2007 Water Quality Monitoring
Winooski Headwaters

In early 2007, the Cabot Conservation Committee and the Marshfield and Plainfield Conservation Commissions joined together to initiate a pilot water quality study in their towns. The study area is the Winooski River mainstem and the tributaries in the three towns. Although there is some water quality data available for selected locations within the study area, more information is needed

- to document water quality conditions for aquatic life support including an important locality for the State threatened eastern pearlshell mussel (*Margaritifera margaritifera* Linn.);
- to support the State of Vermont's Winooski River Basin Planning Initiative;
- to provide baseline data to assess long-term changes to water quality in the river system; and
- to address public concerns about the risk of contact recreation associated with potential contaminants in the waters.

For five months (June through October), ten basic water quality parameters were monitored at twelve sites in the study area. Seven of the monitoring sites are on the mainstem and the rest are located near the mouth of tributarties. Five of the sites area co-located with existing Department of Environmental Conservation biomonitoring sites. In addition, seven sites were sampled for *E. coli* bacteria on a bi-weekly basis from June through early September. These sites were selected based on the likelihood of public contact (swimming holes, fishing spots, etc.). These sites overlap with some of the water quality sampling sites. Table 1 lists the test sites.

Table 1: List of Test Sites

Location	Site # (RMile)	WQ	*e. coli*	Town	Latitude/ Longitude	Location Description
Winooski River	W 70.7*	X		Plainfield	44.1624/ 72.2556	Located below the Plainfield WWTF, in area below complete mixing.
	W 71.4		X	Plainfield	44.2775/ 72.42576	Located immediately below dam in village of Plainfield
	W 72.8	X		Marshfield	44.2871/ 72.4090	Martin Bridge, *Margetifera margetifera* pop.,
	W 81.6*	X	X	Marshfield	44.2050/ 72.2137	Located below Marshfield WWTF and Marshfield Pond Brook
	W 82.6	X		Marshfield	44.35193/ 72.347528	Located above Marshfield Village,at Rt 2 bridge, below hydro gen. station.
	W 83.8*	X	X	Cabot	44.2259/ 72.1958	Just below storage building in Durrant Cemetery; 0.9 mi below Cabot WWTF.
	W 85.5*	X		Cabot	44.2358/ 72.1926	Just above first bridge downstream of Cabot village, and Cabot Cheese Plant
	W 86.3		X	Cabot	44.4047/ 72.3114	Located behind private residence in Cabot Village
	W 86.6*	X		Cabot	44.40655/ 72.3104185	Above small tributary (Cabot Plains) adjacent to Cabot Recreation Field,
Great Brook	GB 0.1	X	X	Plainfield		At Plainfield recreation field, just above confluence with Winooski
Naismith Brook	NB 0.8	X	X	Marshfield	44.29811/ 72.387455	At Paradise swimming hole, below RR bed
Marshfield Brook	MAB 0.1	X	X	Marshfield	44.34762/ 72.358031	At Community trail bridge town land
Molly's Brook	MOB 0.3	X		Marshfield	44.3579/ 72.332697	Near mouth, ab/or bl falls
Jug Brook	JB 1.3	X		Cabot	44.3999/ 72.341779	Located below Blodgget Road

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Water Quality Parameters

As noted above, the twelve water quality sites were tested for ten basic water quality parameters. Follow is a brief excerpt of each parameter and its significance from the Vermont Volunteer Surface Water Monitoring Guide. For more information, you can view the full manual at www.vtwaterquality.org/lakes/htm/lp_monitoringguide.htm

Several parameters are measured in the field:

Temperature (ºC): Aquatic organisms, from microbes to fish, are dependent on certain temperature ranges for their optimum health. If temperatures are outside this optimal range for a prolonged period of time, organisms are stressed and can die.

pH: pH is a measure of the hydrogen ion concentration, or acidity of water. The pH is not an indicator of a particular pollutant; however, it affects many chemical and biological processes in water. For example, low pH can allow toxic elements and compounds to become mobile and "available" for uptake by aquatic plants and animals causing the death of many organisms. This can disrupt the food chain and affect higher level organisms.

Conductivity: Conductivity estimates the amount of dissolved ions in the water. Conductivity is influenced by the size of the watershed and the geology. There are a number of pollution sources that may be signaled by increased conductivity. Wastewater from sewage treatment plants and septic systems, urban runoff from roads and agricultural runoff can all contribute to increased conductivity within a water body.

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Dissolved oxygen (%sat, and mg/l): Water contains oxygen in the form of a dissolved gas, which most aquatic organisms use to breathe. Dissolved oxygen (DO) is the measure of the concentration of the gas dissolved in water. All aquatic organisms have an optimal range of DO for functioning. Some require very high levels in order to flourish, and at low DO concentrations, sensitive animals may move away, weaken, or die.

Laboratory analyses is conducted for the others:

Alkalinity: Alkalinity is a measure of the calcium carbonate, buffering (or acid neutralizing) capacity of the water. Alkalinity is generally not a harmfull pollutant itself. It is often used as a measure of the sensitivity of a waterbody to acid rain. Streams with moderate levels of alkalinity are often more biologically productive and can support higher numbers of trout.

Total Suspended Sediment: (only if waters appear turbid), TSS is an important parameter to consider if you suspect sediment and water clarity issues. The total suspended solids (TSS) parameter is measured in milligrams per liter (mg/L), the mass of solids per unit volume of water.

Turbidity: Turbidity is a measure of light scattering properties of suspended materials. In theory, the more suspended material that exists, the more light scattering (turbid), and hence the less transparent. Turbidity data can reveal problems with water clarity and/ or suspended sediment in streams and rivers. Turbidity is reported in Nephelometric Turbidity Units (NTU).

Total phosphorus (TP): Phosphorus is also an essential plant and animal nutrient and is the nutrient of greatest concern in eutrophication (nutrient enrichment). It is in most cases the "limiting nutrient," meaning it is the one most likely to restrict plant growth because of its naturally low levels in the environment. Thus, even small increases in phosphorus loads to a waterbody can cause large algal blooms and excessive plant growth. This rapid increase in biological activity may disrupt the ecological balance of surface waters.

Total nitrogen (TN) ; Nitrogen is an essential plant and animal nutrient that naturally occurs in numerous forms in surface water. High concentrations of any form of nitrogen in a waterbody may indicate

that pollutants from animal manure, sewage, or fertilizers applied to land are making their way into the water via runoff.

Chloride: Chloride is an ion that is released into surface waters through the breakdown of salt compounds. It is a naturally occurring mineral at very low levels in Vt. Levels above 5 mg/l in surface waters may be attributed to winter road maintenance practices and or to animal or human waste water. Levels above 230 mg/l may cause harm to aquatic life. In addition to negatively impacting water quality, chloride in large concentrations can be corrosive; cause damage to vegetation; and enter the drinking water supply, causing discoloration, foul taste and odor.

e.coli: Fecal bacteria are a particular group of bacteria primarily found in human and animal intestines and wastes. *Escherichia coli* (*E. coli*) is one of the fecal coliform bacteria widely used as indicator organisms to show the presence of such wastes in water and the possible presence of pathogenic (disease-producing) organisms. When *E. coli* is found in waters, its presence is not the problem of concern itself but is used rather as an indicator of fecal contamination (most strains of *E. coli* are not pathogenic) from humans or animals is present. *E. coli* monitoring is commonly conducted to ensure that the water is safe for swimmers; to establish a relationship between rainfall, bird migration migration or other wildlife activity and *E. coli* levels; and to identify pollution sources (e.g., septic system failure, failing manure pit) in a watershed. The bacteria is measured in organisms or colony-forming units per 100 milliliters of water (cfu/100 mL). Vermont's Class B water quality standard sets the maximum tolerable *E. coli* level at 77 colonies per 100 ml of sampled water.

Water Quality Parameters Results and Discussion

On the following pages are a few highlights of the testing. More detailed results are available in Appendix A.

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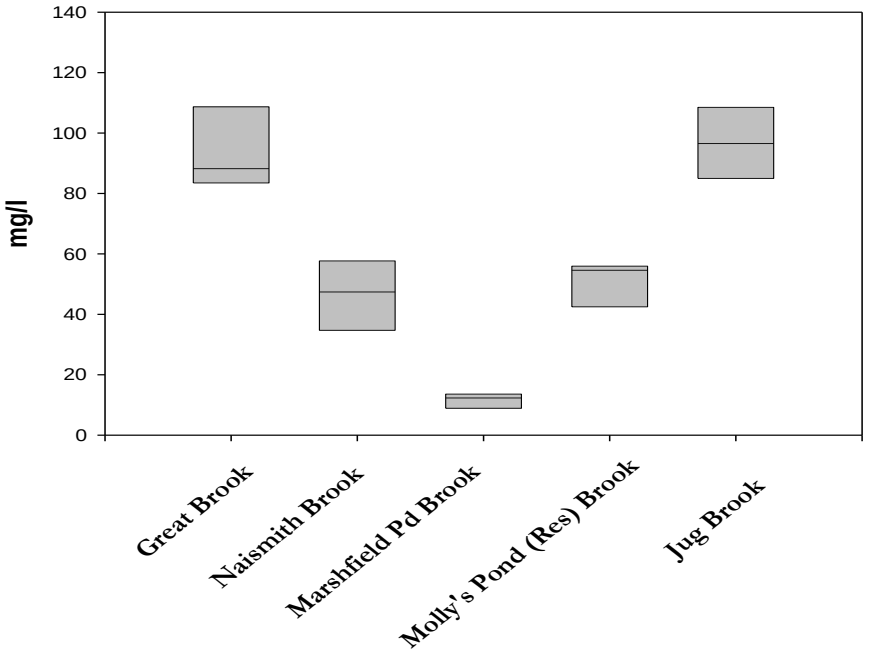
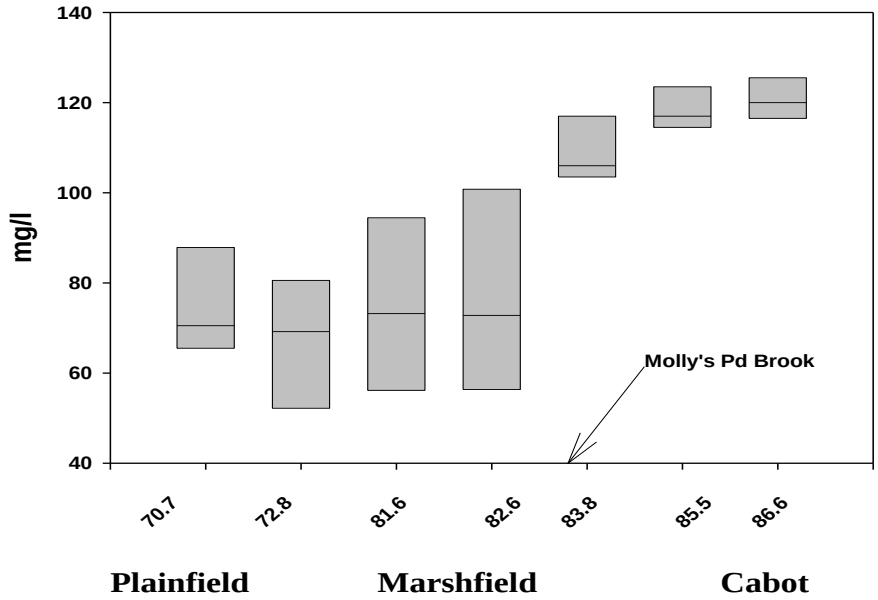
Alkalinity is a measure of the calcium carbonate buffering in water. Streams with alkalinity <10 are sensitive to acid precipitation. Streams with alkalinity 20-50 are moderately buffered. Streams with alkalinity >50 are highly buffered.

Alkalinity of Upper Winooski Tributaries



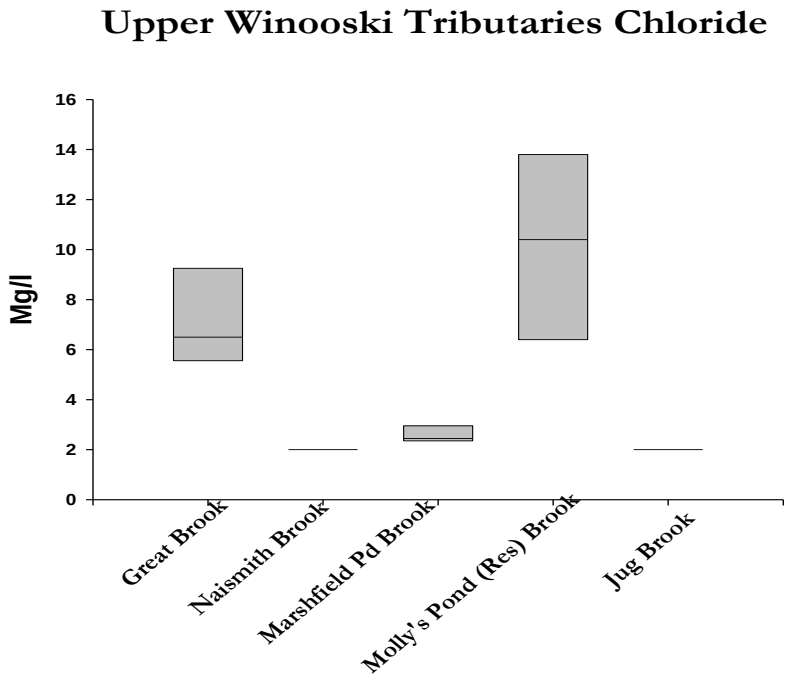
Alkalinity of Upper Winooski River
Plainfield - Marshfield - Cabot

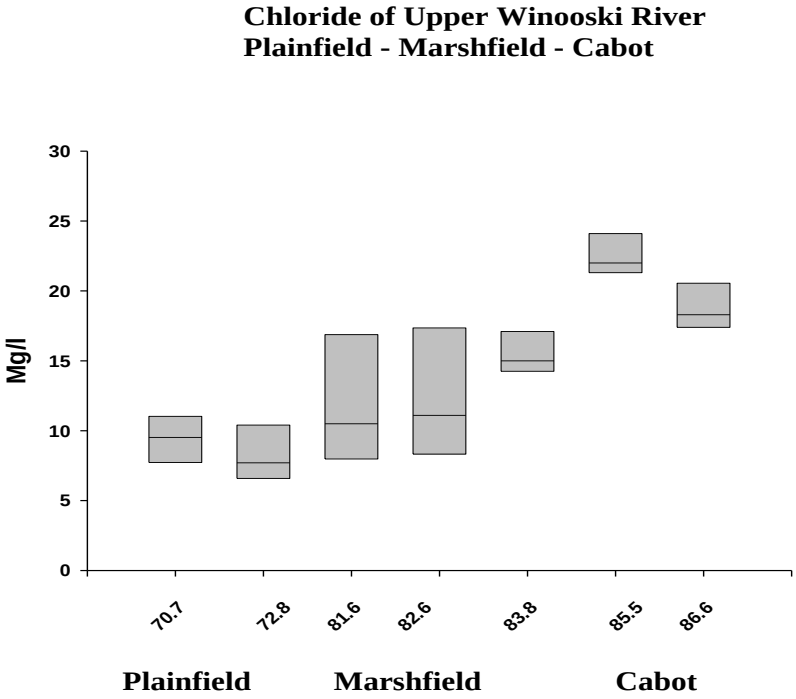


Upper Winooski River Sites by River Mile

2007 Water Quality Monitoring
Winooski Headwaters

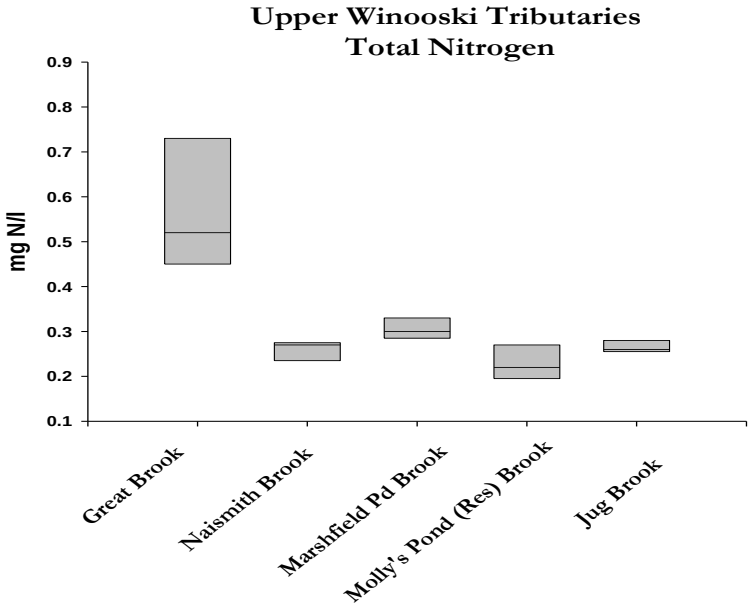
Figure showing **Chloride concentrations** at site in upper Winooski River and Tributaries. EPA guidance Aquatic Life Criteria - Acute 860mg/l, Chronic 230 mg/l.

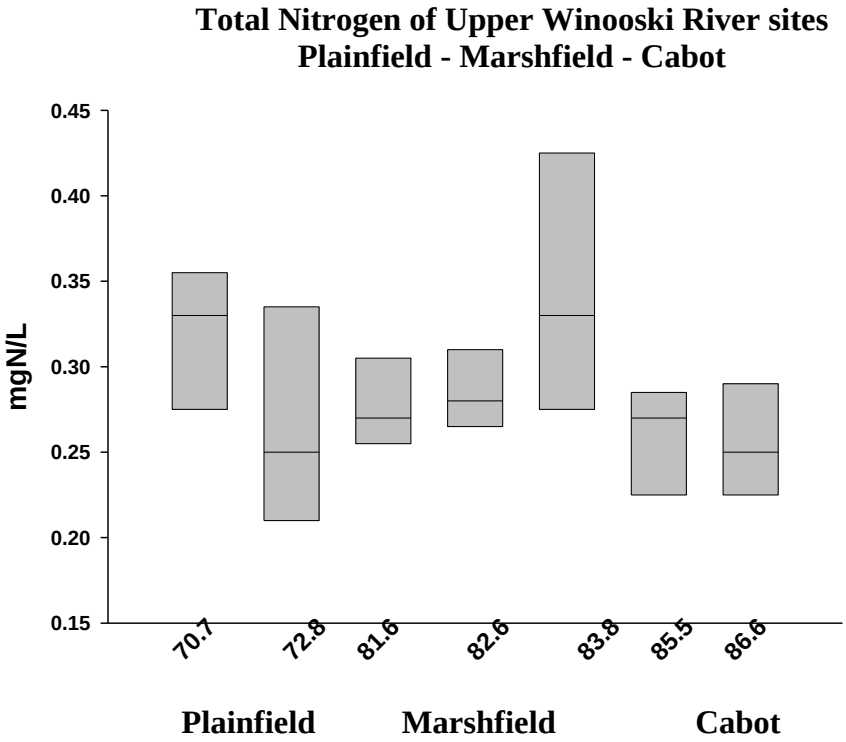




2007 Water Quality Monitoring
Winooski Headwaters

Total nitrogen (TN) Nitrogen is an essential plant and animal nutrient that naturally occurs in numerous forms in surface water. High concentrations of any form of nitrogen in a waterbody may indicate that pollutants from animal manure, sewage, or fertilizers applied to land are making their way into the water via runoff.





2007 Water Quality Monitoring
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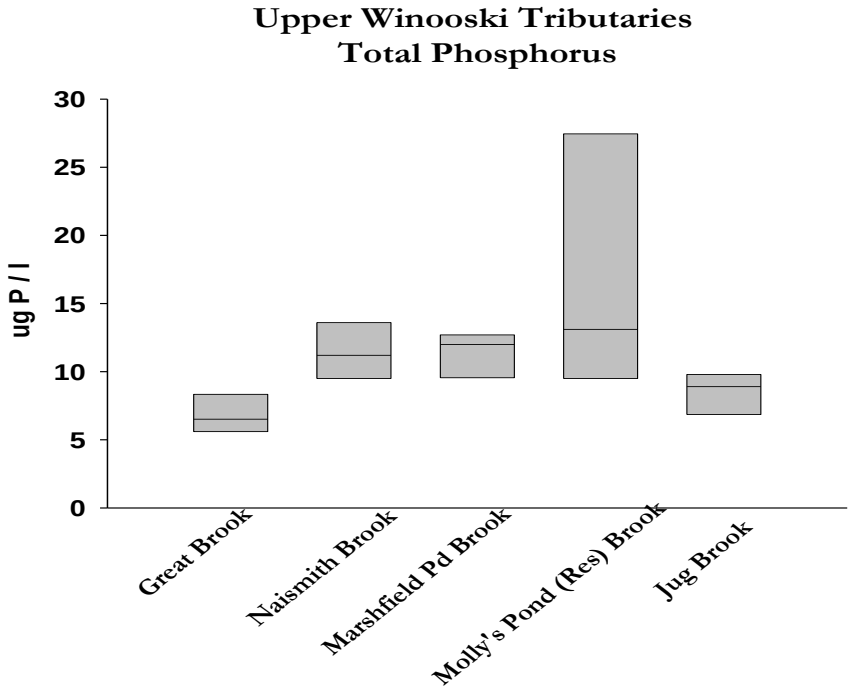
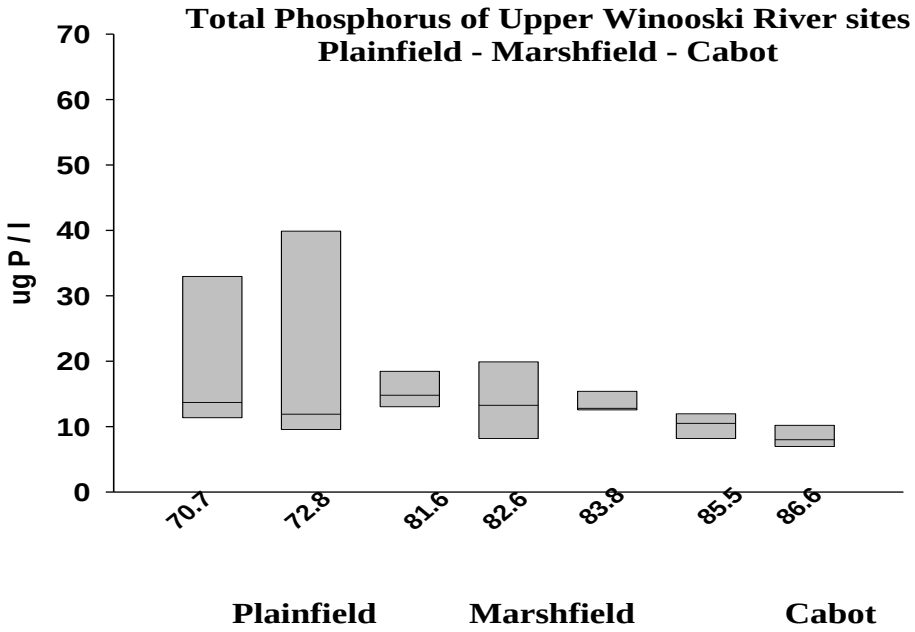
Total phosphorus (TP) Phosphorus is also an essential plant and animal nutrient and is the nutrient of greatest concern in eutrophication (nutrient enrichment). It is in most cases the "limiting nutrient," meaning it is the one most likely to restrict plant growth because of its naturally low levels in the environment. Thus, even small increases in phosphorus loads to a waterbody can cause large algal blooms and excessive plant growth. This rapid increase in biological activity may disrupt the ecological balance of surface waters.





2007 Water Quality Monitoring
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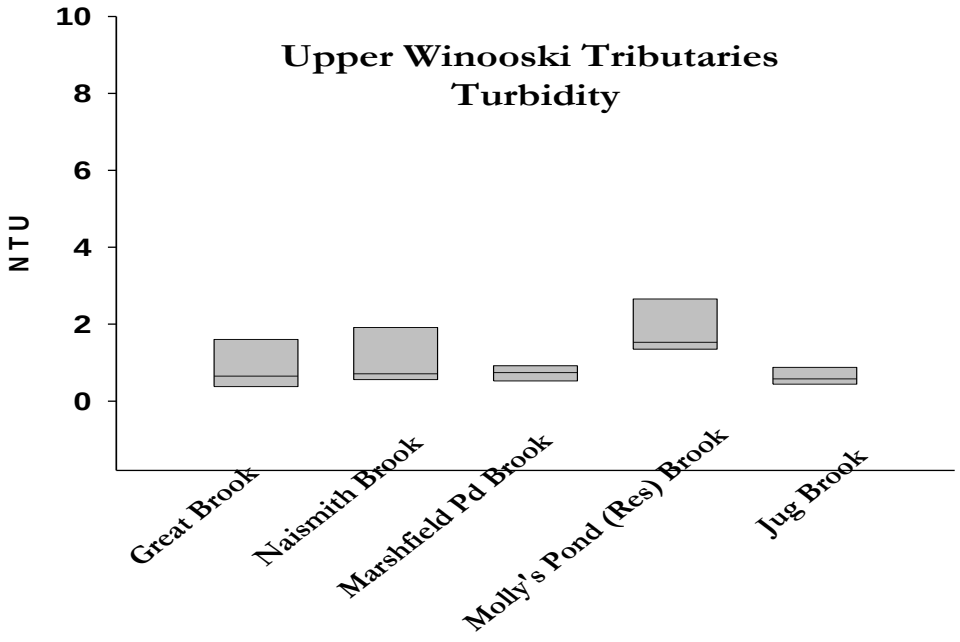
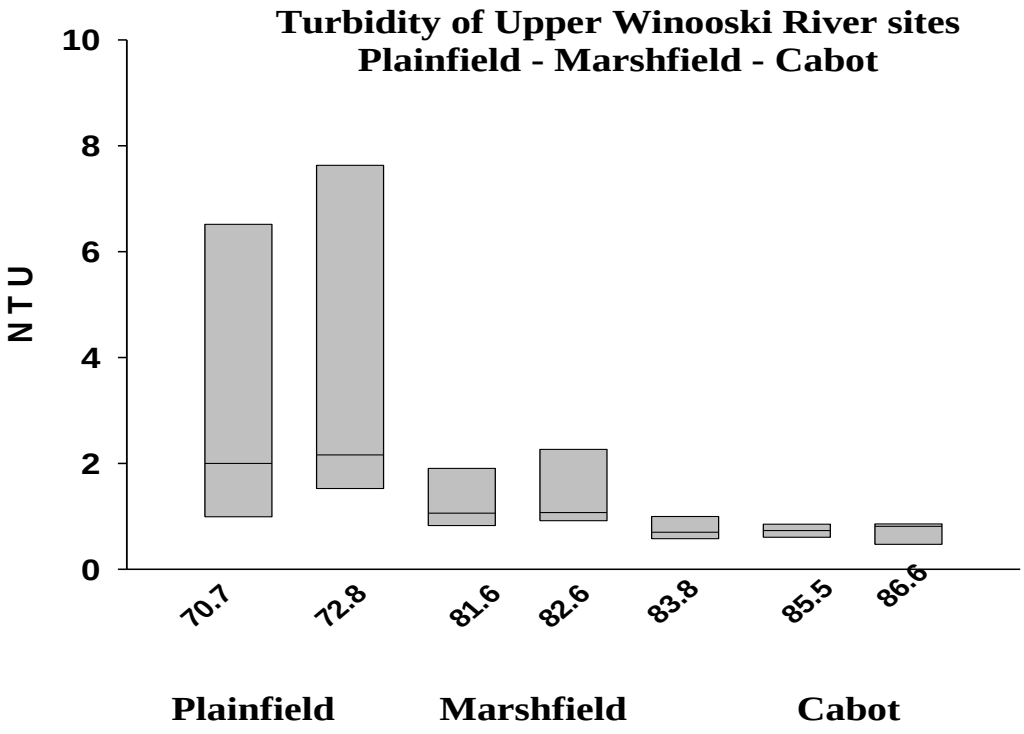
Turbidity is a measure of the clarity of water and is used to indirectly measure total suspended solids. The Aquatic Life Criteria for Class B Cold water habitat is 10 NTU



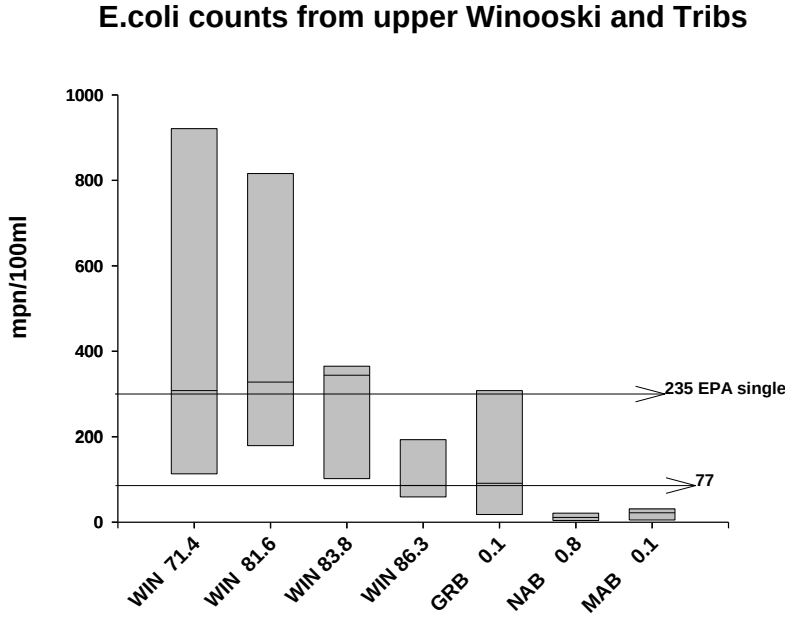


2007 Water Quality Monitoring
Winooski Headwaters

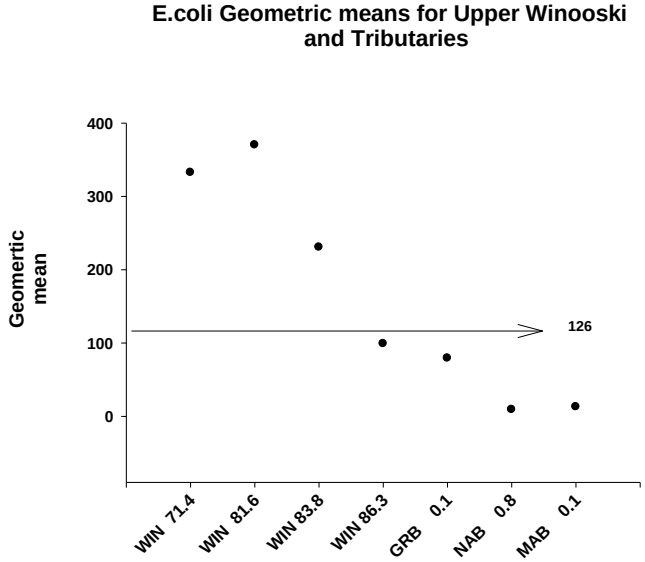
Bacteria *(E. coli)* Results and Discussion

In general, tributaries tested near or well below the Vermont standard of 77 colonies per 100 ml of sampled water. The exception to this was Great Brook. On two sampling dates July 9th and September 10th, the e. coli measured 727 and 308 cfu/100 mL. On July 9th there had been a significant rain event. Those two dates were also among the highest for all of the sites.

E.coli concentrations at site in upper Winooski River and Tributaries.
VTDEC Class B criteria 77/100ml (<4 in 1000 risk), EPA 235/100ml (8 in 1000 acceptable risk)



The geometric mean reduces the influence of very high and very low numbers on the average. The Vermont standard for geometric mean is 126/100ml (8 in 1000 risk).



2007 Water Quality Monitoring
Winooski Headwaters
Appendix A

Water Quality Parameters

Station	Date	Alkalinity	Chloride (mg/L)	Nitrogen, Total - Persulfate (mg N/L)	Phosphorus, Total (ug P/L)	Solids, Total Suspended (mg/L)	Turbidity NTU)	Flow
GRB00.1A	6/24/2007	96.3	7.50	0.61	6.51		0.53	medium
	7/22/2007	83.4	5.71	0.39	9.37	6.02	2.45	medium
	8/19/2007	121.0	11.00	0.85	5.00		0.22	low
	9/16/2007	88.2	5.40	0.51	7.30	3.61	0.65	medium
	10/14/2007	83.5	6.50	0.52	6.20	1.46	0.76	medium
Median		**88.2**	**6.50**	**0.52**	**6.51**		**0.65**	
JUB01.3A	6/24/2007	106.0	2.00	0.30	10.50		1.00	low
	7/21/2007	86.5	2.00	0.25	9.08	2.71	0.76	medium
	8/19/2007	111.0	2.00	0.26	7.30		0.50	medium
	9/16/2007	96.5	2.00	0.26	6.40	1.96	0.38	medium
	10/14/2007	83.5	2.00	0.26	8.90	1.05	0.58	medium
Median		**96.5**	**2.00**	**0.26**	**8.90**		**0.58**	
MAB00.1A	6/24/2007	12.3	2.45	0.28	12.00		0.80	low
	7/22/2007	7.7	2.40	0.35	13.10	2.24	0.74	high
	8/19/2007	14.4	2.30	0.30	7.70		0.43	low
	9/16/2007	12.8	2.80	0.31	12.30	1.36	0.62	medium
	10/14/2007	10.1	3.10	0.29	11.40	1.00	1.04	medium
Median		**12.3**	**2.45**	**0.30**	**12.00**		**0.74**	
MOB00.3A	6/24/2007	56.7	14.00	0.24	13.10		1.53	low
	7/21/2007	54.6	13.60	0.18	11.70	1.52	1.38	medium
	8/19/2007	55.2	10.40	0.30	7.30		1.58	medium
	9/16/2007	41.9	6.60	0.22	27.10	15.50	1.32	medium
	10/14/2007	43.0	6.20	0.21	27.80	14.50	3.73	high
Median		**54.6**	**10.40**	**0.22**	**13.10**		**1.53**	
NAB00.8A	6/24/2007	50.6	2.00	0.27	13.10		0.71	medium
	7/22/2007	31.6	2.00	0.27	14.10	3.43	2.80	medium
	8/19/2007	64.7	2.00	0.23	8.40		0.49	low
	9/16/2007	47.4	2.00	0.28	11.20	1.70	0.63	medium
	10/14/2007	37.8	2.00	0.24	10.60	1.00	1.03	medium
Median		**47.4**	**2.00**	**0.27**	**11.20**		**0.71**	

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Station	Date	Alkalinity	Chloride (mg/L)	Nitrogen, Total - Persulfate (mg N/L)	Phosphorus, Total (ug P/L)	Solids, Total Suspended (mg/L)	Turbidity NTU)	Flow
Values for **WIN70.7**								
		67.7	9.52	0.34	45.40	26.00	10.90	medium
		94.3	11.70	0.28	9.50		0.99	medium
		70.5	7.70	0.37	20.50	3.96	2.13	
		63.3	7.75	0.27	13.20	5.08	2.00	
Median	**WIN70.7**	**70.5**	**9.52**	**0.33**	**13.70**		**2.00**	
Values for WIN72.8								
		78.4	10.10	0.25	11.90		3.31	medium
		46.3	5.58	0.34	61.65	39.50	11.95	
		82.7	10.70	0.18	7.50		1.03	low
		69.2	7.70	0.33	18.10	4.02	2.16	
		58.1	7.60	0.24	11.60	1.94	2.02	
Median	**WIN72.8**	**69.2**	**7.70**	**0.25**	**11.90**		**2.16**	
Values for WIN81.6								
		89.5	16.40	0.32	13.40		1.06	medium
		45.1	5.96	0.27	18.10	4.19	2.42	
		99.4	17.35	0.27	12.65		0.67	medium
		73.2	10.50	0.29	18.80	2.87	0.98	
		67.2	10.00	0.24	14.80	2.17	1.39	
Median	**WIN81.6**	**73.2**	**10.50**	**0.27**	**14.80**		**1.06**	
Values for WIN82.6								
		102.0	17.70	0.34	10.20		0.97	low
		44.6	5.95	0.28	21.10	7.53	2.52	high
		99.6	17.00	0.28	7.50		0.86	medium
		72.8	11.10	0.27	16.30	4.15	1.07	
		68.1	10.70	0.26	349.00	2.96	2.01	
Median	**WIN82.6**	**72.8**	**11.10**	**0.28**	**16.30**		**1.07**	
WIN83.8A	6/24/2007	112.0	16.50	0.33	12.80		0.55	low
	7/21/2007	103.0	13.50	0.30	12.60	2.07	1.01	medium
	8/19/2007	122.0	17.70	0.25	17.20		0.98	medium
	9/16/2007	106.0	15.00	0.43	13.60	1.23	0.70	medium
	10/14/2007	104.0	15.00	0.42	12.50	1.24	0.60	medium
Median		**106.0**	**15.00**	**0.33**	**12.80**		**0.70**	

2007 Water Quality Monitoring
Winooski Headwaters

Station	Date	Alkalinity	Chloride (mg/L)	Nitrogen, Total - Persulfate (mg N/L)	Phosphorus, Total (ug P/L)	Solids, Total Suspended (mg/L)	Turbidity NTU)	Flow
WIN85.5A	7/22/2007	116.0	20.80	0.28	12.40	4.59	0.76	medium
	8/19/2007	128.0	24.60	0.24	6.80		0.73	medium
	9/16/2007	113.0	22.00	0.27	11.50	2.27	0.94	medium
	10/14/2007	117.0	23.60	0.21	10.50	1.00	0.68	medium
Median		**117.0**	**22.00**	**0.27**	**10.50**		**0.73**	
WIN86.6A	6/24/2007	120.0	16.80	0.30	7.60		0.32	low
	7/22/2007	120.0	18.00	0.28	11.00	2.27	0.62	medium
	8/19/2007	130.0	18.30	0.25	6.30		0.81	
	9/16/2007	113.0	19.20	0.25	9.40	1.30	0.88	medium
	10/14/2007	121.0	21.90	0.20	8.00	1.00	0.83	medium
Median		**120.0**	**18.30**	**0.25**	**8.00**		**0.81**	

2007 Water Quality Monitoring
Winooski Headwaters

e. coli Results

Station	Date	Time	E. coli (mpn/100mL)	24 Hr rainfall	48 Hr rainfall	72 Hr rainfall	96 hr rainfall	Flow	Tendency
GRB00.1A	6/25/2007	640	34	0.03	0.00	0.34	0.49	low	falling
	7/9/2007	710	727	0.48	0.78	0.81	0.81	medium	rising
	7/23/2007	725	18	0.00	0.00	0.03	1.17	medium	falling
	8/6/2007	830	91	0.00	0.00	0.00	0.00	low	falling
	8/20/2007	730	16	0.00	0.02	0.12	0.56	low	falling
	9/10/2007	635	308	0.64	1.12	1.12	1.14	medium	falling
	9/17/2007	640	99	0.00	0.24	1.14	1.14	medium	falling
Median			**91**						
Geometric Mean			**79.3**						
NAB00.8A	6/25/2007	630	23	0.03	0.00	0.34	0.49	low	falling
	7/9/2007	645	11	0.48	0.78	0.81	0.81	medium	rising
	7/23/2007	730	7	0.00	0.00	0.03	1.17	medium	falling
	8/6/2007	815	4	0.00	0.00	0.00	0.00	low	falling
	8/20/2007	735	3	0.00	0.02	0.12	0.56	low	falling
	9/10/2007	625	21	0.64	1.12	1.12	1.14	medium	falling
	9/17/2007	715	12	0.00	0.24	1.14	1.14	medium	falling
Median			**11**						
Geometric Mean			**9.1**						
MAB00.1A	6/25/2007	617	31	0.03	0.00	0.34	0.49	low	falling
	7/9/2007	620	40	0.48	0.78	0.81	0.81	medium	rising
	7/23/2007	700	5	0.00	0.00	0.03	1.17	medium	falling
	8/6/2007	750	5	0.00	0.00	0.00	0.00	low	falling
	8/20/2007	710	4	0.00	0.02	0.12	0.56	low	falling
	9/10/2007	615	23	0.64	1.12	1.12	1.14	low	falling
	9/17/2007	645	22	0.00	0.24	1.14	1.14	medium	falling
Median			**22**						
Geometric Mean			**13.0**						

2007 Water Quality Monitoring
Winooski Headwaters

Station	Date	Time	E. coli (mpn/100mL)	24 Hr rainfall	48 Hr rainfall	72 Hr rainfall	96 hr rainfall	Flow	Tendency
WIN 71.4A	6/25/2007	645	308	0.03	0.00	0.34	0.49	low	falling
	7/9/2007	715	1550	0.48	0.78	0.81	0.81	medium	rising
	7/23/2007	730	101	0.00	0.00	0.03	1.17	medium	falling
	8/6/2007	835	135	0.00	0.00	0.00	0.00	low	falling
	8/20/2007	730	113	0.00	0.02	0.12	0.56	low	falling
	9/10/2007	645	921	0.64	1.12	1.12	1.14	medium	falling
	9/17/2007	650	548	0.00	0.24	1.14	1.14	medium	falling
Median			308						
Geometric Mean			332.6						
WIN 81.6A	6/25/2007	615	727	0.03	0.00	0.34	0.49	low	falling
	7/9/2007	635	1050	0.48	0.78	0.81	0.81	medium	falling
	7/23/2007	705	328	0.00	0.00	0.03	1.17	medium	falling
	8/6/2007	755	197	0.00	0.00	0.00	0.00	low	falling
	8/20/2007	720	132	0.00	0.02	0.12	0.56	low	falling
	9/10/2007	620	816	0.64	1.12	1.12	1.14	low	falling
	9/17/2007	700	179	0.00	0.24	1.14	1.14	medium	falling
Median			**328**						
Geometric Mean			**370.1**						
WIN83.8A	6/25/2007	615	344	0.03	0.00	0.34	0.49	low	falling
	7/9/2007	?	365	0.48	0.78	0.81	0.81	medium	rising
	7/23/2007	?	179	0.00	0.00	0.03	1.17	medium	falling
	8/6/2007	740	365	0.00	0.00	0.00	0.00	low	falling
	8/20/2007	645	102	0.00	0.02	0.12	0.56	low	falling
	9/10/2007	530	411	0.64	1.12	1.12	1.14	low	falling
	9/17/2007	530	101	0.00	0.24	1.14	1.14	medium	falling
Median			**344**						
Geometric Mean			**230.7**						
WIN86.3A	6/25/2007	600	59	0.03	0.00	0.34	0.49	low	falling
	7/9/2007	?	109	0.48	0.78	0.81	0.81	medium	rising
	7/23/2007	?	86	0.00	0.00	0.03	1.17	medium	falling
	8/6/2007	735	79	0.00	0.00	0.00	0.00	low	falling
	8/20/2007	630	36	0.00	0.02	0.12	0.56	low	falling
	9/10/2007	545	308	0.64	1.12	1.12	1.14	low	falling
	9/17/2007	545	193	0.00	0.24	1.14	1.14	medium	falling
Median			**86**						
Geometric Mean			**99.0**						