WMA sites using the updated grouping. Five assemblage types are represented, and all are considered commonly or abundantly represented in Vermont. An attempt was made to extrapolate the distribution of assemblage types from the available data for *all* running waters of the West Mountain WMA. The resulting Figure 2 indicates an *estimate* of the general coverage of assemblage types based on known relationships between species assemblages and stream size and gradient. The map lines demarcating the assemblages should not be strictly interpreted. Additional sampling within the WMA would increase the accuracy of these lines and of a sense of the overall distribution of types. It should be noted that even with abundant data representation, the lines should be regarded as arbitrary indications of boundaries. This due to the fact that biological populations respond proportionately to a gradient of changing physical conditions. Consequently, assemblage types will normally gradate from one to the next along physically-driven continua.

Of the 10 sites sampled in the West Mountain WMA, six could be evaluated for biological integrity using one of the two IBIs (Table 5). 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 been designed to apply to this site type). One site was only sampled qualitatively for species presence and therefore the data were not of sufficient quality to generate an IBI score. Where calculated, IBI scores ranged widely for the six sites: from 31 ("good") to 45 ("excellent"). All scored sites met the State Water Quality Standard biocriteria for fish assemblages of Class B waters (IBI greater than 29-31).

Atlantic Salmon Smolt Production Estimates. Electroshock surveys conducted in the fall provide a basis for estimates of the "expected smolt out-migration" in the system during the following spring. The projected out-migration computed for Paul Stream for spring 2002 is 1,593 two-year-old smolts and 65 one-year-old smolts. The low conductance of these waters limits electrofishing efficiency, thereby producing what should be considered as minimal out-migration estimates.

Table 4. Abbreviations for common names, corresponding scientific names, and notes on state distribution for each fish species recorded from the Silvio Conte Refuge in the Nulhegan Basin and the West Mountain Wildlife Management Area, 2000.

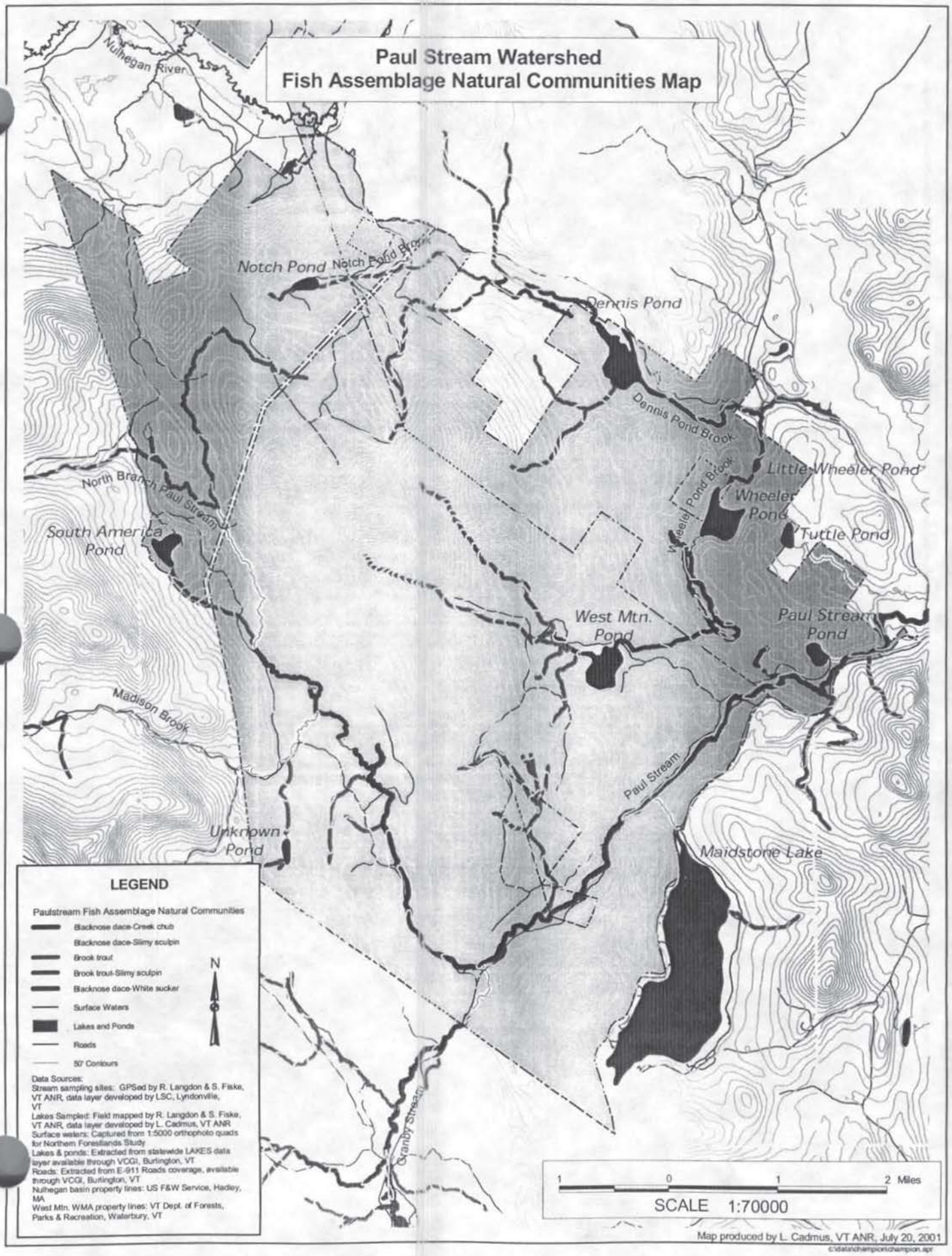
Abbr.	Common Name	Scientific Name	Comments: Native, non-native and extent of distribution in Vermont[1]
As	Atlantic salmon	*Salmo salar*	Native statewide, reintroduced into many lakes and rivers, common
Rt	Rainbow trout	*Onchorynchus mykiss*	Non-native, wide-spread
Bt	Brook trout	*Salvelinus fontinalis*	Native statewide, wide-spread
Br	Brown trout	*Salmo trutta*	Non-native, wide-spread
Cp	Chain pickerel	*Esox niger*	Native statewide, common
Bm	Bluntnose minnow	*Pimephales notatus*	Non-native in Connecticut R. drainage, native to Champlain drainage, common in Champ. drain.
Bd	Blacknose dace	*Rhinichthys atratulus*	Native statewide, wide-spread
Cc	Creek chub	*Semotilus atromaculatus*	Native statewide, wide-spread
Cs	Common shiner	*Luxilus cornutus*	Native statewide, wide-spread
Ff	Fallfish	*Semotilus corporalis*	Native statewide, common
Fd	Finescale dace	*Phoxinus neogaeus*	Native statewide, uncommon
Gs	Golden shiner	*Notemigonus crysoleucas*	Native statewide, common
Ph	Finescale x Redbelly dace	*Phoxinus neogaeus x P. eos*	Native, natural hybrid, uncommon
Lc	Lake chub	*Couesius plumbeus*	Native statewide, uncommon
Ld	Longnose dace	*Rhinichthys cataractae*	Native statewide, wide-spread
Rd	Northern Redbelly dace	*Phoxinus eos*	Native statewide, common
Ls	Longnose sucker	*Catostomus catostomus*	Native statewide, wide-spread
Ws	White sucker	*Catostomus commersoni*	Native statewide, wide-spread
Bb	Brown bullhead	*Ameiurus nebulosus*	Native statewide, common
Bu	Burbot	*Lota lota*	Native statewide, uncommon
Ss	Slimy sculpin	*Cottus cognatus*	Native statewide, wide-spread
Ps	Pumpkinseed	*Lepomis gibbosus*	Native statewide, common
Yp	Yellow perch	*Perca flavescens*	Native statewide, common
Td	Tessellated darter	*Etheostoma olmstedi*	Native statewide, common

1.Extent of distribution in Vermont is estimated from the VTANR 9,000-record database. Wide-spread-300+ records, common-76-299, uncommon-21-75, rare-<21.

Table 5. Assemblage types and measures of fish community health (IBI[1]) for Paul Stream and Wheeler Stream drainage sites sampled during August 2000. Assemblage type is based on an updated version of the classification provided in Aquatic Classification Workgroup (1998).

Location	River Mile[2]	Assemblage Type	IBI - Assessment
Paul Stream Drainage			
North Branch Paul Stream [5]	2.7	**1** Brook trout	None, Meets Class B Std.
Paul Stream	14.5	**3** Blacknose dace-Slimy sculpin	**35-Good.** Meets Class B Std [3].
Paul Stream[5]	12.8	**4b** Blacknose dace-Creek chub	None- Meets Class B Std.
Madison Brook	0.8	**3** Blacknose dace-Slimy sculpin	**39 -Very Good.** Meets Class B Std.
Paul Stream	10.2	**4b** Blacknose dace-Creek chub	None, qualitative sample
Granby Stream	0.1	**3** Blacknose dace-Slimy sculpin	**37-Very Good.** Meets Class B Std.
Paul Stream	3.1	**5** Blacknose dace-White sucker	None, qualitative sample
Wheeler Stream Drainage			
Notch Pond Brook	2.3	**1-2** Brook trout, Brook trout - Slimy sculpin	**45-Excellent** -Meets Class B Std.
Dennis Pond Brook	0.6	**5** Blacknose dace-White sucker	**31-good.** Meets Class B Std.
Wheeler Pond Brook	1.2	**5** Blacknose dace-White sucker	**31-good.** Meets Class B. Std.

1. The IBI is an index of biological integrity, modified for use on Vermont streams and rivers, that is used to assess the fish community health. Index scores range from 9 (poor) to 45 (Excellent). IBI scores are used to determine compliance with the State of Vermont Water Quality Standards.
2. As measured from mouth
3. Class B std refers to the biological criteria contained in the Vermont Water Quality Standards currently designated for these waters.
4. These two sites supported only two fish species and did not show affinity for any towards any existing type. See discussion in text.
5. "Best professional judgment" is used in some evaluations where an IBI cannot be calculated.


Paul Stream Watershed
Fish Assemblage Natural Communities Map
Nulhegan River
Notch Pond
Notch Pond Brook
Dennis Pond
Dennis Pond Brook
Little Wheeler Pond
Wheeler Pond
Wheeler Pond Brook
Tuttle Pond
North Branch Paul Stream
South America Pond
West Mtn. Pond
Paul Stream Pond
Madison Brook
Paul Stream
Unknown Pond
Maidstone Lake
Granby Stream
LEGEND
Paulstream Fish Assemblage Natural Communities
Blacknose dace-Creek chub
Blacknose dace-Slimy sculpin
Brook trout
Brook trout-Slimy sculpin
Blacknose dace-White sucker
Surface Waters
Lakes and Ponds
Roads
50' Contours
N
Data Sources:
Stream sampling sites: GPSed by R. Langdon & S. Fiske, VT ANR, data layer developed by LSC, Lyndonville, VT
Lakes Sampled: Field mapped by R. Langdon & S. Fiske, VT ANR, data layer developed by L. Cadmus, VT ANR
Surface waters: Captured from 1:5000 orthophoto quads for Northern Forestlands Study
Lakes & ponds: Extracted from statewide LAKES data layer available through VCGI, Burlington, VT
Roads: Extracted from E-911 Roads coverage, available through VCGI, Burlington, VT
Nulhegan basin property lines: US F&W Service, Hadley, MA
West Mtn. WMA property lines: VT Dept. of Forests, Parks & Recreation, Waterbury, VT
1 0 1 2 Miles
SCALE 1:70000
Map produced by L. Cadmus, VT ANR, July 20, 2001
c:\data\champion\champion.apr

Macroinvertebrate Assemblages

A list of the running water macroinvertebrate taxa collected from West Mountain WMA and their common names is found in Appendix 4. Physical habitat assessments for sampled sites appear in Appendix 5. 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 a complete taxa list of the running waters of 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 macroinvertebrate 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 VTDEC Biomonitoring database. It was found in Dennis Pond Brook and may be somehow connected to streams below ponds or wetlands.

Following the preliminary macroinvertebrate classification of running waters in Vermont (Aquatic Classification Workgroup 1998), at least six macroinvertebrate assemblage types are present. These *are Cold headwater acidic mountain (Type 1), Cold Headwater Mountain (Type 2), Moderately-Sized Mountain (Type 3), Small Headwater Marsh (type 5), Medium-Sized Mid Reach Meandering (Type 6), and Lake Outlet Reaches (Type 9).* Figure 3 illustrates the location and probable extent of these macroinvertebrate stream types within the West Mountain WMA. As with the fish assemblages distribution, the mapped lines distinguishing the types should not be strictly interpreted. Additional biological sampling would increase the confidence of the estimate of the distribution of macroinvertebrate assemblage types. It should also be kept in mind that spatially, both fish and macroinvertebrate assemblage types change *gradually* from upstream to downstream and the map lines differentiating types reflect more a compromise for ease of presentation than a representation of actual conditions.

The macroinvertebrate stream assemblage types appear to be highly associated with the physical, and chemical characteristics of the streams. To illustrate this association between macroinvertebrate taxa present at a stream reach and selected physico-chemical site parameters the streams sampled in both the West Mountain WMA, and the Silvio Conte National Refuge were examined using CCA ordination. Figure 4 illustrates this arrangement of stream sites sampled within both management areas by the dominant macroinvertebrate taxa found at a site, with physical/chemical parameter vector arrows. All six running-water macroinvertebrate community assemblage types found are common in Vermont.

The integrity of the macroinvertebrate assemblage was evaluated from six of the seven stream reaches. Table 6 presents the assessment and the biometrics used to evaluate the integrity of the macroinvertebrate assemblages. The assessments were made following the guidelines found in VTDEC (2001). This document has established biocriteria for three high gradient wadeable stream assemblage types. 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 in that a number of warm water taxa were present, including *Chimarra atterima*, and *Stenelmis sp.*

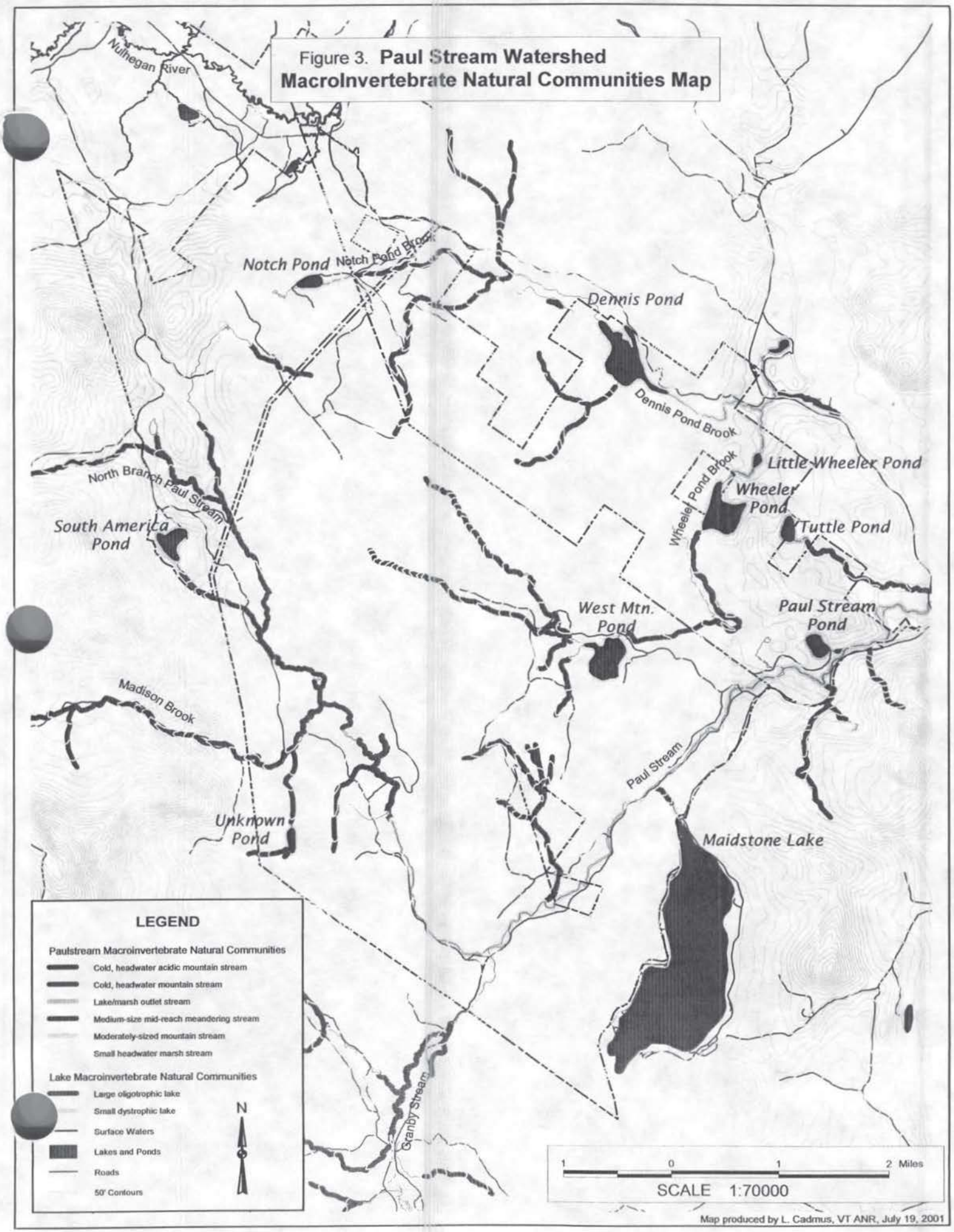


Figure 3. **Paul Stream Watershed MacroInvertebrate Natural Communities Map**

Figure 4. A CCA bi-plot showing the stream sites as arranged by species composition of the dominant taxa. Vector lines represent the relative influence of a number of measured physical and chemical characteristics of the stream reaches.

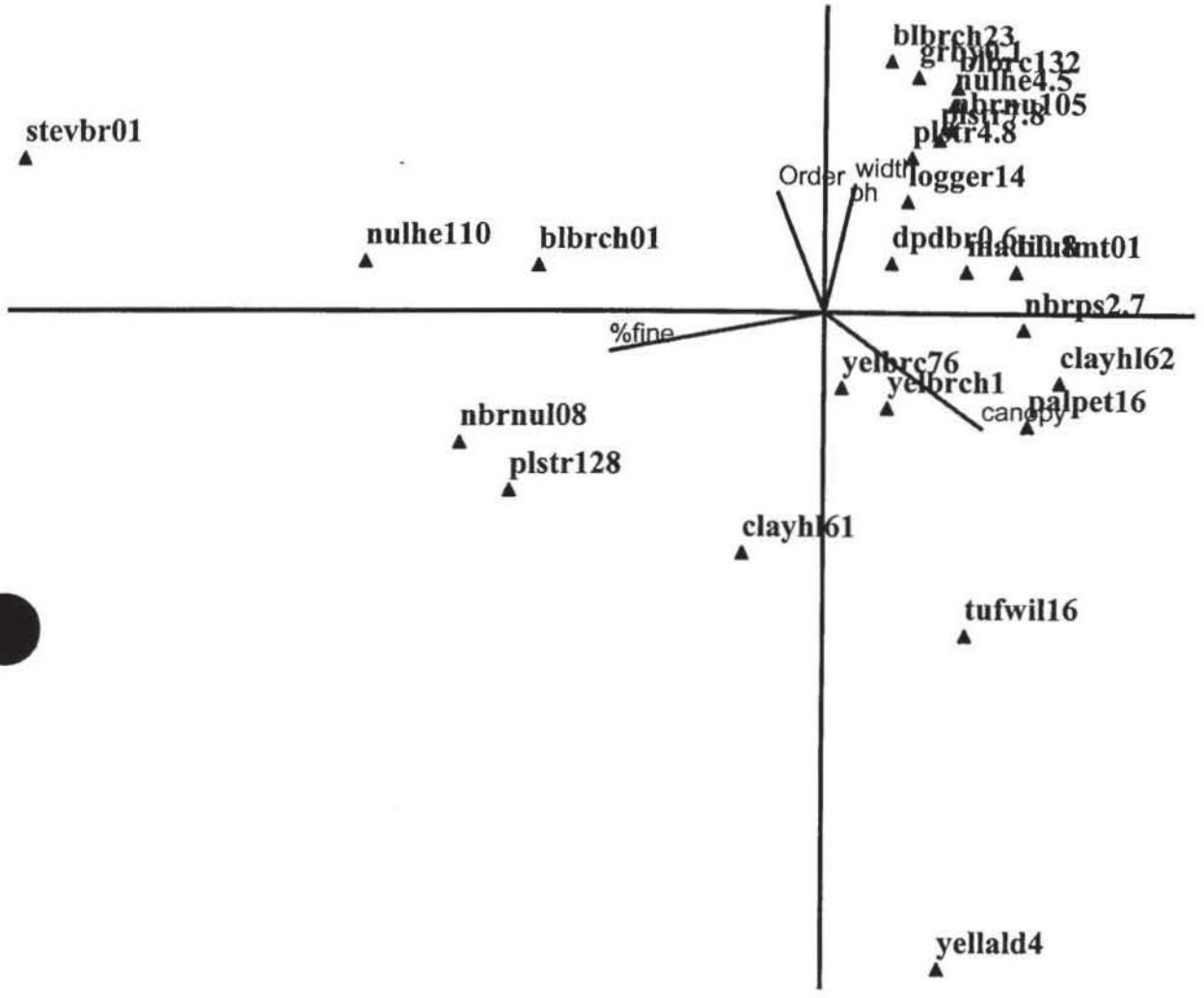


Table 6. Macroinvertebrates biometrics from all stream sites within in the Paul Stream-Dennis Pond watershed. The biological integrity from all wadeable riffle sites sampled with a KN method have been evaluated using the VT Biocriteria for wadeable streams. The corresponding assessment of "excellent", "very good", and "good" are equivalent to WQ stream Classification Type A1, B1, and B2-3, A2. The other sites reported here are from low gradient stream reaches and were sampled in an effort to characterize all the natural stream community types within the watershed. SHG= small high gradient, MHG= medium high gradient stream category and SW, mid-reach meandering (slow winding) stream. See explanation below for metric abbreviations.

Location	Station	Stream Category	Density	Richness	EPT	PMA orders	BI (0-10)	Oligo%	EPT/ EPT&C	PPCS funct grps	Assessment
North Branch Paul St	2.7	SHG	1560	40.0	22.0	89	2.53	0.0	0.88	0.70	Excellent
Paul Stream	12.8	SW	425	49.0	12.0		5.27	0.0	0.74		-
Madison Brook	0.8	SHG	1868	43.5	23.0	61	3.14	0.7	0.90	0.59	Excellent
Paul Stream	7.8	MHG	2228	53.0	30.0	83	3.43	0.4	0.85	0.74	Excellent
Granby Stream	0.1	MHG	3080	50.0	30.0	86	3.56	0.4	0.87	0.56	Excellent
Paul Stream	4.8	MHG	2060	52.0	25.0	89	2.90	0.8	0.87	0.79	Excellent
Dennis Pond Brook	0.6	SHG	2788	48.0	19.0	81	3.56	0.0	0.80	0.59	Very Good
Class B threshhold		*SHG*	*>300*	*>27*	*>16*	*>45*	*<4.50*	*<12*	*>0.45*	*>0.40*	
Class B threshhold		*MHG*	*>300*	*>30*	*>18*	*>45*	*<5.00*	*<12*	*>0.45*	*>0.40*	

EPT- Mean Ephemeroptera-Plecoptera-Trichoptera species richness; PMA-Orders- Percent Model Affinity by insect order; BI- Biotic Index; Oligo % % of sample as oligochaete worms; EPT/EPT&C- ratio of EPT order to the generally tolerant Dipteran family Chironomidae; PPCS- func grps- Pinkam-Pearson Coefficient of similarity between feeding group type.

Silvio Conte National Refuge

Sampling location information for both fish and macroinvertebrate assemblages is presented in Table 7 and Figure 1. Physico-chemical data appears in Table 8. As in the Paul and Wheeler drainage waters, the streams sampled in the Silvio Conte Refuge are fairly dilute with specific conductances of 14-60 Φmhos. 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's (5.45-5.83) and alkalinities (2- 4.5mg/l). These values represent summer flows and most probably are considerably lower during spring snow melt events, which characteristically bring the highest acidities of the year. As a result, the pH and alkalinities in the Yellow Branch will be limiting to sensitive fish and macroinvertebrate taxa especially in the Cyprinidae, Ephemeroptera, Bivalvia, and Gastropoda. Other stream reaches that also had low alkalinity and therefore probably undergo a period of low pH during the spring are Tuffield-Willey and Bluff Mountain Brooks. It seems likely as well, that other high elevation (>600m) streams with small watersheds in the Nulhegan drainage, undergo a period of very low pH and alkalinity during snowmelt.

Table 7. Location parameters and community sampled for Nulhegan drainage sites, within the Silvio Conti National Wildlife Refuge. Sampled in August - September 2000. M-macroinvertebrates, F-fish Stream sites are listed in order from top to bottom of watersheds.

Location and river mile from mouth		Community Sampled	Latitude - Longitude	Elevation (meters)	Drainage Area at site (km^2)
Clay Hill Brook	6.2	M	445015 714954	410	4.5
Clay Hill Brook	6.1	M	445009 714955	407	4.6
Tuffield Willey Brook	1.6	M	445049 715058	549	0.6
Nulhegan River	11.0	M, F	444617 714440	347	86.3
Stevens Brook	0.1	M, F	444616 714437	348	11.7
Palaeagapetus Brook	1.6	M	445221 714856	469	1.3
Bluff Mtn. Brook	0.1	M	445239 714903	475	3.4
N. Branch Nulhegan River	12.5	F	445237 714858	479	10.8
Tim Carroll Brook	1.6	F	445321 714821	539	7.1
N. Branch Nulhegan River	10.5	M	445128 714806	424	30.1
N. Branch Nulhegan River	0.9	F	444643 714457	350	53.7
Yellow Branch Nulhegan R.	7.6	M, F	445001 714525	389	7.9
Yellow Alder Bk	0.4	M, F	444931 714524	384	6.2
Yellow Branch Nulhegan R.	0.1	M	444551 714304	346	21.8
Black Branch Nulhegan R.	13.2	F	445344 714405	500	19.0
Black Branch Nulhegan R.	8.4	F	445101 714340	380	25.2
Black Branch Nulhegan R.	2.3	M	444812 714228	346	56.2
Logger Branch	1.4	M, F	445129 714433	396	15.6
Black Branch Nulhegan R.	0.1	M, F	444701 714155	335	63.3
Nulhegan River	4.5	M	444658 714132	333	243.8
Nulhegan River	1.8	F	444544 713834	280	

Table 8. Physico-chemical data from the 21 sites sampled for fish and macroinvertebrates from the Nulhegan drainage, within the Silvio Conte National Wildlife Refuge. Sampled during August 2000. Stream sites are listed in order from top to bottom of watersheds.

Location and river mile from mouth		Water Temp (°c), Time	Dissolved Oxygen (mg/l)	Specific Conduct. (Φmhos)	pH (std units)	Alkalinity (mg/l)	Calcium (mg/l)	Magnesium (mg/l)	Potassium (mg/l)	Sodium (mg/l)	Tubidity (NTU's)
Clay Hill Brook	6.2	12@0930	-	43	7.20	13.6	4.88	0.80	0.79	1.52	-
Clay Hill Brook	6.1	17@1430	-	43	7.33	13.6	4.48	0.78	0.69	1.54	-
Tuffield -Willey Brook	1.6	14@1530	-	16	6.58	2.5	1.78	0.48	0.25	0.59	-
Nulhegan River	11.0	15 @0945	-	47	6.38	14.6	6.58	0.97	0.83	2.46	0.64
Stevens Brook	0.1	12 @1045	-	41	6.18	13.0	5.43	0.95	-	1.27	-
Palaeagapetus Brook (N.B.Nul.)	1.6	13@1255	-	60	7.50	27.6	8.83	1.27	0.84	1.94	-
Bluff Mtn Brook (N.B.Nulhegan)	0.1	14@1130	-	32	6.02	3.4	4.53	0.78	-	1.02	-
N. Branch Nulhegan River	12.5	-	9.0	31	7.09	12.2	5.80	0.70	27.6	1.08	0.30
Tim Carroll Brook	1.6	10 @1028	10.2	34	7.56	13.2	6.21	0.70	1.17	1.12	0.19
N. Branch Nulhegan River	10.5	13@1045	-	46	7.41	15.3	6.17	0.81	0.54	1.13	-
N. Branch Nulhegan River	0.9	12 @1053	9.8	28	7.10	10.7	5.36	0.71	1.49	1.16	0.45
Yellow Branch Nulhegan River	7.6	12 @1225	-	26	5.45	4.5	3.81	0.63	-	1.03	-
Yellow Alder Brook (Yellow Br.)	0.4	14 @1240	6.4	14	5.83	2.5	4.19	0.72	14.0	0.99	0.58
Yellow Branch Nulhegan River	0.1	12@1220	-	29	5.61	2.0	4.14	0.71	-	0.87	-
Black Branch Nulhegan River	13.2	14 @1400	-	50	7.06	22.2	8.21	1.12	-	1.34	-
Black Branch Nulhegan River	8.4	16@1200	-	-	-	-	-	-	-	-	-
Black Branch Nulhegan River	2.3	16@1540	-	52	7.59	20.8	6.94	1.00	0.59	1.51	-
Logger Branch	1.4	14 @1430	8.9	36	7.68	14.6	7.00	0.86	25.6	1.28	2.0
Black Branch Nulhegan River	0.1	14 @1010	8.4	46	7.10	17.8	7.35	1.01	0.57	1.45	-
Nulhegan River	1.8	11@1145	-	40	-	-	-	-	-	-	-
Nulhegan River	4.5	-	-	49	7.17	16.1	6.70	1.01	0.93	2.62	-

Fish Assemblages

Twelve sites from eight streams and rivers were sampled within the Silvio Conte Refuge of the Nulhegan drainage. A total of 450 fish from 16 species were collected. The VTFW 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 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 been recorded historically in Vermont waters of the Connecticut drainage. Species richness per site ranged from 1-9. The fish collection data are presented in Appendixes 6 and 7.

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 (Table 9) .

There were six fish assemblage types recorded in the Nulhegan using the newly-revised classification discussed above (Table 10). Five are well-represented in Vermont. One of the new sub-types from the low gradient streams -Type 4c, is originally defined by two Nulhegan drainage sites. The Nulhegan River near the mouth of Stevens Brook and Stevens Brook itself are currently the only examples of this newly-defined assemblage type. None of the species are rare, but the association of these particular of species is unique. Subsequent sampling of low gradient Vermont streams may well identify additional examples of this assemblage type. An attempt was made to extrapolate the distribution of assemblage types from the available data for all running waters of the West Mountain WMA. The resulting Figure 5 indicates an *estimate* of the general coverage of assemblage types based on known relationships between species assemblages and stream size and gradient. The map lines demarcating the assemblages should not be strictly interpreted. Any sampling of additional sites within the WMA would increase the accuracy of these lines and of the overall distribution of types. It should be noted that even with abundant data representation, the lines should be regarded as arbitrary indications of boundaries. This due to the fact that biological populations respond proportionately to a gradient of changing physical conditions. Consequently, assemblage types will normally gradate from one to the next along physically-driven continua.

IBI values could be generated from only three of 12 sites in the Silvio Conte Refuge. The three sites scored 36-"very good, 39-"excellent" and 9- "poor"(Table 10). Five of the sites were classified as low gradient (types 4A, 4B and 4C). 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 produce data of suitable quality to calculate an IBI.

The "poor" evaluation given the Yellow Branch-Nulhegan 7.6 site 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, e.g. brook trout and slimy sculpin, 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 are 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.

Atlantic Salmon Smolt Production Estimates. Electroshock surveys conducted in the fall provide a basis for estimates of the "Expected smolt out-migration" in the system during the following spring. The projected out-migration computed for the Nulhegan River for spring 2002 is 362 two-year-old smolts and 0 one-year-old smolts. The low conductance of these waters limits electrofishing efficiency, thereby producing what should be considered as minimal out-migration estimates.

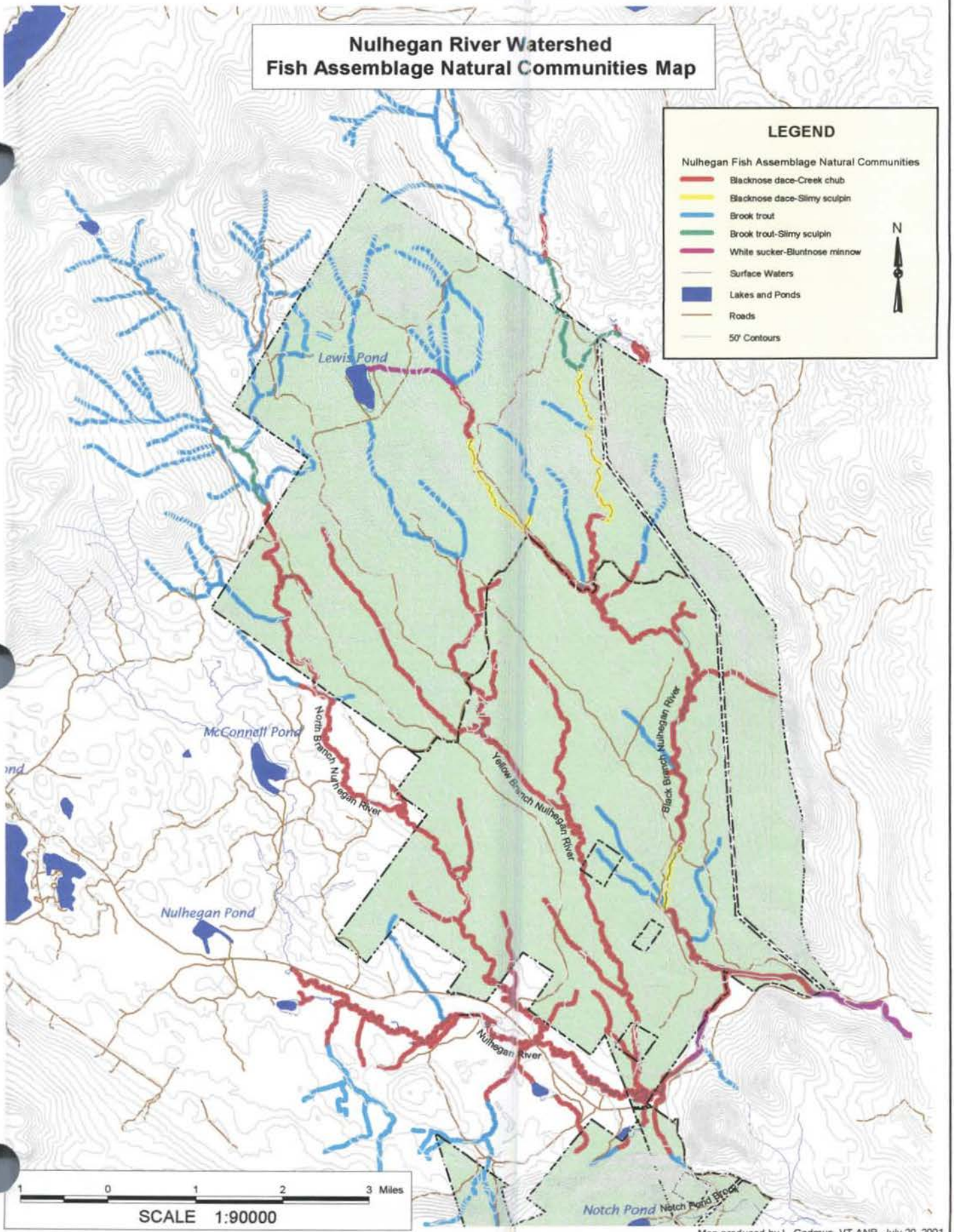
Table 9. Occurrence of fishes collected from streams and rivers in the Nulhegan drainage of the Silvio Conte National Refuge during 2000.

		As	Rt	Bt	Br	Cp	Bd	Cc	Cs	Ff	Gs	Lc	Ld	Ls	Ws	Bb	Bu	Ss	Td
Nulhegan River	11.0				x	x	x			x			x		x	x	x		x
N. Bran. Nulhegan R	0.9			x			x	x					x		x		x		
N. Bran. Nulhegan R	12.5			x			x												
Tim Carroll Brook	1.6			x															
Stevens Brook	0.1					x			x	x	X		x		x				x
Yell. Br. Nulhegan R.	7.6						x	x											
Unnamed trib-Yellow. Br.	0.4						x					x							
Black. Br. Nulhegan R	13.2			x															
Logger Branch	1.4			X			x	x					x	x				x	
Black. Br. Nulhegan R.	8.4			x			x	x					x						
Black. Br. Nulhegan R.	0.1						x	x	x				x		x				x
Nulhegan River	1.8	x	x	x	x		x						x	x			x	x	

Abbreviations for common and scientific names.

As	Atlantic salmon	*Salmo salar*	Gs	Golden shiner	*Notemigonus crysoleucas*
Rt	Rainbow trout	*Onchorynchus mykiss*	Lc	Lake chub	*Couesius plumbeus*
Bt	Brook trout	*Salvelinus fontinalis*	Ld	Longnose dace	*Rhinichthys cataractae*
Br	Brown trout	*Salmo trutta*	Ls	Longnose sucker	*Catostomus catostomus*
Cp	Chain pickerel	*Esox niger*	Ws	White sucker	*Catostomus commersoni*
Bd	Blacknose dace	*Rhinichthys atratulus*	Bb	Brown bullhead	*Ameiurus nebulosus*
Cc	Creek chub	*Semotilus atromaculatus*	Bu	Burbot	*Lota lota*
Cs	Common shiner	*Luxilus cornutus*	Ss	Slimy sculpin	*Cottus cognatus*
Ff	Fallfish	*Semotilus corporalis*	Td	Tessellated darter	*Etheostoma olmstedi*

Nulhegan River Watershed
Fish Assemblage Natural Communities Map



Map produced by L. Cadmus, VT ANR, July 20, 2001

Table 10. Assemblage types and measures of fish community health (IBI[1]) for Nulhegan drainage sites within the Silvio Conti National Refuge sampled during August 2000. Assemblage type is based on an updated version of the classification provided in Aquatic Classification Workgroup (1998). Comments in the "IBI – Assessment" column refer to assemblage characteristics.

Nulhegan Drainage	River Mile[3]	Assemblage Type	IBI - Assessment[2]
Nulhegan River	11.0	**4c** Tessellated darter-Longnose dace	None
Stevens Brook	0.1	**4c** Tessellated darter-Longnose dace	None
N. Branch Nulhegan River	0.9	**4b** Blacknose dace-Creek chub	None
N. Branch Nulhegan River	12.5	**2** Brook trout-Slimy sculpin	**36-Very good**
Tim Carroll Brook	1.6	**1** Brook trout	None
Yellow Branch Nulhegan River	7.6	Unclassified[5]	**9 - Does not meet Class B Std**; natural acidity, temperature?
Unnamed Tributary to Yellow Branch	0.4	Unclassified[5]	None- qualitative sample
Black Branch Nulhegan River	13.2	**1** Brook trout	None- **Passes Class B Std.**
Black Branch Nulhegan River	8.4	**4b** Blacknose dace-Creek chub	None -Low Density, (Natural?)
Black Branch Nulhegan River	0.1	**4c** Tessellated darter-Longnose dace	None -Low Density (Natural?)
Logger Branch	1.4	**3** Blacknose dace-Slimy sculpin	**39-Excellent**
Nulhegan River	1.8	**5** Blacknose dace-White sucker	None - Qualitative sample

1. The IBI is an index of biological integrity, modified for use on Vermont streams and rivers, that is used to assess the fish community health. Index scores range from 9 (poor) to 45 (Excellent). IBI scores are used to determine compliance with the State of Vermont Water Quality Standards.
2. The IBI is currently not calibrated for type 4 (low gradient) streams. It also requires at least two native species to be applied to stream or river data, and finally that the sample is quantitative.
3. As measured from mouth
4. Class B std refers to the biological criteria contained in the Vermont Water Quality Standards currently designated for these waters.
5. These two sites supported only two fish species and did not show affinity for any of the existing 10 types. See discussion in text

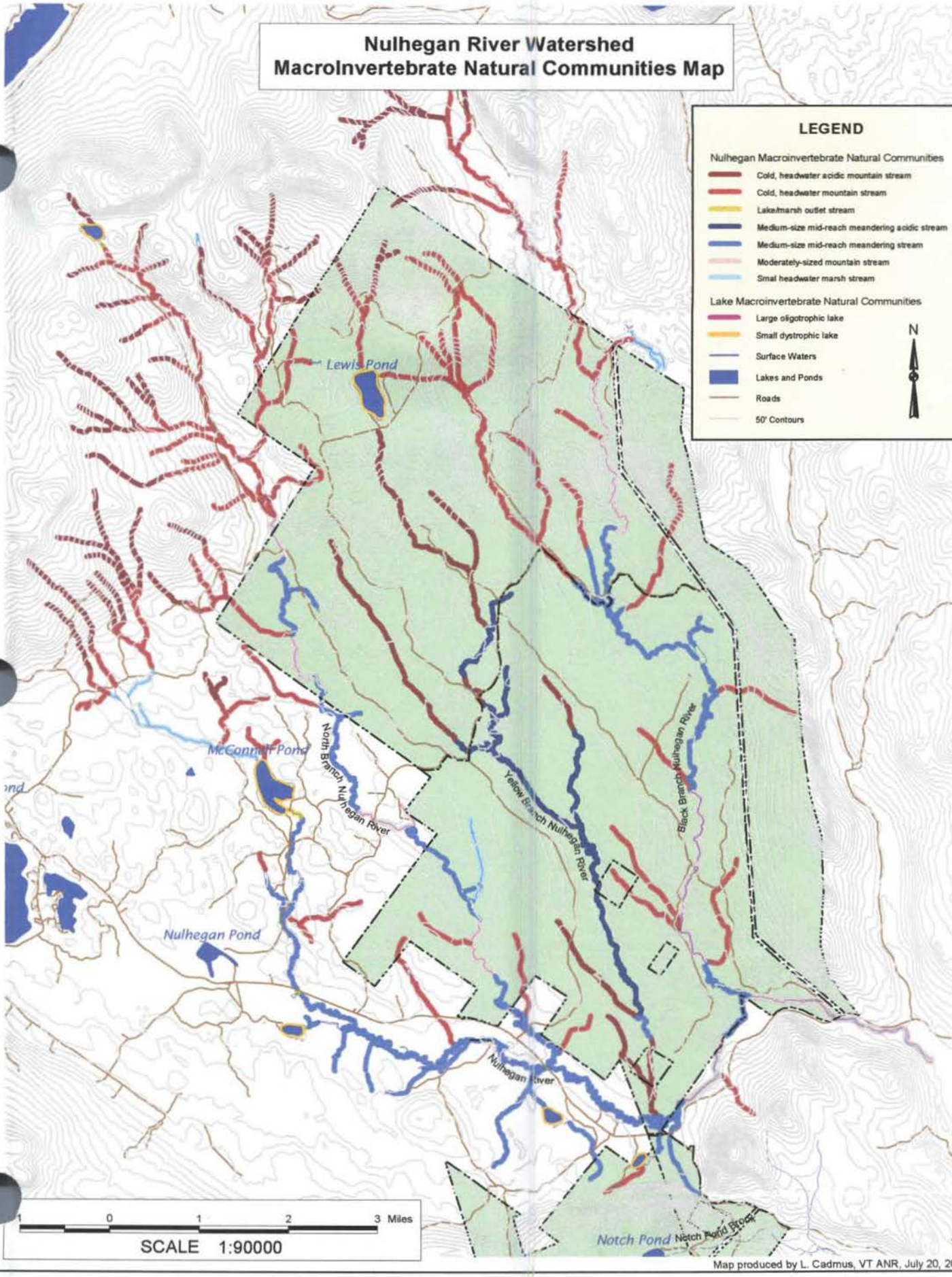
Macroinvertebrate Assemblages:

A list of the running water macroinvertebrate taxa collected from Silvio Conte lands of the Nulhegan River watershed and their common names is found in Appendix 8. Physical habitat assessments for sampled sites appear in Appendix 9. A total of 223 taxa were identified from the 17 stream sites sampled within the Silvio Conte 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 (8), and Bivalvia (6). This by no means should be considered a complete taxa list of the macroinvertebrate species from running waters within the Silvio Conte 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 is 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 VTDEC . 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.

Following the preliminary macroinvertebrate classification of running waters in Vermont (Aquatic Classification Workgroup 1998), at least six macroinvertebrate assemblage types are probably present. These are *Cold Headwater Acidic Mountain (1), Cold Headwater Mountain (2). Moderately Sized Mountain (3), Small Headwater Marsh (5), and Medium-Sized Mid Reach Meandering (6) and Lake Outlet Reaches (9)*. The macroinvertebrate stream assemblage types appear to be highly associated with the physical, and chemical characteristics of the streams. To illustrate this association between macroinvertebrate taxa present at a stream reach and selected physical/chemical site parameters, the streams sampled in both the West Mountain WMA, and the Silvio Conte National Refuge were examined using CCA ordination. Figure 4 illustrates the stream sites sampled within both management areas arranged by the dominant macroinvertebrate taxa found at a site, with physical/chemical parameter vector arrows shown. All the running water macroinvertebrate community assemblage types found are common in Vermont. Figure 6 indicates an *estimate* of the general coverage of assemblage types based on known relationships between species assemblages and stream size and gradient. The map lines demarcating the assemblages should not be strictly interpreted. Any sampling of additional sites within the Nulhegan drainage would increase the accuracy of these lines and of the overall distribution of types.

The macroinvertebrate assemblage integrity was evaluated from 12 of the 17 stream reaches sampled for macroinvertebrates in the Silvio Conte Refuge. Table 11 presents the assessment and the biometrics used to evaluate the integrity of the macroinvertebrate assemblages. The assessments were made following the guidelines found in VTDEC (2001). This document has established biocriteria for three high gradient wadeable stream assemblage types. The stream reaches from the Silvio Conte National Refuge were assigned into an assemblage type based on stream size, elevation and alkalinity. Nine of the reaches were evaluated under the category and three the MHG 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 in 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 moderately-elevated Bio Index and PPCS-f from the North Branch Nulhegan River RM 10.5 and Yellow Branch Nulhegan River RM 7.6 may be due to the extensive wetlands upstream of these sites. It may also be partially related 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.

Nulhegan River Watershed
MacroInvertebrate Natural Communities Map



Map produced by L. Cadmus, VT ANR, July 20, 20

Table 11 Macroinvertebrate biometrics from all stream sites within The Silvio Conte Refuge of the Nulhegan Basin. The biological integrity from all wadeable riffle sites (MHG, SMG) sampled with a kick net method have been evaluated using the Vermont Biocriteria for wadeable streams. The corresponding assessment of excellent, very good, and good are equivalent to WQ stream Classification Type A1, B1, and B2-3, A2. The other sites reported here are: SHG= small high gradient, stream, MHG= medium high gradient mountain stream category and SW- mid-reach meandering ("slow-winder") stream. See explanation below for metric abbreviations.

Location	Station (RM)	Stream Category	Density	Richness	Ept	PMA orders	BI (0-10)	Oligo%	Ept/ EptChiro	PPCS funct. grps	Assessment
Tuffield Willey Brook	1.6	SHG	261	40.0	17.0	66	2.27	0.3	0.59	0.46	Good
Clay Hill Brook	6.2	SHG	1564	42.0	24.0	61	2.67	0.0	0.71	0.41	Very good
Clay Hill Brook	6.1	SW	1912	48.0	18.0		3.21	1.0	0.61		-
Stevens Brook	0.1	SW	391	45.0	10.0		7.04	0.8	0.59		-
Bluff Mountain Brook	0.1	SHG	1646	37.0	20.0	74	3.67	0.0	0.55	0.59	Very good
Palaeagapetus Brook	1.6	SHG	1565	45.5	20.0	77	2.84	0.1	0.82	0.55	Excellent
No.Branch Nulhegan River	10.5	SHG	840	37.0	20.0	58	4.43	0.1	0.77	0.35	Good
No.Branch Nulhegan River	0.8	SW	2612	50.0	20.0		2.56	0.0	0.91		-
Yellow Alder Brook	0.4	SHG	1660	39.0	17.0	82	1.84	0.2	0.82	0.43	Good
Yell. Branch Nulhegan R.	7.6	SHG	2464	47.0	20.0	68	4.04	1.0	0.77	0.42	Good
Yell. Branch Nulhegan R.	0.1	MHG	2916	53.0	25.0	69	3.18	0.0	0.88	0.61	Excellent
Logger Branch	1.4	SHG	1906	48.0	27.0	74	2.89	3.9	0.87	0.71	Excellent
Blk. Branch Nulhegan	13.2	SHG	1348	35.0	19.0	70	2.18	0.3	0.87	0.55	Excellent
Blk. Branch Nulhegan	2.3	MHG	1890	47.0	22.5	88	3.93	0.9	0.76	0.69	Very Good
Blk. Branch Nulhegan	0.1	MHG	501	50.0	12.0		5.35	0.5	0.30		-
Nulhegan River	11.0	MHG	1220	58.0	18.0		5.87	1.6	0.47		-
Nulhegan River	4.5	MHG	2390	46.5	23.0	71	3.56	0.3	0.83	0.51	Excellent
Class B threshhold		SHG	*>300*	*>27*	*>16*	*>45*	*<4.50*	*<12*	*>.45*	*>.40*	-
Class B threshhold		MHG	*>300*	*>30*	*>18*	*>45*	*<5.00*	*<12*	*>.45*	*>.40*	-

EPT- Mean Ephemeroptera-Plecoptera-Trichoptera species richness; PMA-Orders- Percent Model Affinity by insect order; BI- Biotic Index; Oligo % % of sample as oligochaete worms; EPT/EPT&C- ratio of EPT order to the generally tolerant Dipteran family Chironomidae; PPCS- func grps- Pinkam-Pearson Coefficient of similarity between feeding group type.

Standing Waters -Fish Assemblages (West Mountain WMA)

All ponds were As a group the sampled lakes are poorly-buffered with alkalinities from 2.1 to 15.6 mg/l. Acidities during the time period sampled were only slightly acidic to circumneutral however (6.18-7.15). All were considered moderately colored with tannic acids.(Appendix 10a). Dissolved oxygen profiles by depth were taken for six lakes (Appendices 10b and 10c). During the fall sampling, most ponds were well-oxygenated to the bottom with the exception of Wheeler Pond which exhibited near-anoxic conditions at depths below 4m. Winter dissolved oxygen levels were taken through the ice in February 2001. Concentrations were low under deep snow cover in South America, Unknown (Ferdinand), Paul Stream, Tuttle and West Mountain Ponds. Samples collected just before ice out were especially low (<2.0 mg./l) near the bottom of these lakes.

Nine ponds on, and adjacent to, the West Mountain Wildlife Management Area were sampled in the Fall of 2000 by the VTFW (Table 12). A total of 12 fish species were collected (Table 13). From one to four species were collected from each pond. Although all of these waters are considered cool to coldwater, brook trout were recorded only from Unknown Pond in Ferdinand. The remaining species are considered warmwater or eurythermal (tolerant of a wide range of temperature). While 11 of the 12 species are considered native to the Connecticut drainage, many of these natives may have been introduced through unauthorized stockings or "bait-bucket" releases. This would seem especially true for yellow perch and possibly pumpkinseed and common shiner. Golden shiner may have also been introduced to Unknown Pond. The bluntnose minnows collected from West Mountain Pond are non-native to the Connecticut drainage and may have been introduced via the bait-bucket by anglers. All species recorded from the ponds are considered to exhibit an abundant or common statewide distribution (Table 4).

Table 12. Location and physico-chemical measures at ten lakes, and two stream sites sampled for fish and Mollusca in and adjacent to the West Mountain Wildlife Management Area and Silvio Conte National Refuge.

Location	Town	Latitude-Longitude	Elevation (meters)	Lake Area (ha.)	Maximum Depth (m)
Paul Stream Pond	Brunswick	4441 / 7137	1025	8.1	3.1
South America Pond	Ferdinand	4442 / 7145	1747	11.7	1.6
Unknown Pond	Ferdinand	4440 / 7143	1667	4.9	4.3
West Mountain Pond	Maidstone	4441 / 7140	1235	24.3	3.7
Notch Pond	Ferdinand	4444 / 7143	1555	8.9	8.9
Dennis Pond	Brunswick	4444 / 7139	1030	74.9	0.9
Wheeler Pond	Brunswick	4443 / 7139	1028	26.7	10.7
Little Wheeler Pond	Brunswick	4443 / 7138	990	3.6	-
Tuttle Pond	Brunswick	4442 / 7138	994	5.7	-
Lewis Pond	Lewis	4453 / 7147	1830	27.4	2.4
Ferdinand Bog (Paul Stream 10.2)	Ferdinand	444023/714216	1460	-	-
Maidstone Lake	Maidstone	4439/7139	1303	301.5	37

Attempting to classify natural fish communities in lakes is problematic in Vermont. Since the 1860's, widespread and unrecorded dissemination of various native and non-native species has obscured the natural composition of native communities in these waters. As a result of this practice there exist few, if any, truly

reference-level lakes in Vermont from which to base a community classification scheme. The lakes and ponds sampled in and near the West Mountain Wildlife Management Area could probably be placed into either the "Dystrophic Lakes" or the "High-Elevation Lakes" category as defined by the Aquatic Classification Workgroup (1998).

Table 13. Fish collection data by sampling gear from lakes in the West Mountain Wildlife Management Area. Dashes indicate that the gear was not used. Number of nets set appears in parenthesis.

Lake	Species	Electroshocker	Gill Nets	Trap Nets	Minnow Traps
Paul Stream Pond[1]	White sucker	0	29 (*1*)	9 (*2*)	1 (*6*)
	Pumpkinseed	5	6	15	53
South America Pond	Yellow perch	0	69	25	6
	Blacknose dace	Abundant	-	0 (*2*)	3 (*8*)
	Northern redbelly dace	Abundant	-	0	1,310
	Brook trout	-	19 (*1*)	0 (*2*)	0 (*5*)
Unknown Pond	Golden shiner	-	0	62	10
	Northern redbelly dace	-	0	0	19
Notch Pond	Northern redbelly dace	-	0	-	66
Dennis Pond	Brown bullhead	4	-	-	-
	White sucker	2	-	-	-
	Creek chub	12	-	-	-
Wheeler Pond	Chain pickerel	-	0 (*2*)	2 (*2*)	1 (*6*)
	White sucker	-	1	4	0
	Yellow perch	-	0	3	0
	Pumpkinseed	-	0	23	0
Little Wheeler Pond	Brown bullhead	-	-	4 (*1*)	0 (*5*)
	White sucker	-	-	4	0
Tuttle Pond	Northern redbelly dace	-	-	0 (*1*)	22 (*5*)
	Common shiner	Present	-	-	-
West Mountain Pond	Creek chub	Present	-	5	Present
	Bluntnose minnow	Present	-	-	Present
	Golden shiner	Present	-	2	-
	Blacknose dace	Present	-	-	12
	White sucker	-	-	24	-

1 Electroshocking efficiency was low

Mollusca Survey -Standing and Running Waters

West Mountain Management Area

The Mollusca species found within the streams and lakes of the West Mountain WMA, and their common names are presented in Table 14. A total of 25 species were found; 15 Gastropoda (snails) and 10 Bivalvia (clams and mussels). None of the species are considered rare or endangered in Vermont. Most of the species are common and all are native to Vermont.

Two species may be considered as uncommon but widely spread in Vermont. The are the bugle sprite snail (*Micromenetus dilatatus)* found in Maidstone Lake, and to date found by VTDEC in 13 other locations in Vermont. This is a small species that will probably be found in more localities as further gastropod-specific surveys are completed. The other is the triangle floater mussel (*Alasmidonta undulata),* found in Dennis Pond. This species is reported as widely scattered in throughout the state by Fichtel and Smith (1995). The nearest population was reported from the Nulhegan watershed. It's host fish has been reported as the blacknose dace which is very common throughout this watershed as well as in the rest of the state.

The lakes generally had a greater number of Mollusca species then the streams. Dennis Pond had the greatest number of snail species (7), followed by Little Wheeler (5). Little Wheeler also had four bivalves giving it the highest number of Mollusca (9) altogether. Only 5 of the ten streams sampled contained Mollusca species, with Paul Stream RM 10.2 (actually Ferdinand bog) having the highest number of taxa (7) of all the streams. Paul Stream at this reach would be classified as a medium-sized, mid-reach meandering stream. Most of the stream reaches sampled were small high-gradient mountain streams that usually do not contain many Mollusca species.

Silvio Conte National Refuge

The Mollusca species found within the streams and lakes of the Silvio Conti NWR, and their common names are presented in **Table 15**. A total of 14 species were found: six Gastropoda (snails) and eight Bivalvia (Clam & mussels). The Eastern pearlshell mussel (*Margaritifera margaritifera),* found at RM 4.5 of the Nulhegan River, is listed as threatened in Vermont. No Mollusca found are listed as endangered. None of the species are Federally listed. Most of the species are common in Vermont and all are considered native to Vermont.

The Eastern pearlshell mussel was previously documented in the Nulhegan River by Fichtel and Smith (1995), who reported it as rare in the Nulhegan drainage. It was found in the Nulhegan river at mile 4.5, just below the Black Branch. The population was one of widely scattered individuals and may be described as low in abundance. The species prefers moderate gradient streams and rivers, cold water, and cobble/gravel/sand substrate reaches. The host fish species for the Eastern pearlshell are salmonids including the brook trout and brown trout. Both of these species are present in the lower Nulhegan, and throughout the watershed. The nearest Vermont population is found in the Moose River watershed.

The other uncommon Mollusca species collected is the buffalo pebblesnail (*Gilia altilis*), found at the Stevens Brook site. This is a snail which prefers slow moving sand/silt bottom rivers and streams. To date the VTDEC has only found populations in several large rivers and lakes (total of eight locations), all at low elevations in the Lake Champlain drainage, and Lake Champlain itself. Increased sampling would allow for a better determination of the relative rarity and distribution of this species in Vermont. Two reaches contained the majority of the Mollusca species. These were Nulhegan 4.5 (three snail and six clam/mussel) and Stevens Brook 0.1 (five snail and two clam). Both of these sites are low to moderate in gradient with silt/mud backwater areas, and macrophyte coverage. This type of stream reach should be further surveyed for Mollusca as they are likely to harbor the most diversity.

Table 14. The Mollusca taxa from the running and standing waters of the Paul Stream/Wheeler Stream watersheds, within the West Mountain WMA. Numbers following stream name are distance from mouth in river miles.

Common Name	Genus	Species	Dennis Pond	Little Wheeler Pond	Maidstone Lake	Notch Pond	Paul Stream Pond	South America Pond	Unknown Pond	West Mt. Pond	Wheeler Pond	Dennis Pond Brook 0.6	Paul Stream 4.8	Paul Stream 7.8	Paul Stream 10.2	Paul Stream 12.8
Gastropoda (Snails)																
Mud amnicola	*Amnicola*	*limosa*	X	X			X			X	X				X	
Pointed campeloma	*Campeloma*	*decisa*			X											
Fragile ancylid	*Ferrissia*	*californica*						X	X		X					
Creeping ancylid		*rivularis*											X			
Oblong ancylid		*parallela*	X						X						X	
Mimic lymnaea	*Pseudosuccinea*	*columella*	X	X			X			X						
Physa	*Physa*	*sp*	X												X	
Pewter physa		*heterostropha*	X													
Ashy physa		*gyrina*				X										
Ash gyro	*Gyraulus*	*parvus*	X	X												
Two-ridge rams-horn	*Helisoma*	*anceps*	X	X	X	X				X	X				X	
Bellmouth rams-horn		*campanulata*		X												
Marsh rams-horn		*trivovis*					X			X						
Bugle sprite	*Micromenetus*	*dilatatus*			X											
Sharp sprite	*Promenetus*	*exacuous*				X										
Bivalvia (Clams/mussels)																
Fingernail clams	*Musculium*	*securis*		X		X										
		lacustre						X								
Fingernail clams	*Pisidium*	*sp*		X						X	X	X		X	X	X
		casertanum		X	X		X		X		X	X	X		X	X
		punctatum									X					
		ventricosum														X
		nitidium										X				
		variable													X	
Triangle Floater	*Alasmidonta*	*undulata*	X													
Eastern Floater	*Pyganodon*	*cataracta*		X							X				X	
Easterm lamp mussel	*Elliptio*	*complanata*		X							X					

Table 15. The Crustacea, and Mollusca taxa from running and standing waters, of the Nulhegan watershed, within the Silvio Conti National Wildlife Refuge in the Nulhegan watershed . Numbers following stream name are distance from mouth in river miles.

Common Name	Genus	Species	Lewis Pond	Black Branch 0.1	Black Branch 2.3	Clay Hill Brook 6.1	E. Branch Nulhegan River 0.7	E. Branch Nulhegan River 9.9	Logger Branch 1.4	N. Branch Nulhegan River 0.8	N. Branch Nulhegan River 10.5	Nulhean River 4.5	Nulhegan River 11.0	Steven=s Branch 0.1	Yellow Alder Brook 0.4	Yellow Branch Nulhegan River 0.1	Yellow Branch Nulhegan River 7.6
Gastropoda (Snails)																	
Mud amnicola	*Amnicola*	*limosa*	X									X	X	X			
Buffalo pebblesnail	*Gillia*	*altilis*												X			
Creeping ancylid	*Ferrissia*	*rivularis*			X				X		X	X		X			
Fossaria snail	*Fossaria*	*sp*												X			
Rams-horn	*Helisoma*	*sp*												X			
Two-ridge rams-horn		*anceps*										X					
Marsh rams-horn		*trivolvis*			X												
Bivalvia (Clams/Mussels)																	
Fingernail clams	*Musculium*	*sp*								X							
	Pisidium	*sp*						X	X			X	X	X	X		X
		casertanum		X	X	X	X			X		X	X			X	X
		henslowanu								X							
		compressum										X					
		nitidium										X					
		ferrugineum										X					
		variable										X		X			
Eastern pearlshell	*Margaritifera*	*margaritifer*										X					

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Appendix 1. Numbers of fish captured in streams and rivers in and near the West Mountain Wildlife Management Area. Locations are given with miles from mouth as location and with length of section sampled by electrofishing run, or pass.

Location	Species	Run1	Run2	Total	Percent Composition
Paul Stream 3.1 (115m)	Atlantic Salmon	-	-	124	-
	Brook Trout	-	-	10	-
	Longnose Dace	-	-	Present	-
	Blacknose Dace	-	-	Present	-
	Longnose Sucker	-	-	Present	-
	Slimy Sculpin	-	-	Present	-
Paul Stream 10.2 (120 m)	Common Shiner	115	-	115	(Qualitative Sample)
	Creek Chub	104	-	104	
	Blacknose Dace	93	-	93	
	White Sucker	28	-	28	
	Longnose Dace	13	-	13	
	Redbelly Dace	8	-	8	
	Longnose Sucker	1	-	1	
	Phoxinus Hybrid	4	-	4	
	Finescale Dace	1	-	1	
	Golden Shiner	1	-	1	
Paul Stream 12.8 (120 m)	Creek Chub	53	-	53	41.7
	Blacknose Dace	44	-	44	34.6
	Common Shiner	23	-	23	18.1
	Brook Trout	3	-	3	2.4
	Redbelly Dace	2	-	2	1.6
	Longnose Sucker	1	-	1	0.8
	White Sucker	1	-	1	0.8
Paul Stream 14.5 (102 m)	Blacknose Dace	7	-	7	25.9
	Brook Trout	6	-	6	22.2
	Slimy Sculpin	6	-	6	22.2
	White Sucker	6	-	6	22.2
	Longnose Sucker	2	-	2	7.4
Granby Stream 0.1 (153 m)	Longnose Dace	53	67	120	34.8
	Blacknose Dace	65	48	113	32.8
	Slimy Sculpin	24	20	44	12.8
	White Sucker	20	24	44	12.8
	Atlantic Salmon	11	4	15	4.3
	Creek Chub	4	0	4	1.2
	Brook Trout	1	4	5	1.4

Appendix 1 continued.

Location	Species	Run1	Run2	Total	Percent Composition
Madison Brook 0.8 (123m)	Blacknose Dace	61	22	83	35.9
	Brook Trout	42	19	61	26.4
	White Sucker	23	22	45	19.5
	Longnose Dace	18	10	28	12.1
	Slimy Sculpin	7	7	14	6.1
North Branch Paul Stream 1.2 (85 m)	Brook Trout	34	8	42	100.0
Wheeler Stream 1.2 (103 m)	Blacknose Dace	31	-	31	24.2
	Longnose Dace	22	-	22	17.2
	Yellow Perch	19	-	19	14.8
	Common Shiner	19	-	19	14.8
	White Sucker	9	-	9	7.0
	Pumpkinseed	8	-	8	6.3
	Creek Chub	6	-	6	4.7
	Fallfish	6	-	6	4.7
	Redbelly Dace	5	-	5	3.9
	Brown Trout	1	-	1	0.8
	Golden Shiner	1	-	1	0.8
	Chain Pickerel	1	-	1	0.8
Dennis Pond Brook 0.6 (116 m)	Common Shiner	225	-	225	48.7
	Blacknose Dace	102	-	102	22.1
	Longnose Dace	60	-	60	13.0
	Fallfish	28	-	28	6.1
	Burbot	18	-	18	3.9
	Pumpkinseed	12	-	12	2.6
	White Sucker	6	-	6	1.3
	Redbelly Dace	5	-	5	1.1
	Brown Trout	1	-	1	0.2
	Bluntnose Minnow	1	-	1	0.2
	Creek Chub	2	-	2	0.4
	Brown Bullhead	1	-	1	0.2
	Yellow Perch	1	-	1	0.2
Notch Pond Brook 2.3 (80 m)	Brook Trout	26	6	32	97.0
	Blacknose Dace	1	0	1	3.0

Appendix 2. Lengths (mm) and weights (gm.) of salmonid species collected from running waters from the West Mountain Wildlife Management Area. Numbers following stream name are distance from mouth in river miles.

Location		Length-Weight
Notch Pond Brook	Brook trout	48, 51, 53, 54, 55, 55, 55, 58, 60, 60, 65, 65, 73, 79, 80, 93, 95, 95, 95, 98, 98, 101, 102, 103, 118, 123, 130, 135, 138, 140, 146, 146,
Wheeler Stream Brook	Brown trout	146-
Dennis Pond Brook	Brown trout	162-
North Branch Paul Stream 2.7	Brook trout	51-2, 52-2, 52-2, 54-2, 55-?, 56-2, 58-2, 62-2, 63-2, 63-2, 63-2, 65-3, 65-2, 65-5, 65-3, 67-3, 77-4, 78-5, 81-4, 81-4, 85-6, 86-8, 87-6, 87-5, 91-8, 91-8, 96-8, 97-10, 98-9, 100-6, 102-10, 103-9, 106-9, 106-7, 110-13, 111-18, 117-14, 118-12, 120-14, 130-24, 130-20, 144-23
Paul Stream 14.5	Brook trout	65-2, 65-6, 71-4, 81-6, 120-20, 122-20
Paul Stream 12.8	Brook trout	60-2, 68-2, 131-21
Madison Brook 0.8	Brook trout	57-2, 61-2, 62-2, 62-3, 63-4, 63-2, 64-3, 65-2, 65-3, 65-3, 65-2, 66-3, 67-2, 67-3, 67-3, 68-3, 68-3, 68-3, 68-4, 69-3 69-4, 69-3, 69-4, 70-3, 70-3, 70-3, 71-2, 71-4, 72-4, 72-4 73-4, 73-3, 73-5, 73-3, 75-4, 75-3, 76-3, 77-5, 78-5, 79-4, 79-5, 79-5, 81-6, 85-5, 85-6, 95-8, 96-8, 97-11, 102-0, 104-13, 104-11, 110-11, 112-16, 118-16, 125-23, 125-28, 126-20, 129-21, 142-27, 157-39, 217-118
Granby Stream 0.1	Brook trout	78-5, 82-5, 87-6, 89-7, 130-21
	Atlantic salmon	82-5, 82-6, 82-5, 87-7, 87-6, 89-7, 90-6, 90-8, 91-7, 92-9 92-8, 93-9, 94-9, 95-8, 95-9

Appendix 2, continued

Location		Length-Weight
Paul Stream 3.1	Brook trout	71-3, 89-7, 91-6, 93-8, 100-9,101-11, 102-10, 102-10, 102-11, 110-11
	Atlantic salmon	75-4, 90-6, 91-6, 92-6, 92-6, 92-7, 93-7, 94-8, 94-7, 94-7, 95-7, 95-7, 96-8, 96-8, 97-8, 98-8, 98-9, 98-8, 98-9, 99-8, 99-9, 99-9, 99-7, 99-8, 99-9, 100-7, 102-9, 102-9, 102-9, 102-9, 103-8, 104-10, 105-9, 105-10, 108-8, 113-13, 115-9 127-19, 127-194, 129-21, 132-21, 133-20, 134-24, 135-23, 136-22, 137-25, 137-25, 137-23, 138-27, 140-27, 140-29, 140-26, 141-26, 142-27, 143-30, 143-27, 143-28, 144-25, 144-24, 144-23, 144-25, 145-26, 145-24, 146-25, 146-25 147-29, 147-29, 147-32, 148-25, 148-30, 148-26, 148-27, 150-33, 151-26, 151-27, 151-28, 152-28, 152-31, 152-30, 153-29, 153-29, 153-33, 153-31, 153-31, 154-30, 154-33, 154-37, 154-33, 155-30, 156-31, 156-31, 156-33, 156-31, 156-29, 156-35, 156-36, 156-32, 157-31, 157-30, 157-32, 157-32, 157-38, 158-33, 158-31, 158-32, 158-37, 158-32, 159-32, 159-32, 159-37, 159-31, 162-33, 162-36, 163-37, 164-42, 165-36, 166-40, 166-37, 166-44, 167-46, 167-45, 167-42, 170-40, 174-48, 174-47, 175-46, 191-65, 197-70

Appendix 3. Second iteration of the Classification of Running Water Vermont Fish Assemblages, December 2000.

Assemblage Type	Biological Name	Mean Species Richness	Stream Type	Assemblage Rarity
1	*Brook trout*	1	Small coldwater, headwater streams	Abundant
2	*Brook trout-slimy sculpin*	2.6	Small coldwater , headwater streams	Abundant
3	*Blacknose dace-Slimy sculpin*	4.8	Small to medium-sized coldwater streams	Abundant
4a	*Blacknose dace-Bluntnose minnow*	10.0	Moderate-size to large warmwater, low gradient streams	Common
4b	*Blacknose dace-Creek chub*	7.2	Small warmwater and small to large coldwater, low gradient streams	Common
4c	*Tessellated darter-Fallfish*	6.7	Moderate to large coldwater low gradient streams	Moderately Rare
5	*Blacknose dace-Slimy sculpin*	7.8	Moderate sized coldwater streams to moderate sized coldwater rivers	Common
6	*White sucker-Tessellated darter*	11.7	Moderate sized warmwater streams to moderate sized warmwater rivers	Common
7	*Atlantic Salmon-American Shad*	>20	Lower Connecticut River (warmwater ,coldwater) to Bellows Falls	Rare (1)
8	*Redhorse-Lake sturgeon*	>20	Large warmwater tributaries to Lake Champlain below the fall line	Rare ? (6)

Appendix 4. Macroinvertebrate taxa from stream reaches in the Paul Stream/Wheeler Stream watersheds within the West Mountain Wildlife Management Area. The number following the stream name is the distance from mouth in river miles.

Common Name	Family /Genus	Species	North Branch Paul Stream 2.7	Paul Stream 12.8	Madison Brook 0.8	Paul Stream 7.8	Granby Stream 0.1	Paul Stream 4.8	Dennis Pond Brook 0.6	Paul Stream 10.2
Coleoptera (Beetles)										
Riffle beetles	*Elmidae*									
	Microcylloepus	*pusillus*							X	
	Dubiraphia	*quadrinotata*								X
	Optioservus	*sp.*			X	X				
	Optioservus	*trivittatus*						X		
	Optioservus	*ovalis*			X	X				
	Oulimnius	*latiusculus*			X		X	X	X	
	Promoresia	*tardella*	X	X	X	X	X	X	X	
	Stenelmis	*sp.*							X	
Water pennies	*Psephenidae*									
	Ectopria	*sp.*								
	Ectopria	*nervosa*					X	X	X	
	Psephenus	*herricki*							X	
Diptera (True flies)										
Watersnipe	*Atherix*	*sp.*		X	X	X			X	
Biting midges (No-see-ums)	*Ceratopogonidae*									
	Bezzia	*group*		X	X	X	X	X	X	
	Mallochohelea	*sp.*		X						
	Probezzia	*sp.*		X						
Midges	*Chironomidae*									
	Brillia	*sp.*		X						
	Cardiocladius	*sp.*				X				
	Cricotopus	*sp.*		X		X	X	X	X	
	Diamesa	*sp.*	X	X	X				X	
	Epoicocladius	*sp.*		X						
	Eukiefferiella	*devonica*							X	
	Eukiefferiella	*brehmi*	X							
	Eukiefferiella	*claripennis*		X	X					
	Heterotrissocladius	*sp.*								
	Microtendipes	*sp.*				X	X	X		
	Odontomesa	*sp.*		X						
	Orthocladius	*sp.*				X			X	
	Pagastia	*sp.*	X	X				X		
	Nanocladius	*sp.*				X	X	X		

Appendix 4 cont.

Common Name	Family / Genus	Species	North Branch Paul Stream 2.7	Paul Stream 12.8	Madison Brook 0.8	Paul Stream 7.8	Granby Stream 0.1	Paul Stream 4.8	Dennis Pond Brook 0.6	Paul Stream 10.2
Diptera (True Flies)										
Midges	*Parachaetocladius*	*sp.*	X						X	
	Parametriocnemus	*sp.*	X	X			X	X	X	
	Polypedilum	*illionoense*						X		
	Polypedilum	*scalaenum*		X						
	Polypedilum	*aviceps*	X	X	X	X	X	X	X	
	Potthastia	*gaedii*				X				
	Potthastia	*longimana*			X				X	
	Procladius	*sp.*		X						
	Rheocricotopus	*sp.*		X	X					
	Rheotanytarsus	*distinctissimus*		X	X	X	X		X	
	Stempellina	*sp.*		X	X	X				
	Stempellinella	*sp.*					X			
	Synorthocladius	*sp.*			X					
	Thienemanniella	*sp.*			X					
	Thienemannemyia	*group*	X	X	X	X	X	X	X	
	Tvetenia	*discoloripes*				X	X	X	X	
	Tvetenia	*bavarica*	X	X	X	X	X	X	X	
	Zavrelimyia	*sp.*			X					
	Micropsectra	*sp.*	X		X	X	X	X	X	
	Symposiocladius	*sp.*		X						
	Xylotopos	*sp.*		X						
	Apsectrotanypus	*sp.*		X						
	Lopescladius	*sp.*				X		X	X	
Aquatic dance flies	*Empididae*	*unid*	X	X	X			X	X	
Moth flies	*Psychodidae*									
	Pericoma	*sp.*	X							
	Palaeodipteron	*sp.*			X					
Black flies	*Simulidae*									
	Simulium	*fibrinflatum*		X						
	Simulium	*tubersom*	X	X	X		X		X	
	Simulium	*vittatum*		X						
Horseflies	*Tabanidae*									
	Chrysops	*sp.*		X						
Crane flies	*Tipulidae*									
	Antocha	*sp.*	X		X		X	X		
	Dicranota	*sp.*	X		X	X			X	
	Hexatoma	*sp.*	X	X	X	X	X	X		
	Tipula	*sp.*	X	X						

Appendix 4 cont.

Common Name	Family / Genus	Species	North Branch Paul Stream 2.7	Paul Stream 12.8	Madison Brook 0.8	Paul Stream 7.8	Granby Stream 0.1	Paul Stream 4.8	Dennis Pond Brook 0.6	Paul Stream 10.2
			Ephemeroptera (Mayflies)							
Small minnow mayflies	*Baetidae*	*imm*	X	X	X	X	X	X	X	
	Baetis	*sp.*	X		X	X	X			
	Baetis	*flavistriga*	X	X	X	X	X	X		
	Baetis	*intercalaris*				X	X		X	
	Baetis	*tricaudatus*	X		X		X	X		
	Acentrella	*sp.*			X	X	X	X	X	
	Acentrella	*turbida*			X	X	X	X	X	
Small squaregills	*Caenidae*									
	Caenis	*sp.*		X						
Spiny crawlers	*Ephemerellidae*	*imm*	X	X	X	X	X	X	X	
	Ephemerella	*sp.*			X					
	Ephemerella	*subvaria*				X	X	X		
	Ephemerella	*Invar/Rotun*	X		X					
	Eurylophella	*funeralis*		X	X					
Common burrowers	*Ephemeridae*									
	Hexagenia	*limbata*		X						
Flathead mayflies	*Heptageniidae*	*imm.*	X		X	X	X	X	X	
	Epeorus	*sp.*	X		X	X	X	X		
	Rhithrogena	*sp.*	X		X					
	Stenonema	*sp.*						X	X	
	Stenonema	*luteum*				X	X			
Prong gills	*Leptophlebiidae*	*unid*	X	X	X	X	X			
	Paraleptophlebia	*sp.*						X	X	
Brushlegged mayflies	*Oligonouridae*									
	Isonychia	*sp.*					X	X		
Primitive minnow mayflies	*Siphlonuridae*	*unid*		X						

Appendix 4 cont.

Common Name	Family / Genus	Species	North Branch Paul Stream 2.7	Paul Stream 12.8	Madison Brook 0.8	Paul Stream 7.8	Granby Stream 0.1	Paul Stream 4.8	Dennis Pond Brook 0.6	Paul Stream 10.2
Trichoptera (Caddisfly)										
Humpless case makers	*Brachycentridae*									
	Brachycentrus	*numerosus*				X	X	X		
	Micrasema	*wataga*							X	
Saddlecase makers	*Glossosomidae*									
	Glossosoma	*sp.*	X		X	X	X	X	X	
Snailcase makers	*Helicopsychidae*									
	Helicopsyche	*borealis*					X		X	
Common netspinners	*Hydropsychidae*									
	Arctopsyche	*ladogensis*			X					
	Cheumatopsyche	*sp.*				X	X	X	X	
	Parapsyche	*apicalis*	X							
	Symphitopsyche	*bronta*					X			
	Symphitopsyche	*morosa*				X	X	X		
	Symphitopsyche	*alhedra*			X				X	
	Symphitopsyche	*slossonae*			X	X	X			
	Symphitopsyche	*sparna*	X		X	X	X	X	X	
Micro caddisfliies	*Hydroptilidae*									
	Hydroptila	*sp.*		X		X		X		
Lepidostomid case makers	*Lepidostomatidae*									
	Lepidostoma	*sp.*	X		X	X	X	X	X	
	Mystacides	*sp.*		X						
	Oecetis	*sp.*							X	
Northern case makers	*Limnephilidae*									
	Apatania	*sp.*	X		X		X			
	Hydatophylax	*sp.*		X						
Finger-net caddisflies	*Philopotamidae*									
	Chimarra	*aterrima*							X	
	Dolophilodes	*sp.*	X		X	X	X	X	X	
Large caddisflies	*Phryganeidae*									
	Ptilostomis	*sp.*		X						
Tube-making caddisflies	*Polycentropodidae*									
	Polycentropus	*sp.*			X	X	X			
Primitive caddisflies	*Rhyacophilidae*									
	Rhyacophila	*fuscula*	X		X	X	X	X		

Appendix 4 cont.

Common Name	Family / Genus	Species	North Branch Paul Stream 2.7	Paul Stream 12.8	Madison Brook 0.8	Paul Stream 7.8	Granby Stream 0.1	Paul Stream 4.8	Dennis Pond Brook 0.6	Paul Stream 10.2
Trichoptera (Caddisflies)										
Primitive caddisflies	*Rhyacophila*	*melita*				X	X	X		
	Rhyacophila	*carolina*	X							
	Rhyacophila	*fenestra*			X					
	Rhyacophila	*minora*	X					X		
	Rhyacophila	*carpenteri*								
	Rhyacophila	*acutiloba*	X		X	X	X	X		
	Rhyacophila	*carolina grp*	X		X					
	Uenoidae									
	Neophylax	*nacatus*			X					
Plecoptera (Stoneflies)										
Slender winter stoneflies	*Capniidae*	*imm*				X		X		
Green stoneflies	*Chloroperlidae*	*imm*	X		X	X	X	X		
	Sweltsa	*sp.*	X							
Rolledwinged stoneflies	*Leuctridae*	*imm*	X		X	X	X	X		
Nemourid broadbacks	*Nemouridae*	*imm*				X				
Roachlike Stoneflies	*Peltoperlidae*									
	Peltoperla	*sp.*	X		X					
Common stoneflies	*Perlidae*	*unid*				X				
	Acroneuria	*sp.*				X				
	Acroneuria	*abnormis*					X	X	X	
	Paragnetina	*sp.*					X			
	Paragnetina	*media*				X	X		X	
	Paragnetina	*immarginata*				X		X	X	
	Agnetina	*capitata*			X	X	X			
Perlodid stoneflies	*Perlodidae*									
	Isoperla	*sp.*	X	X	X	X	X			
	Malirekus	*sp.*	X							
Giant stoneflies	*Pteronacrcyidae*									
	Pteronarcys	*biloba*				X	X	X		
	Pteronarcys	*proteus*	X		X	X				
Taeniopterygid broadbacks	*Taeniopterygidae*									
	Taeniopteryx	*sp.*		X	X					
	Pteronarcys	*sp.*	X						X	

Appendix 4 cont.

Common Name	Family / Genus	Species	North Branch Paul Stream 2.7	Paul Stream 12.8	Madison Brook 0.8	Paul Stream 7.8	Granby Stream 0.1	Paul Stream 4.8	Dennis Pond Brook 0.6	Paul Stream 10.2
Odonata (Dragonflies and Damselflies)										
Blue darners	*Aeshna*	*sp.*								X
Stream darner	*Boyeria*	*vinosa*		X				X	X	
Bandwings	*Calopteryx*	*sp.*		X						
Biddies	*Cordulegaster*	*sp.*		X						
Clubtails	*Gomphidae*	*imm*	X	X				X		
Common clubtails	*Gomphus*	*sp.*								X
Snake darners	*Ophiogomphus*	*sp.*						X	X	
Megaloptera (Alderflies and Fishflies										
Fishflies	*Nigronia*	*sp.*				X	X	X		
Alderflies	*Sialis*	*sp.*								X
Gastropoda (Snails)										
Mud amnicola	*Amnicola*	*limosa*								X
Oblong ancylid	*Ferrissia*	*parallela*								X
Creeping ancylid	*Ferrissia*	*rivularis*						X		
Physa snail	*Physa*	*sp.*								X
Two-ridge rams-horn	*Helisoma*	*anceps*								X
Bivalvia (Mussels and Clams)										
Fingernail clams	*Pisidium*	*sp.*		X		X			X	X
	Pisidium	*casertanum*		X	X			X	X	X
	Pisidium	*variable*								X
	Pisidium	*ventricosum*		X						
Eastern floater	*Pyganodon*	*cataracta*								X
Tricladida (Flatworms)										
	Cura	*sp.*							X	
Gordida (Horsehair Worms)										
	Gordius	*sp.*						X		
Oligochaeta (Aquatic Segmented Worms)										
	Lumbriculidae	*unid*			X	X	X	X		
	Enchytraeidae	*unid*						X		
Hydrachnidia (Watermites)										
	Limnocharidae	*unid*			X				X	
Hemiptera (True Bugs)										
Water striders	*Gerris*	*sp.*			X					
Shortlegged striders	*Microvelia*	*sp.*				X				

Appendix 5. The percent composition of the substrate, percent embeddedness range and percent canopy cover for all macroinvertebrate stream/river sampling areas within the West Mountain WMA.

Location	RM[1]	Ledge %	Boulder %	Cobble %	Cgravel %	Gravel %	Sand %	Silt %	Embed-dedness %	Canopy %
North Branch Paul Stream	2.7	0	45	29	21	0	5	0	5-25	80
Paul Stream*	12.8	0	0	0	0	0	50	50	NA	50
Madison Brook	0.8	0	48	7	26	19	0	0	5-25	80
Paul Stream	7.8	0	48	33	10	4	5	0	5-25	60
Granby Stream	0.1	4	50	26	19	0	1	0	0-5	50
Paul Stream	4.8	0	14	50	20	14	2	0	5-25	50

1. RM- river mile-distance from mouth.

* Substrate composition for this sample is based on observational estimate, all others are based on 100 pebble count method.

Appendix 6. Numbers of fish captured in streams and rivers in and near the Silvio Conte National Refuge. Locations are given by distance from mouth in river miles followed by (distance of stream section fished). Numbers of fish are given by electrofishing run ,or pass.

Location	Species	Run1	Run2	Total	% Composition
Nulhegan River 11.0 (115 m)	Fallfish	11	-	11	35.5
	Chain Pickerel	5		5	16.1
	White Sucker	5	-	5	16.1
	Longnose Dace	3	-	3	9.7
	Tessellated Darter	3	-	3	9.7
	Blacknose Dace	1	-	1	3.2
	Brown Bullhead	1	-	1	3.2
	Brown Trout	1	-	1	3.2
	Burbot	1	-	1	3.2
North Branch Nulhegan River 0.9 (154 m)	Blacknose Dace	7	-	7	36.8
	Creek Chub	7	-	7	36.8
	Longnose Dace	2	-	2	10.5
	Brook Trout	1	-	1	5.3
	Burbot	1	-	1	5.3
	White Sucker	1	-	1	5.3
No. Br. Nulhegan River 12.5 (130 m)	Blacknose Dace	46	13	59	59.6
	Brook Trout	31	9	40	40.4
Tim Carroll Brook 1.6 (112 m)	Brook Trout	33	19	52	100.0
Stevens Brook 0.1 (107 m)	Common Shiner	11	-	11	34.4
	Fallfish	10	-	10	31.3
	Tessellated Darter	4	-	4	12.5
	White Sucker	3	-	3	9.4
	Chain Pickerel	2	-	2	6.3
	Golden Shiner	1	-	1	3.1
	Longnose Dace	1	-	1	3.1
Yellow Branch Nulhegan River 7.6 (75 m)	Blacknose Dace	35	-	35	71.4
	Creek Chub	14	-	14	28.6
Yellow Alder Brook 0.4 (40 m)	Blacknose Dace	2	-	2	Qualitative
	Lake Chub	1	-	1	Sample
Black Branch Nulhegan River 13.2 (120 m)	Brook Trout 33		13	46	100.0
Logger Branch 1.4 (102 m)	Brook Trout	10	-	10	30.3
	Blacknose Dace	9	-	9	27.3
	Longnose Sucker	7	-	7	21.2
	Creek Chub	4	-	4	12.1
	Slimy Sculpin	2	-	2	6.1
	Longnose Dace	1	-	1	3.0

Appendix 6 cont.

Black Branch Nulhegan 8.4 (130 m)	Blacknose Dace	3	-	3	42.9
	Creek Chub	2	-	2	28.6
	Brook Trout	1	-	1	14.3
	Longnose Dace	1	-	1	14.3
Black Branch Nulhegan 0.1 (208 m)	Tessellated Darter	32	-	32	40.5
	Blacknose Dace	16	-	16	20.3
	Common Shiner	16	-	16	20.3
	Creek Chub	6	-	6	7.6
	Longnose Dace	5	-	5	6.3
	White Sucker	4	-	4	5.1
Nulhegan River 1.8 (106 m)	Atlantic Salmon	16	9	25	-
	Brook Trout	1	0	1	-
	Brown Trout	2	1	3	-
	Rainbow Trout	1	1	2	-
	Longnose Dace	-	-	Present	-
	Blacknose Dace	-	-	Present	-
	Slimy Sculpin	-	-	Present	-
	Longnose sucker	-	-	Present	-
	Burbot	-	-	Present	-

Appendix 7. Lengths (mm) and weights (gms) of salmonid species collected from running waters from the Silvio Conte National Wildlife Refuge holdings in the Nulhegan basin and the West Mountain Wildlife Management Area.. Numbers following stream name are distance from mouth in river miles.

Location/Species		Length - Weight
Nulhegan River 11.0	Brown trout	190-72
N. Branch Nulhegan River 0.9	Brook trout	110
N. Branch Nulhegan River 12.5	Brook trout	58-3, 60-2, 62-6, 64-6, 65-4, 66-3, 68-4, 69-2, 70-6, 70-8 70-4, 70-3, 72-6, 73-3, 73-5, 74-4, 78-8, 98-13, 102-12, 106-15, 106-15, 113-14, 120-20, 128-21, 130-20, 139-22, 144-25, 180-62, 180-58, 183-63, 252-169
Tim Carroll Brook 1.6	Brook trout	51-2, 52-2, 53-2, 53-2, 55-2, 56-2, 58-2, 60-3, 62-3, 65-4, 74-9, 74-7, 89-6, 90-10, 93-8, 94-8, 94-9, 95-8, 95-10, 95-9 96-11, 100-12, 100-6, 102-12, 104-12, 105-12, 106-10, 107-10, 108-11, 130-24, 132-28, 152-36, 209-96
Black Branch Nulhegan River	Brook trout	61-3, 69-3, 69-4, 71-3, 75-4, 75-4, 77-5, 78-5, 79-6, 79-5 80-7, 82-6, 85-8, 86-6, 87-7, 90-8, 93-9, 94-8, 96-10, 96-10 96-7, 97-7, 100-13, 100-9, 103-10, 103-12, 103-11, 104-11 105-11, 107-12, 109-13, 112-14, 112-13, 112-17, 112-12 115-15, 116-17, 117-17, 120-17, 121-18, 129-22, 129-21 130-21, 130-21, 151-38, 159-46
Black Branch Nulhegan River 8.4	Brook trout	122-13
Logger Branch 1.4	Brook trout	63-4, 66-4, 67-3, 70-4, 71-4, 72-4, 76-6, 136-25, 147-28 148-40
Nulhegan River 1.8	Atlantic salmon	72-3, 75-3, 76-3, 77-3, 75-3, 79-4, 80-4, 80-4, 81-4, 81-5, 81-4, 82-4, 82-5,82-4 84-5, 86-5, 86-5 88-5, 89-5, 91-6, 92-7, 92-6, 129-17, 131-18, 131-20, 132-21, 135-21, 158-32, 163-37, 208-87
	Brown trout	81-5
	Rainbow trout	76-4

Appendix 8: Macroinvertebrate taxa from stream reaches in the Nulhegan River watersheds within the Nulhegan drainage in the Silvio Conte National Refuge. Numbers following stream name are distance from mouth in river miles.

Common Name	Family / Genus	Species	Clay Hill Brook 6.2	Clay Hill Brook 6.1	Tuffield Willey Brook 1.6	Stevens Brook 0.1	Palaeagapetus Brook 1.6	Bluff Mtn. Brook 0.1	N. Br. Nulhegan River 10.5	N. Br. Nulhegan River 0.9*	Yellow Br. Nulhegan R. 7.6	Yellow Alder Brook 0.4	Yellow Br. Nulhegan R. 0.1	Black Br. Nulhegan R. 13.2	Black Br. Nulhegan R. 2.3	Logger Branch 1.4	Black Br. Nulhegan R. 0.1	Nulhegan River 11.0	Nulhegan River 4.5
Coleoptera (Beetles)																			
Aquatic leaf beetles	*Chrysomelidae*	*unid*														X			
Riffle beetles	*Elmidae*																		
	Ancyronyx	*variegata*																X	
	Dubiraphia	*sp*				X				X								X	
	Dubiraphia	*quadrinotata*				X											X	X	
	Dubiraphia	*minima*																X	
	Macronychus	*glabratus*											X					X	X
	Optioservus	*sp*								X	X	X	X		X	X			X
	Optioservus	*trivittatus*													X				X
	Optioservus	*ovalis*					X							X					X
	Oulimnius	*latiusculus*	X	X	X		X	X				X		X		X			
	Promoresia	*tardella*	X	X			X	X	X	X	X	X	X	X		X	X		X
	Stenelmis	*sp*									X		X						X
	Stenelmis	*crenata*											X						X
Whirligig beetles	*Gyrinidae*																		
	Gyrinus	*sp*				X													
Water pennies	*Psephenidae*																		
	Ectopria	*leechi*														X			X
	Ectopria	*nervosa*											X						
Predaceous diving beetles	*Dytiscidae*																		
	Dytiscus	*verticalis*																X	
	Hydroporus	*sp*																X	
Crawling water beetles	*Haliplidae*																		
	Haliplus	*pantherinus*																X	
	Haliplus	*connexus*																X	
Water weevils	*Curculionidae*	*unid*					X	X				X							
Rove beetles	*Staphylinidae*	*unid*					X												
Diptera (True fly)																			
Westersnipes	*Atherix*	*sp*	X					X	X			X		X		X			X
Biting midges (No-see-ums)	*Ceratapogonidae*																		
	Bezzia	*group*		X	X		X	X	X	X			X		X	X	X	X	X
	Probezzia	*sp*				X				X							X	X	

Appendix 8 cont.

Common Name	Family / Genus	Species	Clay Hill Brook 6.2	Clay Hill Brook 6.1	Tuffield Willey Brook 1.6	Stevens Brook 0.1	Palaeagapetus Brook 1.6	Bluff Mtn. Brook 0.1	N. Br. Nulhegan River 10.5	N. Br. Nulhegan River 0.9*	Yellow Br. Nulhegan R. 7.6	Yellow Alder Brook 0.4	Yellow Br. Nulhegan R. 0.1	Black Br. Nulhegan R. 13.2	Black Br. Nulhegan R. 2.3	Logger Branch 1.4	Black Br. Nulhegan R. 0.1	Nulhegan River 11.0	Nulhegan River 4.5
		Diptera (True Flies)																	
Midges	*Chironomidae*	*unid*					X												
	Orthocladiinae	*unid*			X		X												
	Ablabesmyia	*sp*															X		
	Brillia	*sp*			X			X				X							
	Cladotanytarsus	*sp*				X				X		X							
	Clinotanypus	*sp*				X													
	Corynoneura	*sp*		X	X		X	X							X			X	
	Cricotopus	*sp*						X		X			X		X		X		X
	Cricotopus	*bisinctus*				X		X					X				X		
	Cricotopus	*trifascia*												X					
	Cryptochironomus	*sp*				X				X							X	X	
	Diamesa	*sp*	X				X												
	Eukiefferiella	*devonica*	X																X
	Eukiefferiella	*brehmi*					X	X	X					X	X				
	Eukiefferiella	*claripennis*	X											X		X			
	Heleniella	*sp*		X															
	Heterotrissocladius	*sp*		X												X			
	Labrundinia	*sp*				X											X	X	
	Limnophyes	*sp*			X	X													
	Macropelopia	*sp*		X															
	Microtendipes	*sp*			X					X	X		X		X		X		X
	Nanocladius	*sp*															X	X	
	Nilothauma	*sp*													X		X		X
	Nilothauma	*baybyii*											X						
	Orthocladius	*sp*													X	X			
	Pagastia	*sp*	X					X	X	X	X		X		X				
	Parachaetocladius	*sp*		X	X		X				X								X
	Parametriocnemus	*sp*	X	X	X	X	X	X			X	X	X	X	X	X			X
	Polypedilum	*fallax*			X														
	Polypedilum	*illionoense*	X							X	X						X		X
	Polypedilum	*scalaenum*								X							X		
	Polypedilum	*aviceps*	X				X	X	X		X			X	X	X	X		X
	Polypedilum	*halterale*		X															
	Potthastia	*gaedii*																	

Appendix 8 cont.

Common Name	Family / Genus	Species	Clay Hill Brook 6.2	Clay Hill Brook 6.1	Tuffield Willey Brook 1.6	Stevens Brook 0.1	Palaeagapetus Brook 1.6	Bluff Mtn. Brook 0.1	N. Br. Nulhegan River 10.5	N. Br. Nulhegan River 0.9*	Yellow Br. Nulhegan R. 7.6	Yellow Alder Brook 0.4	Yellow Br. Nulhegan R. 0.1	Black Br. Nulhegan R. 13.2	Black Br. Nulhegan R. 2.3	Logger Branch 1.4	Black Br. Nulhegan R. 0.1	Nulhegan River 11.0	Nulhegan River 4.5
			Diptera (True Flies)																
Midges, continued	*Potthastia*	*longimana*																	X
	Procladius	*sp*				X											X	X	
	Psectrocladius	*sp*		X											X				
	Rheocricotopus	*sp*		X	X		X	X	X		X	X		X		X		X	X
	Rheotanytarsus	*sp*				X										X			
	Rheotanytarsus	*distinctissimus*	X						X	X	X	X	X				X	X	X
	Stempellina	*sp*		X						X			X		X				
	Stempellinella	*sp*			X	X							X		X		X	X	
	Stenochironomus	*sp*									X				X		X		
	Sublettea	*sp*													X				
	Synorthocladius	*sp*		X	X														
	Tanytarsus	*sp*								X							X	X	
	Thienemanniella	*sp*	X	X	X		X	X						X			X	X	
	Thienemannemyia	*group*		X	X	X		X	X	X	X	X	X		X	X	X	X	X
	Tribelos	*sp*															X	X	
	Tvetenia	*discoloripes*							X				X		X	X	X		X
	Tvetenia	*bavarica*	X	X	X		X	X	X	X	X	X	X	X	X	X			X
	Micropsectra	*sp*	X	X	X		X	X	X		X	X	X	X		X			X
	Symposiocladius	*sp*					X									X	X		
	Paralimnophyes	*sp*			X														
	Saetheria	*sp*				X													
	Xylotopos	*sp*															X		
	Brundiniella	*sp*		X															
	Lopescladius	*sp*													X				
	Rheosmittia	*sp*				X													
Dixid midges	*Dixidae*																		
	Dixa	*sp*			X		X	X											
Aquatic longlegged flies	*Dolichopodidae*	*unid*			X														
Aquatic dance flies	*Empididae*	*unid*			X		X	X		X	X	X	X		X	X	X	X	X
Aquatic muscids	*Muscidae*	*unid*																X	
Moth flies	*Psychodidae*																		
	Pericoma	*sp*					X									X			
	Pericoma	*albitarsis*					X												

Appendix 8 cont.

Common Name	Family / Genus	Species	Clay Hill Brook 6.2	Clay Hill Brook 6.1	Tuffield Willey Brook	Stevens Brook 0.1	Palaeagapetus Brook 1.6	Bluff Mtn. Brook 0.1	N. Br. Nulhegan River 10.5	N. Br. Nulhegan River 0.9*	Yellow Br. Nulhegan R. 7.6	Yellow Alder Brook 0.4	Yellow Br. Nulhegan R. 0.1	Black Br. Nulhegan R. 13.2	Black Br. Nulhegan R. 2.3	Logger Branch 1.4	Black Br. Nulhegan R. 0.1	Nulhegan River 11.0	Nulhegan River 4.5
Diptera (True Flies)																			
Waternymph flies	*Nymphomyiidae*																		
	Palaeodipteron	*sp*							X										
Blackflies	*Simulidae*																		
	Simulium	*fibrinflatum*									X	X							
	Simulium	*jenningsi*				X				X								X	X
	Simulium	*tubersom*	X		X		X	X	X		X	X	X	X	X	X		X	X
	Simulium	*vittatum*									X	X							
Horse flies	*Tabanidae*	*unid*								X									
	Chrysops	*sp*		X		X											X	X	
Crane flies	*Tipiludiae*																		
	Antocha	*sp*	X				X	X	X		X		X						
	Cryptolabis	*sp*			X														
	Dicranota	*sp*	X	X	X		X	X	X		X	X	X			X			
	Hexatoma	*sp*	X	X	X		X	X	X	X			X	X	X	X		X	X
	Pseudolimnophila	*sp*		X		X													
	Rhabdomastix	*sp*										X							
	Tipula	*sp*		X	X		X				X	X							
	Molophilus	*sp*																X	
Ephemeroptera (Mayflies)																			
Small minnow mayflies	*Baetidae*	*imm*	X			X	X	X	X	X			X	X	X	X	X	X	X
	Baetis	*sp*		X		X		X	X		X		X	X		X	X		
	Baetis	*flavistriga*	X						X				X	X	X	X			X
	Baetis	*intercalaris*											X		X	X	X		X
	Baetis	*pluto*							X										
	Baetis	*tricaudatus*	X		X		X	X	X		X			X		X			X
	Acentrella	*sp*	X					X	X					X	X	X			X
	Acentrella	*turbida*							X				X		X	X			X
Shieldback mayflies	*Baetiscidae*																		
	Baetisca	*sp*								X							X	X	
Spiny crawlers	*Ephemerellidae*	*imm*	X	X		X	X	X	X	X	X		X	X	X	X		X	X
	Ephemerella	*sp*							X								X		
	Ephemerella	*dorothea*		X															
	Ephemerella	*subvaria*											X		X	X			X
	Ephemerella	*Invar/rotun grp*	X	X			X	X						X					
	Eurylophella	*sp*		X	X					X							X		

Appendix 8 cont.

Common Name	Family / Genus	Species	Clay Hill Brook 6.2	Clay Hill Brook 6.1	Tuffield Willey Brook	Stevens Brook 0.1	Palaeagapetus Brook 1.6	Bluff Mtn. Brook 0.1	N. Br. Nulhegan River 10.5	N. Br. Nulhegan River 0.9*	Yellow Br. Nulhegan R. 7.6	Yellow Alder Brook 0.4	Yellow Br. Nulhegan R. 0.1	Black Br. Nulhegan R. 13.2	Black Br. Nulhegan R. 2.3	Logger Branch 1.4	Black Br. Nulhegan R. 0.1	Nulhegan River 11.0	Nulhegan River 4.5
	Eurylophella	*funeralis*		X					X		X	X					X		
Common burrowers	*Ephemeridae*																		
Flathead mayflies	*Heptageniidae*	*unid*		X	X		X	X	X	X	X		X	X	X	X		X	X
	Epeorus	*sp*					X	X	X					X	X				X
	Rhithrogena	*sp*	X				X	X	X					X		X			X
	Stenonema	*sp*						X		X	X		X					X	X
	Stenonema	*luteum*								X	X		X		X	X			
Pronggills	*Leptophlebiidae*	*unid*	X				X	X	X		X	X	X				X	X	X
	Paraleptophlebia	*sp*				X				X				X	X	X			
Brushlegged mayflies	*Oligonouriidae*																		
	Isonychia	*sp*																	X
Primitive minnow mayflies	*Siphlonuridae*	*unid*				X												X	
	Ameletus	*sp*			X														
Little stout crawlers	*Tricorythidae*																		
	Tricorythodes	*sp*								X					X		X		
Trichoptera (Caddisflies)																			
Humpless case makers	*Brachycentridae*																		
	Brachycentrus	*americanus*	X									X							
	Brachycentrus	*lateralis*																X	
	Brachycentrus	*numerosus*				X			X						X				X
	Micrasema	*sp*									X		X	X		X		X	
	Micrasema	*rusticum*	X																
Saddlecase makers	*Glossosomatidae*																		
	Glossosoma	*sp*	X					X	X				X		X	X			X
Snailcase makers	*Helicopsychidae*																		
	Helicopsyche	*borealis*											X		X				X
Common netspinners	*Hydropsychidae*																		
	Arctopsyche	*ladogensis*		X				X	X										
	Cheumatopsyche	*sp*								X	X		X		X	X	X	X	X
	Diplectrona	*modesta*										X							
	Hydropsyche	*betteni*				X													
	Hydropsyche	*dicantha*																	
	Parapsyche	*apicalis*			X		X	X											
	Symphitopsyche	*bronta*													X				X
	Symphitopsyche	*morosa*													X	X			X

Appendix 8 cont.

Common Name	Family / Genus	Species	Clay Hill Brook 6.2	Clay Hill Brook 6.1	Tuffield Willey Brook 1.6	Stevens Brook 0.1	Palaeagapetus Brook 1.6	Bluff Mtn. Brook 0.1	N. Br. Nulhegan River 10.5	N. Br. Nulhegan River 0.9*	Yellow Br. Nulhegan R. 7.6	Yellow Alder Brook 0.4	Yellow Br. Nulhegan R. 0.1	Black Br. Nulhegan R. 13.2	Black Br. Nulhegan R. 2.3	Logger Branch 1.4	Black Br. Nulhegan R. 0.1	Nulhegan River 11.0	Nulhegan River 4.5
Trichoptera (Caddisfly)																			
	Symphitopsyche	*alhedra*	X					X			X		X						
	Symphitopsyche	*slossonae*	X						X		X				X	X			X
	Symphitopsyche	*sparna*	X					X	X	X	X	X	X	X	X	X			X
Micro caddisfly	*Hydroptilidae*																		
	Hydroptila	*sp*											X			X			
	Palaegapetus	*sp*										X							
	Palaegapetus	*celsus*			X														
Lepidostomid case maker	*Lepidostomatidae*																		
	Lepidostoma	*sp*	X	X	X		X	X	X	X	X	X	X	X	X	X		X	X
Longhorned case maker	*Leptoceridae*																		
	Mystacides	*sp*				X											X	X	
	Oecetis	*sp*																X	X
	Setodes	*sp*			X			X											
	Triaenodes	*sp*		X															
Northern case maker	*Limnephilidae*	*imm*								X									
	Apatania	*sp*	X				X	X	X			X		X		X			
	Hydatophylax	*sp*				X											X	X	
	Limnephilus	*sp*				X												X	
Hoodcase maker	*Mollanidae*																		
	Molanna	*sp*								X									
Strongcase maker	*Odontoceridae*																		
	Psilotreta	*sp*			X			X				X	X			X			
Finger-net caddisfly	*Philopotamidae*																		
	Chimarra	*aterrima*									X		X					X	
	Dolophilodes	*sp*	X	X	X		X	X	X	X	X	X	X	X	X	X			X
Large caddisfly	*Phryganeidae*																		
	Ptilostomis	*sp*				X												X	
Tube-making caddisfly	*Polycentropodidae*																		
	Polycentropus	*sp*		X					X		X			X	X	X	X	X	
Nettube caddisfly	*Psychomyidae*																		
	Lype	*sp*															X		
Primitive caddisfly	*Rhyacophilidae*																		
	Rhyacophila	*fuscula*						X	X					X	X	X			
	Rhyacophila	*melita*													X				

Appendix 8 cont.

Common Name	Family / Genus	Species	Clay Hill Brook 6.2	Clay Hill Brook 6.1	Tuffield Willey Brook	Stevens Brook 0.1	Palaeagapetus Brook 1.6	Bluff Mtn. Brook 0.1	N. Br. Nulhegan River 10.5	N. Br. Nulhegan River 0.9*	Yellow Br. Nulhegan R. 7.6	Yellow Alder Brook 0.4	Yellow Br. Nulhegan R. 0.1	Black Br. Nulhegan R. 13.2	Black Br. Nulhegan R. 2.3	Logger Branch 1.4	Black Br. Nulhegan R. 0.1	Nulhegan River 11.0	Nulhegan River 4.5
Trichoptera (Caddisflies)																			
	Rhyacophila	*carolina*			X			X											
	Rhyacophila	*manistee*								X									
	Rhyacophila	*minora*					X				X	X	X				X		X
	Rhyacophila	*invaria*					X					X							
	Rhyacophila	*invaria spa*										X							
	Rhyacophila	*acutiloba*			X		X	X					X		X	X			X
	Rhyacophila	*carolina group*	X	X			X				X	X				X			
	Uenoidae																		
	Neophylax	*nacatus*	X				X						X			X			
Plecoptera (Stoneflies)																			
Slender Winter Stoneflies	*Capniidae*	*imm*			X		X						X						
Green Stoneflies	*Chloroperlidae*	*unid*	X	X	X		X	X	X	X	X			X		X			X
	Sweltsa	*sp*												X	X				
	Utaperla	*sp*							X										
Rolledwinged Stoneflies	*Leuctridae*	*imm*	X	X	X		X	X			X	X	X	X	X	X			X
	Leuctra	*sp*		X								X	X						
Nemourid Broadbacks	*Nemouridae*	*imm*			X							X							
	Ostrocerca	*sp*					X												
Roachlike Stoneflies	*Peltoperla*	*sp*	X	X	X		X	X								X			
Common Stoneflies	*Perlidae*	*imm*								X	X								
	Acroneuria	*carolinesis*												X					X
	Acroneuria	*abnormis*									X		X		X				X
	Paragnetina	*sp*								X									
	Paragnetina	*media*									X			X	X	X			
	Paragnetina	*immarginata*												X		X			X
	Agnetina	*capitata*							X	X			X		X	X			X
Perlodid stoneflies	*Perlodidae*																		
	Isogenoides	*sp*													X				
	Isoperla	*sp*	X	X	X		X	X		X	X		X			X			
	Malirekus	*sp*	X	X			X		X					X					
Giant stoneflies	*Pteronarcyidae*																		
	Pteronarcys	*sp*	X				X												X
	Pteronarcys	*biloba*	X							X						X			
	Pteronarcys	*proteus*	X	X			X							X					

Appendix 8 cont.

Common Name	Family / Genus	Species	Clay Hill Brook 6.2	Clay Hill Brook 6.1	Tuffield Willey Brook	Stevens Brook 0.1	Palaeagapetus Brook 1.6	Bluff Mtn. Brook 0.1	N. Br. Nulhegan River 10.5	N. Br. Nulhegan River 0.9*	Yellow Br. Nulhegan R. 7.6	Yellow Alder Brook 0.4	Yellow Br. Nulhegan R. 0.1	Black Br. Nulhegan R. 13.2	Black Br. Nulhegan R. 2.3	Logger Branch 1.4	Black Br. Nulhegan R. 0.1	Nulhegan River 11.0	Nulhegan River 4.5
Plecoptera (Stoneflies)																			
Taeniopterygid Broadback	*Taeniopterygidae*	*imm*		X															
	Taeniopteryx	*sp*								X		X				X		X	X
Odonata (Dragonfly and damselflies)																			
Darners	*Aeshnidae*	*unid*								X									
Stream Darners	*Boyeria*	*sp*								X									
	Boyeria	*vinosa*				X			X		X		X		X		X		
Broadwinged Damselflies	*Calopterygidae*	*imm*								X									
Bandwings	*Calopteryx*	*sp*				X											X	X	
Narrowinged Damselflies	*Coenagrionidae*	*imm*								X									
Dancers	*Argia*	*sp*																X	
Biddies	*Cordulegaster*	*sp*		X		X											X	X	
Bog Skimmers	*Somatochlora*	*sp*				X											X		
Clubtails	*Gomphidae*	*imm*					X		X	X	X			X			X	X	
Snake Darners	*Ophiogomphus*	*sp*								X			X						X
Clubtails	*Stylurus*	*sp*		X															
Megaloptera (Alderfly/dobbsonflies)																			
Fishflies	*Nigronia*	*sp*								X	X		X		X	X			X
Alderflies	*Sialis*	*sp*		X		X											X	X	
Lepidoptera (Butterfly/moths)																			
	Pyralidae																		
	Petrophila	*sp*				X												X	
Amphipoda (Scuds)																			
	Hyallela	*azteca*				X												X	
Gastropoda (Snails)																			
	Hydrobiidae																		
Mud amnicola	*Amnicola*	*limosa*				X												X	X
Buffalo pebblesnail	*Gillia*	*altilis*				X													
	Ancylidae																		
Fragile ancylid	*Ferrissia*	*californica*				X													
Creeping ancylid	*Ferrissia*	*rivularis*							X						X	X			X
	Lymnaeidae																		
Fossaria snails	*Fossaria*	*sp*				X													
	Planorbidae																		
Rams-horns	*Helisoma*	*sp*				X													
Two-ridge rams-horn	*Helisoma*	*anceps*																	X

Appendix 8 cont.

Common Name	Genus	Species	Clay Hill Brook 6.2	Clay Hill Brook 6.1	Tuffield Willey Brook	Stevens Brook 0.1	Palaeagapetus Brook 1.6	Bluff Mtn. Brook 0.1	N. Br. Nulhegan River 10.5	N. Br. Nulhegan River 0.9*	Yellow Br. Nulhegan R. 7.6	Yellow Alder Brook 0.4	Yellow Br. Nulhegan R. 0.1	Black Br. Nulhegan R. 13.2	Black Br. Nulhegan R. 2.3	Logger Branch 1.4	Black Br. Nulhegan R. 0.1	Nulhegan River 11.0	Nulhegan River 4.5
Gastropoda (Snails)																			
Bellmouth campanulatum	*Helisoma*	*campanulata*																	
Marsh rams-horm	*Helisoma*	*trivolvis*													X				
Bivalvia (Mussel and clams)																			
	Sphaeriidae																		
	Musculium	*sp*								X									
	Pisidium	*sp*				X					X	X				X		X	X
	Pisidium	*casertanum*		X						X	X		X				X	X	X
	Pisidium	*henslowanum*								X									
	Pisidium	*compressum*																	X
	Pisidium	*ferrugineum*																	X
	Pisidium	*variabile*				X													
Tricladida (Flatworms)																			
	Planaridae																		
	Cura	*sp*									X								
	Hymanella	*retenuova*					X						X						
Gordida (Horsehair worms)																			
	Gordidae																		
	Gordius	*sp*		X			X	X	X										
Oligochaeta (Aquatic segmented worms)																			
	Naididae	*unid*																X	
	Nais	*bretscheri*													X				
	Stylaria	*lacustris*																X	
	Tubificidae	*unid*		X													X		
	Lumbriculidae	*unid*		X		X			X		X			X		X	X	X	
	Enchytraeidae	*unid*			X		X					X			X	X			X
Hirudinea (Leeches)																			
	Erpobdellidae																		
	Nephelopsis	*obscura*				X													
Hydrachnidia (Watermites)																			
	Limnocharidae	*unid*																X	
	Hygrobatidae																		
	Hygrobates	*sp*	X								X								
	Lebertiidae																		
	Lebertia	*sp*													X				
	Sperchonidae																		

Appendix 8 cont.

Common Name	Family / Genus	Species	Clay Hill Brook 6.2	Clay Hill Brook 6.1	Tuffield Willey Brook	Stevens Brook 0.1	Palaeagapetus Brook 1.6	Bluff Mtn. Brook 0.1	N. Br. Nulhegan River 10.5	N. Br. Nulhegan River 0.9*	Yellow Br. Nulhegan R. 7.6	Yellow Alder Brook 0.4	Yellow Br. Nulhegan R. 0.1	Black Br. Nulhegan R. 13.2	Black Br. Nulhegan R. 2.3	Logger Branch 1.4	Black Br. Nulhegan R. 0.1	Nulhegan River 11.0	Nulhegan River 4.5
Hydrachnidia (Watermites)																			
	Sperchon	*sp*													X				
Hemiptera (True bugs)																			
Water boatmen	*Unid*					X													
	Corixidae	*unid*															X	X	
	Callicorixa	*sp*				X												X	
	Callicorixa	*audeni*																X	
	Sigara	*sp*				X													
Water striders	*Gerridae*	*unid*																X	
	Gerris	*sp*															X		
Shortlegged striders	*Microvelia*	*sp*										X							

*North Branch Nulhegan River 0.8 data collected in 1993

Appendix 9. The percent composition of the substrate, percent embeddedness range and percent canopy cover for all macroinvertebrate stream/river sampling areas within the Nulhegan watershed.

Location	Site	Ledge%	Boulder %	Cobble %	CGravel%	Gravel%	Sand %	Silt %	Embed-dedness %	Canopy%
Nulhegan River	4.5	0	2	33	36	10	19	0	5-25	20
Nulhegan River*	11.0	0	0	0	5	0	45	50	NA	10
Black Br. Nulhegan R.	0.1	0	0	1	59	0	29	11	NA	30
Black Br. Nulhegan R.	2.3	0	28	30	23	14	5	0	5-25	20
Black Br. Nulhegan R.	13.2	0	17	53	18	10	2	0	5-25	40
Logger Branch	1.4	13	31	30	19	0	7	0	5-25	70
Yellow Br. Nulhegan R.	0.1	0	0	5	70	19	6	0	5-25	50
Yellow Br. Nulhegan R.	7.6	0	40	39	15	4	2	0	5-25	70
Yellow Alder Brook	0.4	0	11	35	33	9	12	0	0-5	90
N.Br..Nulhegan .*(1993)	0.8	0	0	0	0	10	90	0	NA	30
N Br. Nulhegan R.	10.5	0	22	39	24	7	8	0	25-50	50
Palaeagapetus Brook	1.6	0	28	18	20	19	15	0	25-50	90
Bluff Mountain Brook	0.1	0	27	36	26	8	3	0	0-5	90
Stevens Brook	0.1	0	0	0	0	0	50	50	NA	10
Clay Hill Brook*	6.1	0	0	0	10	10	40	40	NA	80
Clay Hill Brook	6.2	0	4	17	58	19	2	0	25-50	80
Tuffield Willey Brook	1.6	5	26	23	18	21	7	0	0-5	100

* Substrate composition for these samples are based on observational estimates, all others are based on 100 pebble count method.

Appendix. Physico-chemical data from ten lake and one bog site samples for fish, snails, crayfish and clams from the Paul Stream, Wheeler Stream and Nulhegan River Drainage Areas, Within the West Mountain Wildlife Management Area, or the Silvio Conti Wildlife Refuge respectively. Samples were collected during August and September 2000 or are from VTDEC Lakes database. All samples were collected from a depth of 1 meter, unless total depth was less than 1 meter, then the sample was taken at 0.5 m.

Location	Date	Water Temp (°c), Time	Total Phos. (ug/l)	Specific Conduct (Φmhos)	Field pH (std. units)	Lab pH (std units)	Alkalinity (mg/l)	Calcium (mg/l)	Magnesium (mg/l)	Potassium (mg/l)	Sodium (mg/l)	Apparent Color (Pt-Co)	Transparency (m)
Paul Stream Pond	9/19/00	16.5@ 1015	11	34.4	6.62	7.17	8.4	3.50	0.80	1.05	0.90	40	2.3
South America Pond	9/20/00	16.0@ 1015	11	22.6	6.72	6.71	4.5	2.18	0.46	0.53	0.90	70	>1.7
Unknown Pond (Ferd)	9/19/00	15.0@ 1420	12	20.4	6.18	6.16	2.1	2.06	0.45	0.37	0.81	>70	1.3
West Mt. Pond	8/18/00	21.0@ 1130	20	26.6	6.83	6.71	5.5	3.61	0.64	0.59	1.36	70	1.3
Notch Pond	8/16/00	21.6@ 1100	9	32.4	6.59	7.13	7.9	4.65	0.73	0.80	1.11	55	3.0
Dennis Pond	8/17/00	17.0@ 1420	15	48.3	6.83	7.29	15.6	6.21	1.00	0.87	1.62	70	>1.0
Wheeler Pond	10/09/95	13.0@ 1400	-	33.7	-	6.82	8.31	-	-	-	-	82	2.9
Little Wheeler Pond	8/18/00	18.5@ 0900	10	31.0	7.08	6.95	7.4	4.64	0.64	0.62	1.23	70	>1.9
Lewis Pond	8/17/00	17.0@ 1116	18	26.7	7.15	6.99	6.5	3.81	0.55	0.29	0.76	50	1.5
Ferdinand Bog, Paul Stream 10.2	9/20/00	15.0@ 1300	14	29.4	6.52	6.62	6.4	3.30	0.70	0.64	1.08	70	NA
Maidstone Lake	8/03/88	-	5.6*	-	-	7.27	6.5*	2.85	0.64	0.76	1.18	20	8.2*

A A>@symbol in the Secchi column indicates the Secchi disk was observed all the way to the bottom.*Mean Spring value 11 yr data total phos and transparency, 1 yr Alk.

Appendix 10b. Water temperature (Bc) and dissolved oxygen (mg/l) data taken in summer from lakes sampled for fish and molluscs in the West Mountain Wildlife Management Area. Date and times are given in parenthesis.

Water Temp(^{0}C), *Dissolved Oxygen* (ppm)	Paul Stream Pond (09/07/00)		South America Pond (09/15/00)		Unknown Pond (09/06/00)		Notch Pond (09/12/01)	Dennis Pond (08/24/00)	Wheeler Pond (09/05/00)	
	Sta. 1 (0856)	Sta. 2 (0906)	Sta.1 (1040)	Sta. 2 (1000)	Sta. 1 (1045)	Sta. 2 (1050)	Sta 1. (1123)	(Random surface measurements)	Sta.1 (1056)	Sta. 2 (1114)
0m	18.3, *8.79*	18.2, *8.76*	18.8, *8.55*	18.7, *8.76*	15.5, *7.90*	14.5, *7.90*	18.7, *8.76*	19.0-22.0 ^{0}C, *6.00- 7.00*	18.2, *8.02*	18.1, *8.00*
1m	18.3, *8.72*	18.2, *8.95*	18.6, *8.66*	18.7, *8.70*	14.8, *7.62*	15.0, *7.51*	18.6, *8.55*		18.2, *8.00*	18.2, *8.14*
2m	18.3, *5.80*	18.2, *8.77*	18.2, *8.57*		14.6, *7.35*	14.7, *7.44*	18.3, *8.54*		18.0, 7.95	18.1, *8.05*
3m					14.6, *7.51*		16.4, *8.21*		15.3, *4.40*	15.7, *6.18*
4m					14.5, *7.80*		14.7, *5.93*		13.4, *1.03*	9.7, *2.84*
5m							8.5, *5.00*		11.0, *0.98*	7.7, *2.90*
6m									7.1, *1.18*	
7m									6.6, 0.75	
8m									6.3, 0.36	
9m									6.2, 0.28	

Appendix 10c. Dissolved oxygen concentrations (mg/l) taken in February to April, 2001 at various *depths* for lakes within the West Mountain Wildlife Management Area. Depths are given first (AUI@ = under ice) followed by dissolved oxygen concentrations.

Little Wheeler Pond	Wheeler Pond	Notch Pond	Paul Stream Pond	South America Pond	Unknown Pond (Ferdinand)	Tuttle Pond	West Mountain Pond
(2-7-01)	(2-15-01)	(2-15-01)	(2-7-01)	(2-7-01)	(2-15-01)	(3-26-01)	(2-15-01)
outlet- 13.4	*UI* - 10.8	UI-*11.5*	UI - *1.4*	UI *-2.1*	UI *-6.4*	UI *-1.2*	2.3m *-1.2*
	1.8m -*11.0*	2.7m-*10.2*	1.8m *-2.2*	1.5m *-1.7*	1.0m *-1.2*		0.3m *-3.3*
	3.7m -*9.4*	4.6m-*10.0*			2.7m *-0.9*		
	5.5m -*7.5*	6.4m-*4.3*					
	7.3m -*4.0.*	8.2m-*1.3*					
	9.1-m -*0.8*	(4-5-01)					
	(3-26-01)	UI - *6.0*					
	UI - *5.6*	0.9m - *4.6*					
	1.8m - *4.8*	2.7m -*3.7*					
	3.7m - *2.6*	4.6m - *2.4*					
	5.5m - *1.9*	5.5m - *1.1*					
	7.3m - *0.8*						