2010 UPPER OTTER CREEK WATERSHED

Water Quality Monitoring Report

Submitted by:

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Submitted to:

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Introduction

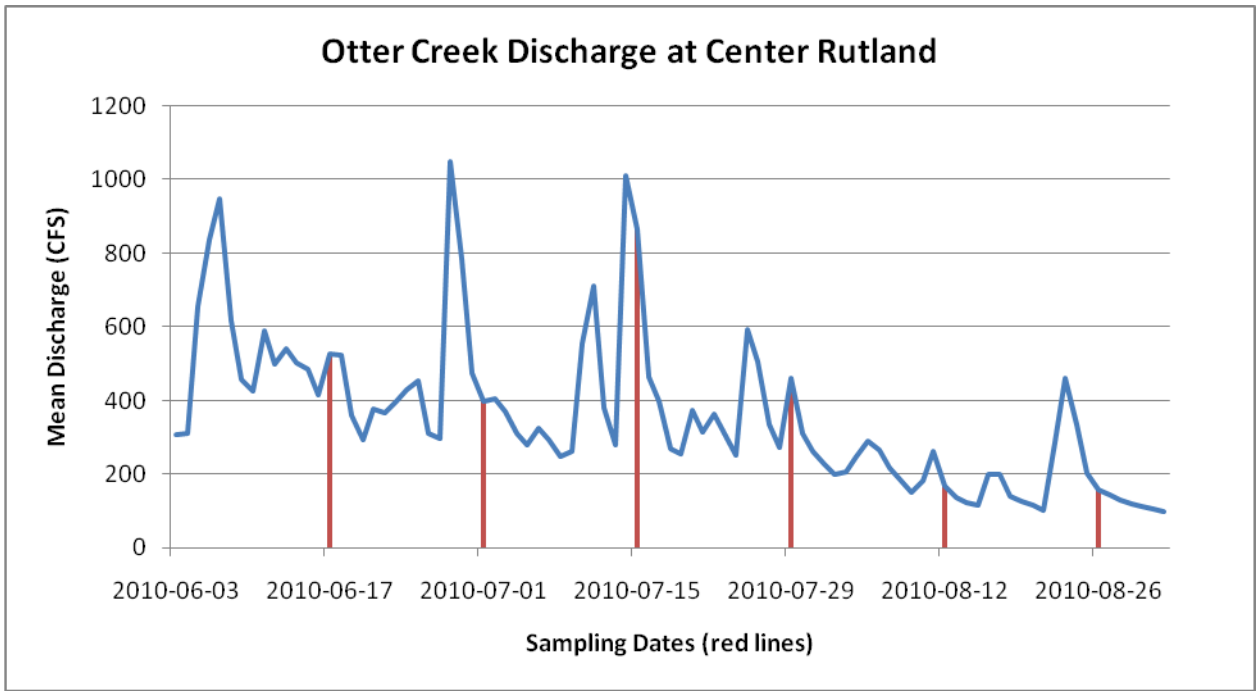
During the summer months of 2010, the Rutland Natural Resources Conservation District, with the help of volunteer monitors, collected samples from area creeks for analysis at the LaRosa Analytical Lab in Waterbury, Vermont. Samples from seventeen sites (listed in table 1) were analyzed for *E. coli*, total nitrogen, total phosphorus, and turbidity levels. The District would like to thank the Vermont Department of Environmental Conservation for their continuing support of this program through LaRosa Laboratory Grants. This is the seventh year that the District has participated in the volunteer water quality monitoring program.

Table 1: Upper Otter Creek watershed volunteer water quality monitoring sites for the 2010 sampling season.

Site	Location Description
mill06	Mill River at US Rte. 7 swimming hole
muss04	Mussey Brook, upstream of Park Street bridge
clar08	Clarendon River at business route 4A crossing
clar07	Clarendon River at the West Rutland Rec. Area
clar05	Clarendon River upstream confluence Ira Brook
weath19	Smokey House Center monitoring program # WB1, minimal impact headwaters reference site
baker22	Baker Brook from Baker Brook Road
baker21	Baker Brook from Hossington Crossroad in Danby
baker20	Baker Brook at East Road Bridge
moon03	Moon Brook, below Forest Street Bridge
east07	East Creek at Meadow Street Recreation Area
tenn12	Tenney Brook off Rte 7 behind Sewards Restaurant
tenn10	Tenney Brook at Lincoln Avenue Park
cook05	Wetlands complex, headwaters of South Branch (of Cascades Brook)
cook04	Southern Branch of Cascades Brook flowing Northeasterly
cook03	Northern Mainstem of Cascades Brook
cook01	Cascades Brook, south of Cook Road

Data observations

The following graph (chart 1) shows the water level, or discharge, measured in cubic feet per second at the US Geological Survey monitoring station on the Otter Creek located at Center Rutland during the 2010 sample season (sample dates shown in red).



Discharge rates are often studied in conjunction with rainfall data for the sampling period. The discharge rate (CFS) of the Otter Creek tells us several important things about water flow when monitoring samples are collected. It shows how much water is in the stream and it shows if the samples were taken as water levels were rising or receding. The discharge rate, combined with rainfall data provides information related to storm events and stream conditions when the samples were collected.

Rainfall data collected at the Rutland Airport and archived by Weather Underground shows that there was a slight rainfall event on the first sampling date, June 17, 2010 (0.01 inches). There was another slight rainfall event on July 1 (0.03 inches). Relatively large storm events are recorded before and/or during the third and fourth sampling dates (July 13, 0.05 inches; July 14, 0.25 inches; July 15, 0.28 inches; and July 29, 0.25 inches). The August 12 sampling event occurs two days after a rain event (August 9, 0.14 inches and August 10, 0.01 inches) and the August 26 sampling event occurs three days after a relatively large storm (August 22, 0.69 inches and August 23 0.36 inches).

E. Coli

The Vermont Water Quality Standard for *E. coli* concentrations in class B waters is 77 colonies per 100 ml of water. The US EPA standard for *E. coli* concentrations is 235 colonies per 100 ml of water. As illustrated in Table 2, most of the streams in this study do not meet State or Federal guidelines for *E. coli* levels throughout the sampling season.

Table 2: Percent of samples at each site that exceed State and Federal Water Quality Guidelines for *E. coli* concentrations.

Site	Location Description	% of samples above Vermont	% of samples above Federal
mill06	Mill River at US Rte 7 swimming hole	67	0
muss04	Mussey Brook, upstream of Park Street bridge	100	83
clar08	Clarendon River at business route 4A crossing	67	50
clar07	Clarendon River at the West Rutland Rec. Area	67	17
clar05	Clarendon River upstream confluence Ira Brook	100	0
weath19	Smokey House Center monitoring program # WB1, minimal impact headwaters reference site	17	17
baker22	Baker Brook from Baker Brook Road	33	17
baker21	Baker Brook from Hossington Crossroad in Danby	67	33
baker20	Baker Brook at East Road Bridge	50	0
moon03	Moon Brook, below Forest Street Bridge	100	100
east07	East Creek at Meadow Street Recreation Area	100	83
tenn12	Tenney Brook off Rte 7 behind Sewards Restaurant	40	20
tenn10	Tenney Brook at Lincoln Avenue Park	17	17
cook05	Wetlands complex, headwaters of South Branch (of Cascades Brook)	50	17
cook04	Southern Branch of Cascades Brook flowing Northeasterly	100	80
cook03	Northern Mainstem of Cascades Brook	0	0
cook01	Cascades Brook, south of Cook Road	50	0

*77 colonies of *E. coli* bacteria per 100 mL of stream water
**235 colonies of *E. coli* bacteria per 100 mL of stream water

Moon03 on Moon Brook in Rutland exceeded both EPA and State guidelines during all sample collection dates and even its lowest reading, 387 colonies per 100 mL of water, was over five times the state recommended maximum and more than 1.5 times the EPA recommended maximum.

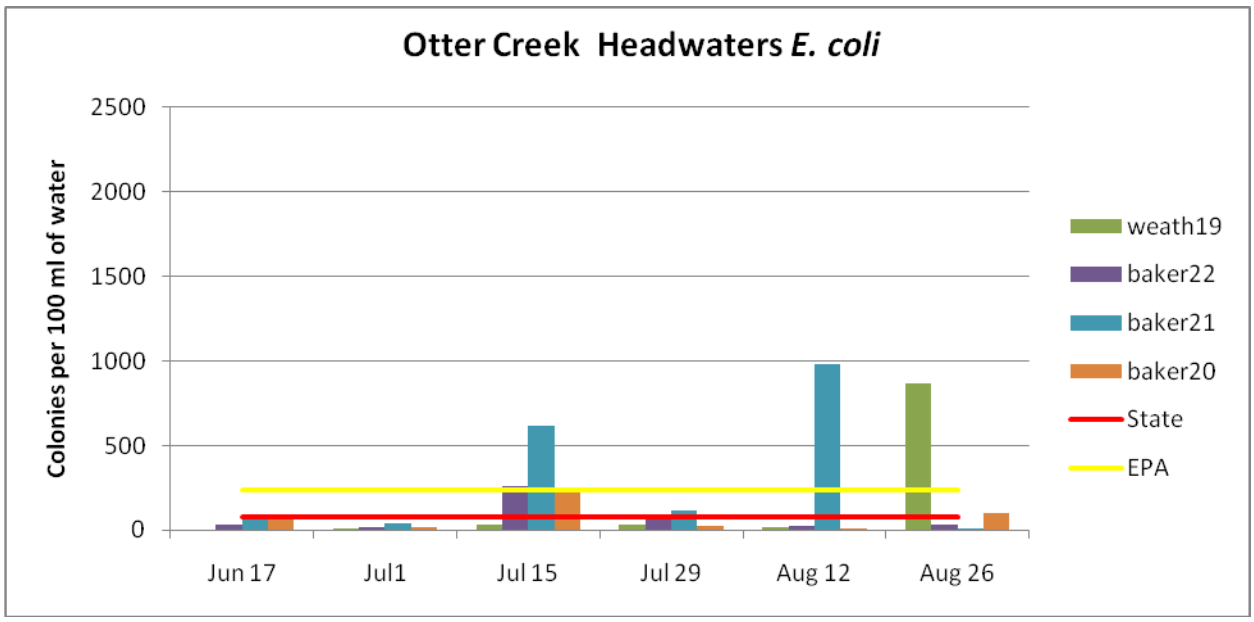
Four more sites, Muss04 on Mussey Brook, Clar05 on Clarendon River, East07 on East Creek, and Cook04 on the southerly branch of Cascades Brook, exceeded State guidelines during all of the sampling events. Clar05 never exceeded Federal Guidelines, however, the other three sites exceeded Federal guidelines in approximately 80% of the samples (all but one sample for each of them). Ironically, Cascades Brook, had the only site to not exceed 77 colonies per 100mL of water for the entire sampling season and also a site, slightly upstream, that regularly exceeded both guidelines.

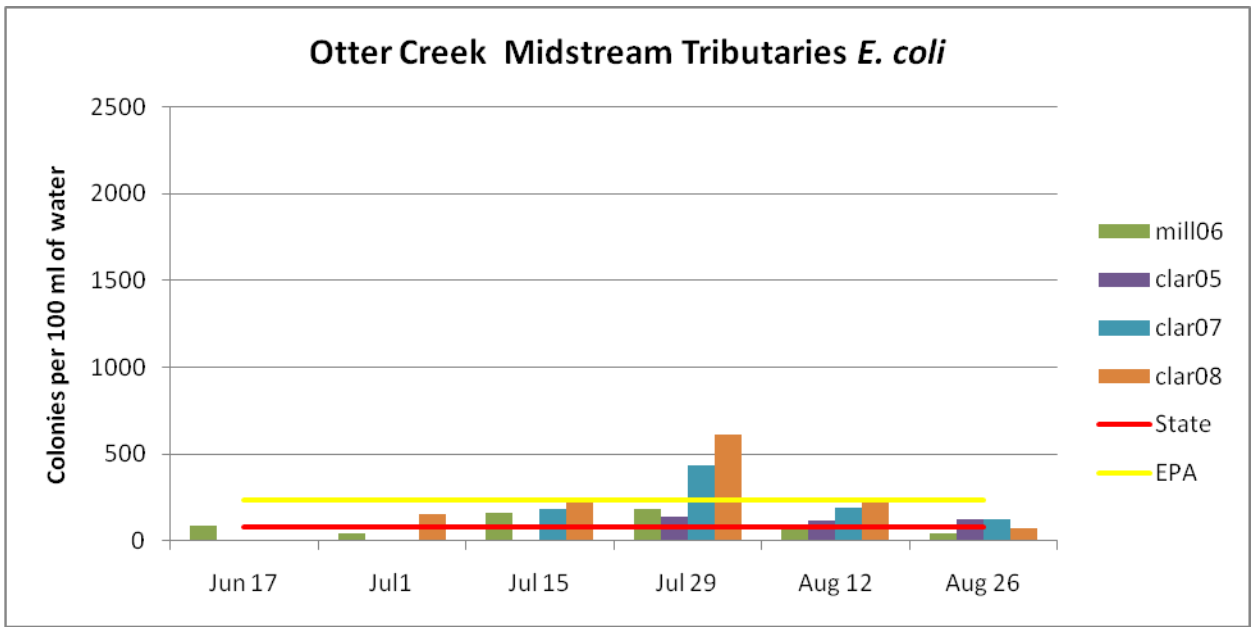
In the Otter Creek headwaters area, Baker Brook sites showed higher *E. coli* concentrations after storm events (7/15 and 7/29, refer to chart 1), especially July 15. In general, *E. coli* concentrations decreased from Baker 21 to Baker 22 to Baker 20. Baker21 had a high reading on August 12. Weatherby 19 had low *E. coli* concentrations throughout the study, except on August 26th, which was a low flow stage on the Otter Creek (see chart 1), receding after storm events on August 22 and August 23. This site is mainly forested; perhaps a thunderstorm would explain this seeming anomaly?

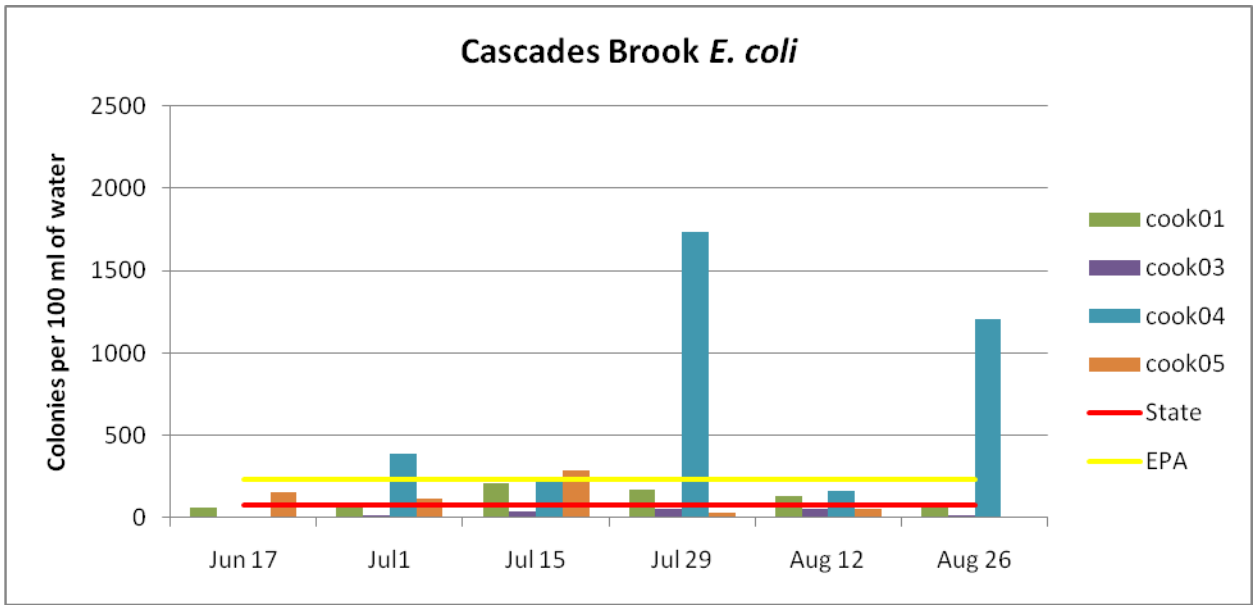
In the Otter midstream) tributary area, (Clarendon and Mill Rivers) all sites measured the highest for *E. coli* concentrations on July 29, and concentrations generally increased during storm events. *E. coli* levels consistently increased from Clar05 upstream at the Ira Brook confluence to Clar08 in Rutland Town, potentially showing higher concentrations of *E. coli* in the downstream reaches of the Clarendon River. Between these sample locations are agricultural operations, the wastewater treatment facility, and the urban corridor along Route 4A in Center Rutland, all of which could contribute to *E. coli* levels in the river.

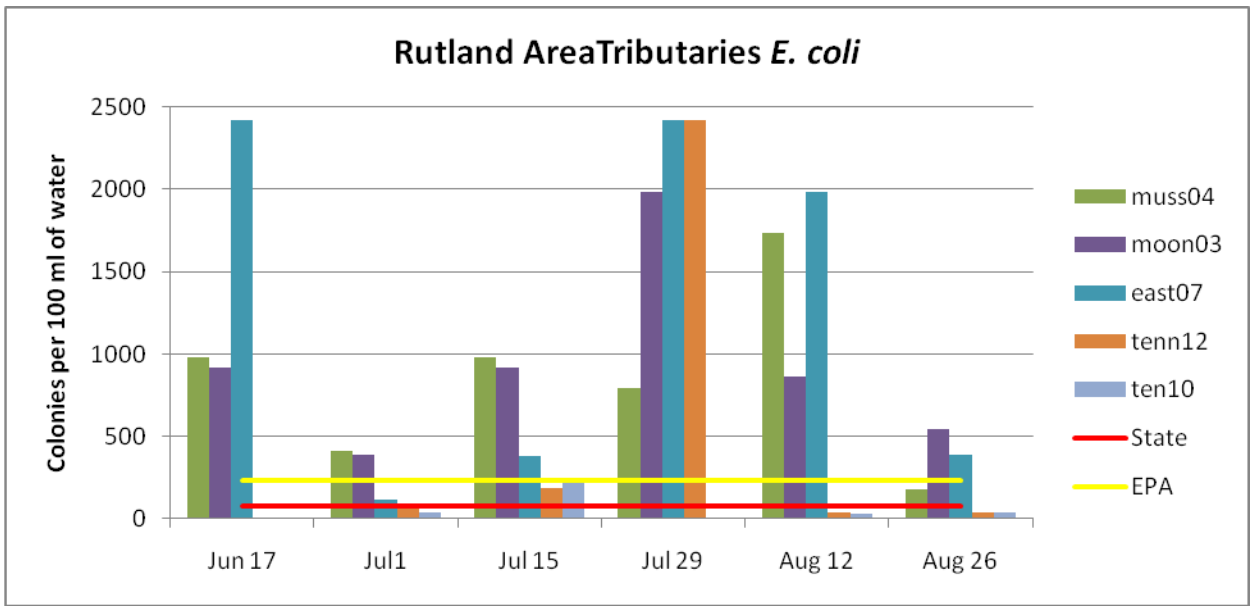
Rutland area tributaries measured quite high levels of *E. coli*, especially East07 on June 17, July29, and August 12. Tenn12 measured high E. coli concentrations on July 29. The Moon and Mussey Brook sampling sites measured high *E. coli* concentrations throughout the sampling season, especially Moon Brook on July 29th and Mussey Brook on August 18th. The RNRCD and Vermont DEC have focused past efforts on these tributaries, helping property owners to decrease nutrient and *E. coli* inputs and stabilize their streambanks.

E. coli levels at Cook 04 increased dramatically on July 29 and August 26 despite relatively low flows. In this case, high flows may be diluting discharges that become more apparent during low flow conditions. The District hopes to follow up with additional sampling at this site.


Otter Creek Headwaters E. coli
Colonies per 100 ml of water
2500
2000
1500
1000
500
0
Jun 17
Jul1
Jul 15
Jul 29
Aug 12
Aug 26
weath19
baker22
baker21
baker20
State
EPA


Otter Creek Midstream Tributaries E. coli
Colonies per 100 ml of water
2500
2000
1500
1000
500
0
Jun 17
Jul1
Jul 15
Jul 29
Aug 12
Aug 26
mill06
clar05
clar07
clar08
State
EPA


Cascades Brook E. coli
Colonies per 100 ml of water
2500
2000
1500
1000
500
0
Jun 17
Jul1
Jul 15
Jul 29
Aug 12
Aug 26
cook01
cook03
cook04
cook05
State
EPA


Rutland AreaTributaries E. coli
Colonies per 100 ml of water
2500
2000
1500
1000
500
0
Jun 17
Jul1
Jul 15
Jul 29
Aug 12
Aug 26
muss04
moon03
east07
tenn12
ten10
State
EPA

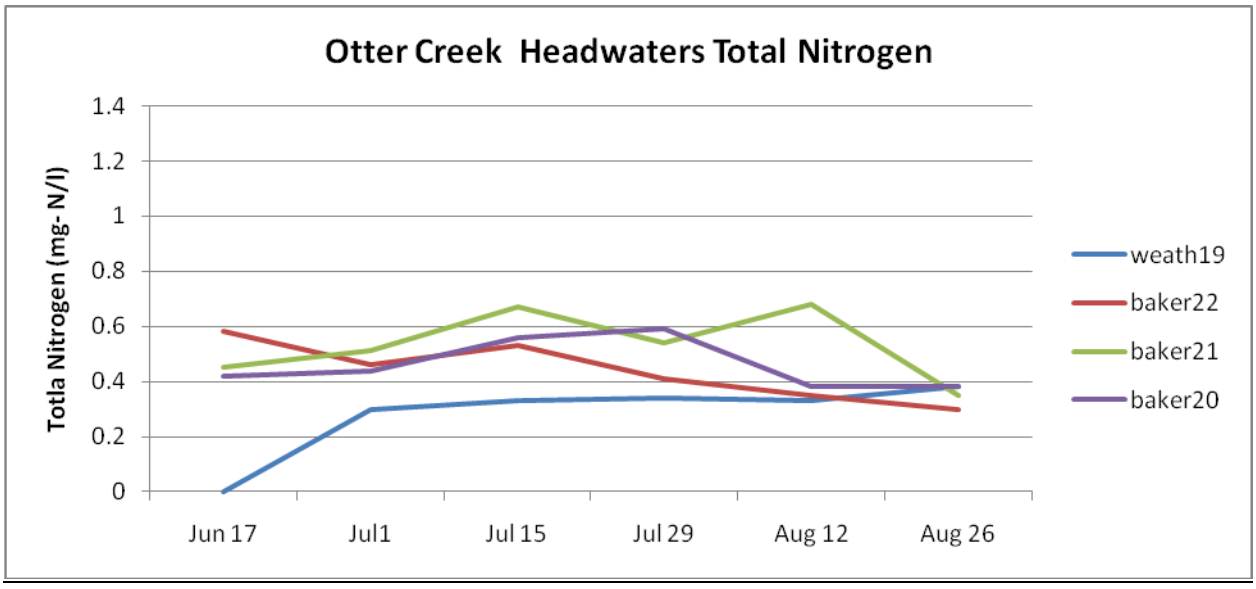
Total Nitrogen

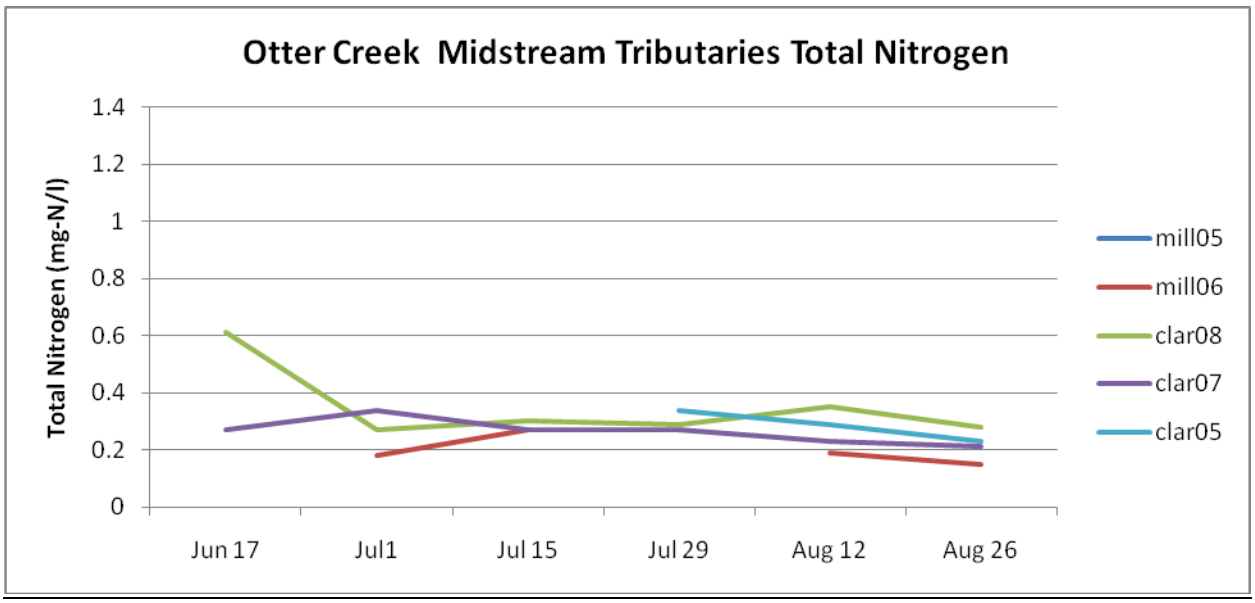
As stated in the Vermont Water Quality Standards (p. 23), "In all waters nitrates shall be limited so that they will not contribute to the acceleration of eutrophication, or the stimulation of the growth of aquatic biota, in a manner that prevents the full support of uses."

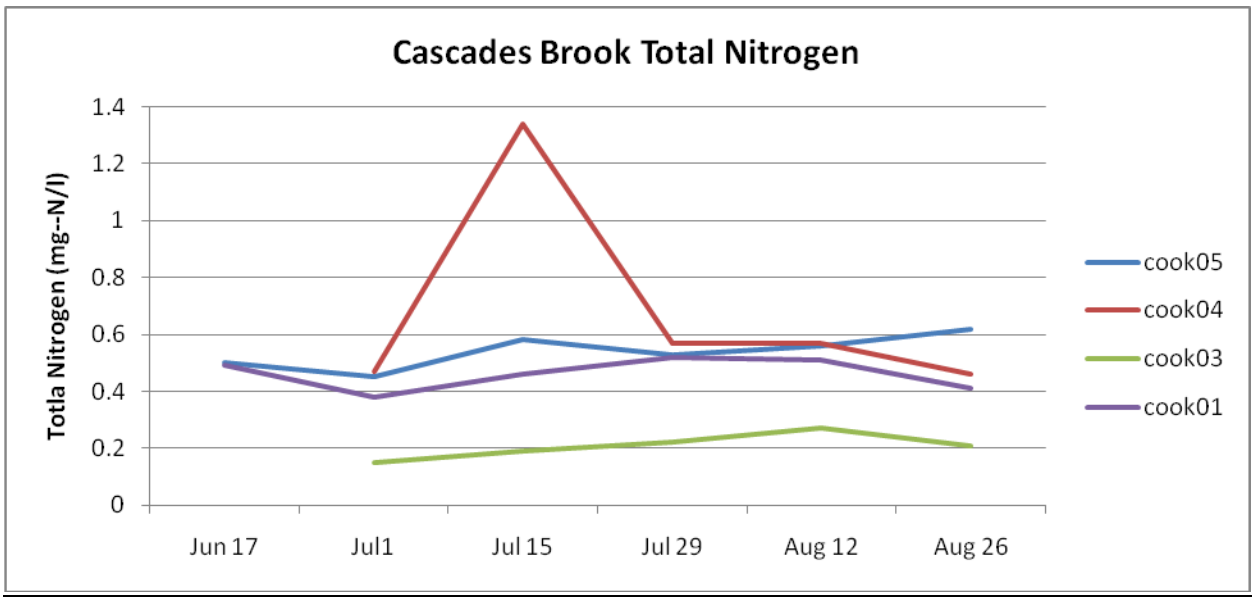
Lakes, Ponds, and Reservoirs, not including Riverine Impoundments, are not to exceed 5.0 mg/l as NO_3-N (nitrate) regardless of classification. Class A(1) and A(2) waters over 2,500 feet elevation are not to exceed 0.20 mg/l, as nitrate-nitrogen (NO_3-N) at flows exceeding low median monthly flows. Class A(1) and A(2) waters below 2,500 feet elevation are not to exceed 2.0 mg/l as NO_3-N at flows exceeding low median monthly flows. *Class B waters are not to exceed 5.0 mg/l as NO_3-N at flows exceeding low median monthly flows* (WQS, p 23.)

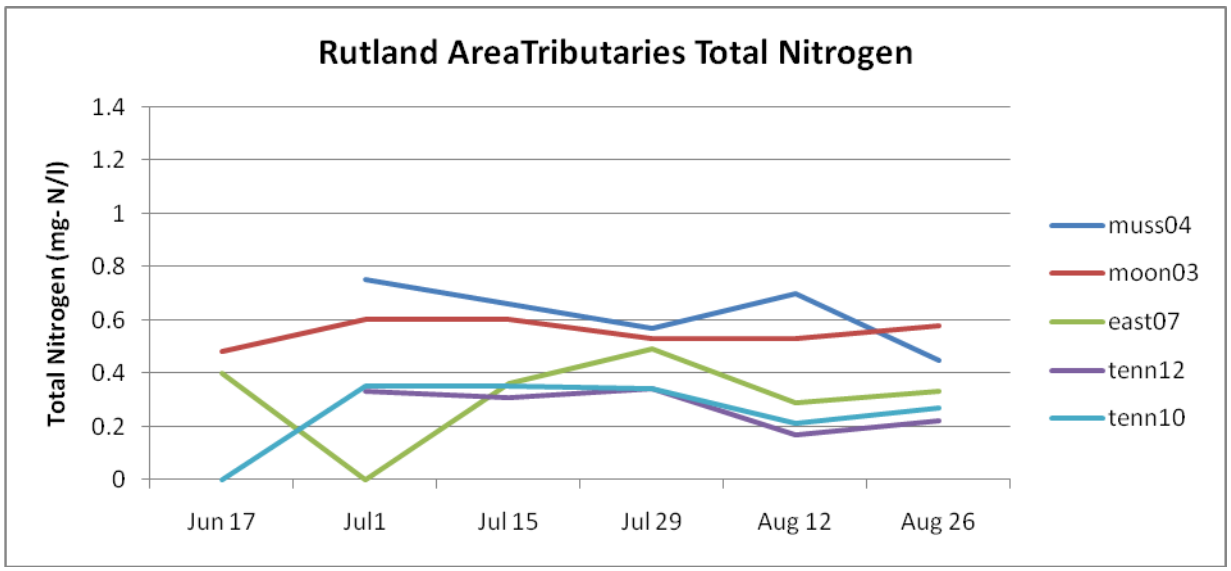
The streams in our study are class B waters and thus not to exceed 5.0 mg/l of nitrogen as nitrate, a soluble and biologically available form of nitrogen, during higher flow events. Nitrate is water soluble and moves freely through most soils. Nitrate contributions to surface water from agriculture are primarily from groundwater connections and other subsurface flows rather than overland runoff (Follett, 1995).

The highest sample result during the 2010 sample season was a spike at Cook04 of less than 1.4mg/l NO_3, on July 15, which corresponds with high stream flow and high turbidity, but not with high E. coli or phosphorus at that site. All of the other sample results were less than one mg/l NO_3.




Otter Creek Midstream Tributaries Total Nitrogen
Total Nitrogen (mg-N/l)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Jun 17
Jul1
Jul 15
Jul 29
Aug 12
Aug 26
mill05
mill06
clar08
clar07
clar05


Cascades Brook Total Nitrogen
Totla Nitrogen (mg--N/l)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Jun 17
Jul1
Jul 15
Jul 29
Aug 12
Aug 26
cook05
cook04
cook03
cook01



Total Phosphorous

According to the Vermont Water Quality Standards, "In all waters, total phosphorous loadings shall be limited so that they will not contribute to the acceleration of eutrophication or the stimulation of the growth of aquatic biota in a manner that prevents the full support of uses."

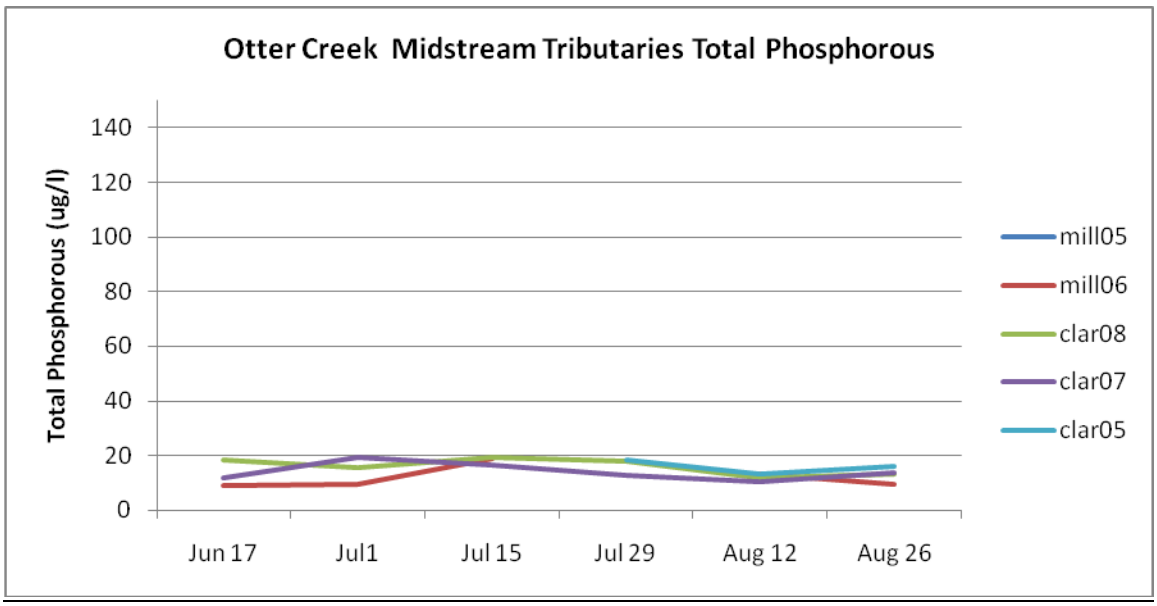
In addition to compliance with the general policy above, for all streams above 2,500 feet in elevation, total phosphorus shall not exceed 0.010 mg/l at low median monthly flow.

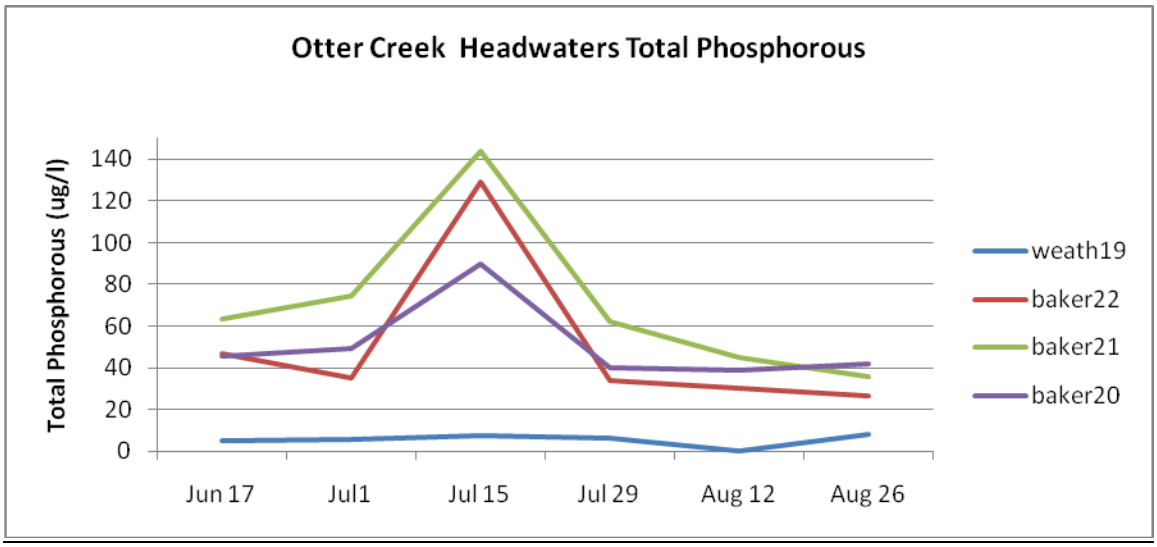
Additionally, it is the policy of the State of Vermont to accomplish net reductions in current phosphorus loadings to Lake Champlain that are necessary to achieve the in-lake total phosphorus concentration criterion listed in the Water Quality Standards. The phosphorus criterion for the Otter Creek segment of Lake Champlain and the tributaries in that basin is 0.014 mg/l (p.22).

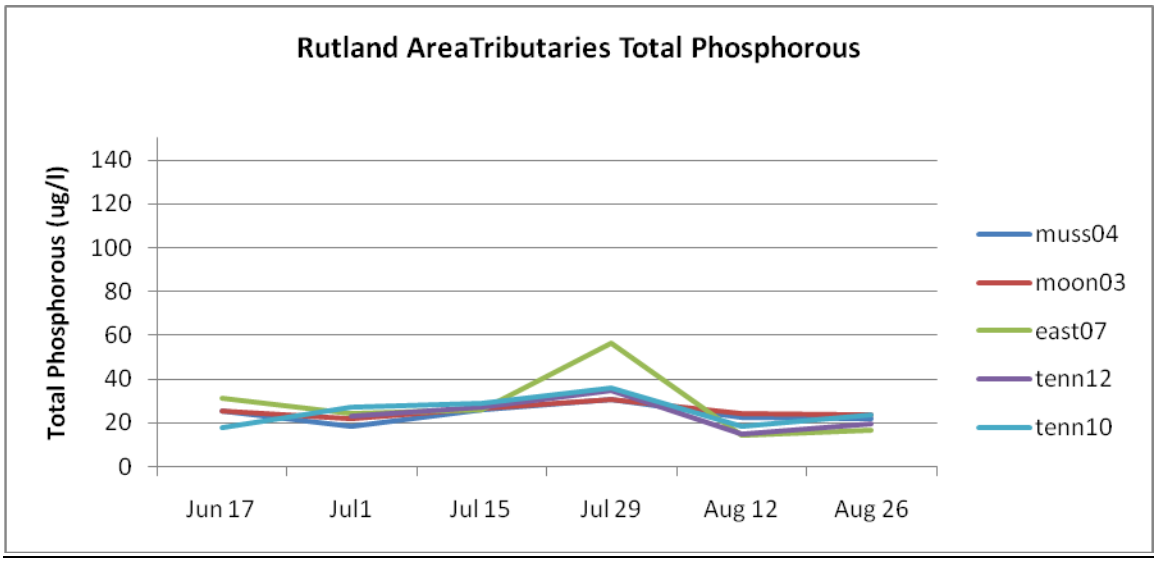
Baker Brook is the only stream that approaches the water quality standard of 0.014 mg/l or 140 ug/l. All of the Baker Brook sites showed higher phosphorous levels, particularly during the high flow event on July 15, where baker21 was above the 140 ug/l limit. Generally, the highest levels were found at the upstream site (baker 21) and decreased downstream. During the high flow event of July 15 that trend changed, with the lowest site showing higher phosphorous levels than the middle site.

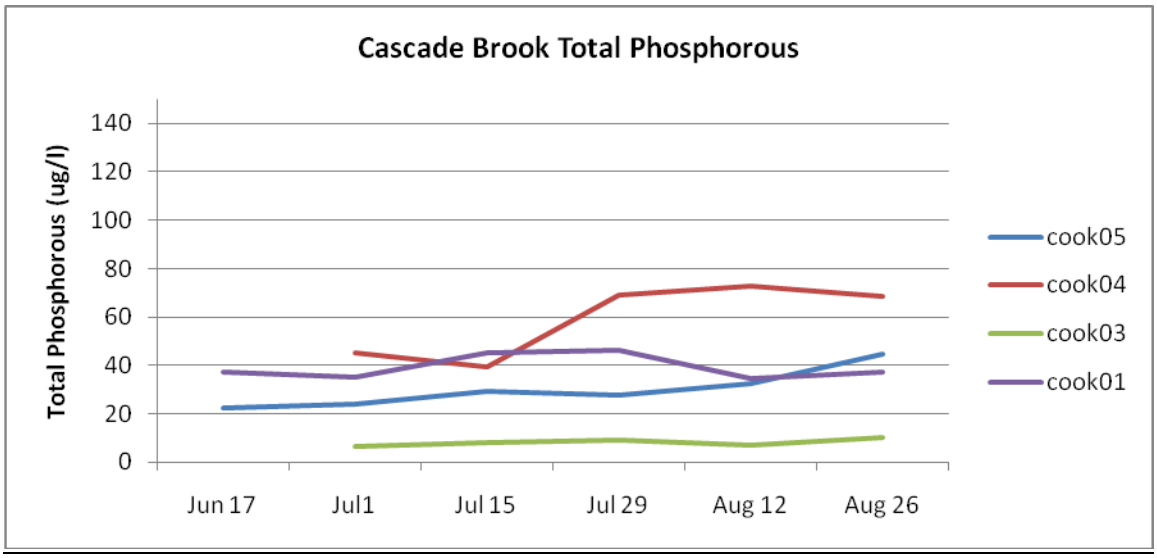
Another stream, Cascades Brook, potentially showed local phosphorus inputs. On four of the five sampling dates, Cook04, the southern branch of Cascades Brook showed elevated phosphorous levels (near 80 ug/l) compared to the other Cascade Brook sampling sites (though not on July 15, when nitrogen and turbidity measurements at this site were highest). The

difference became more pronounced near the end of the season, which corresponds with lower flow rates.







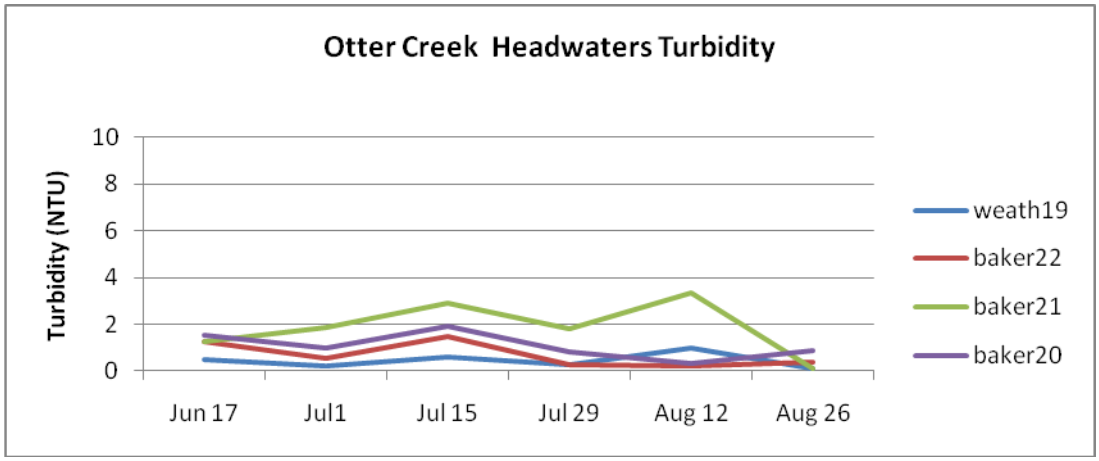


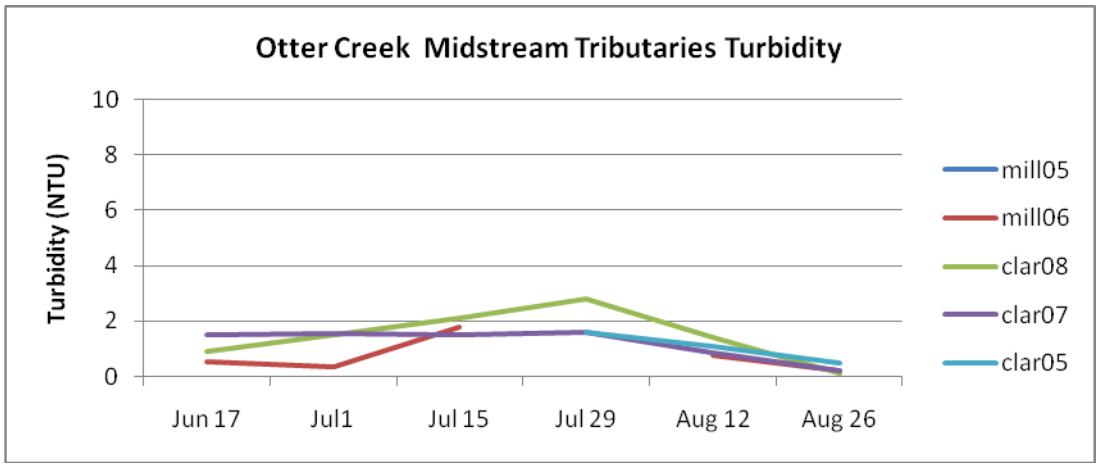
Turbidity

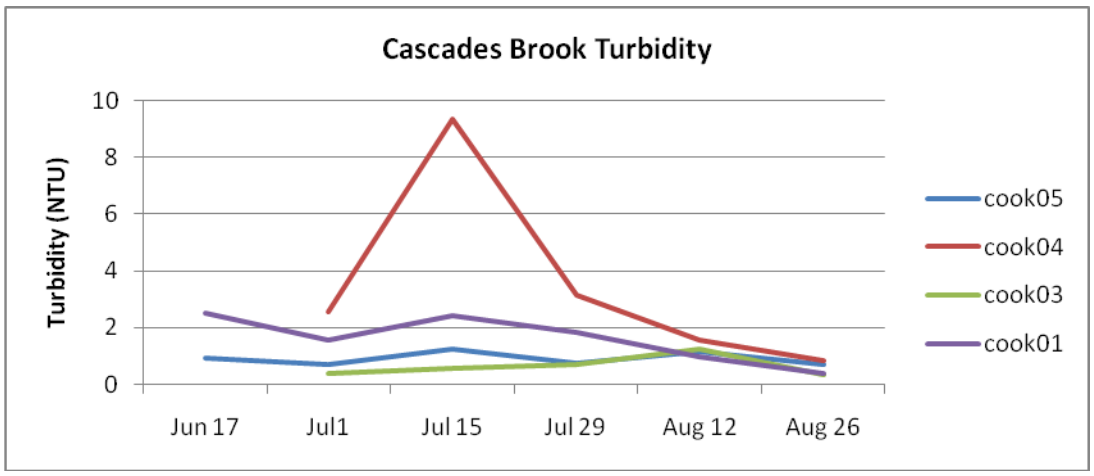
The Vermont Water Quality Standards state that in Cold Water Fish Habitat waters turbidity levels are not to exceed 10 NTU (nepholometric turbidity units) as an annual average under dry weather base-flow conditions; and in Warm Water Fish Habitat turbidity concentrations are not to exceed 25 NTU (nepholometric turbidity units) as an annual average under dry weather base-flow conditions (p. 32).

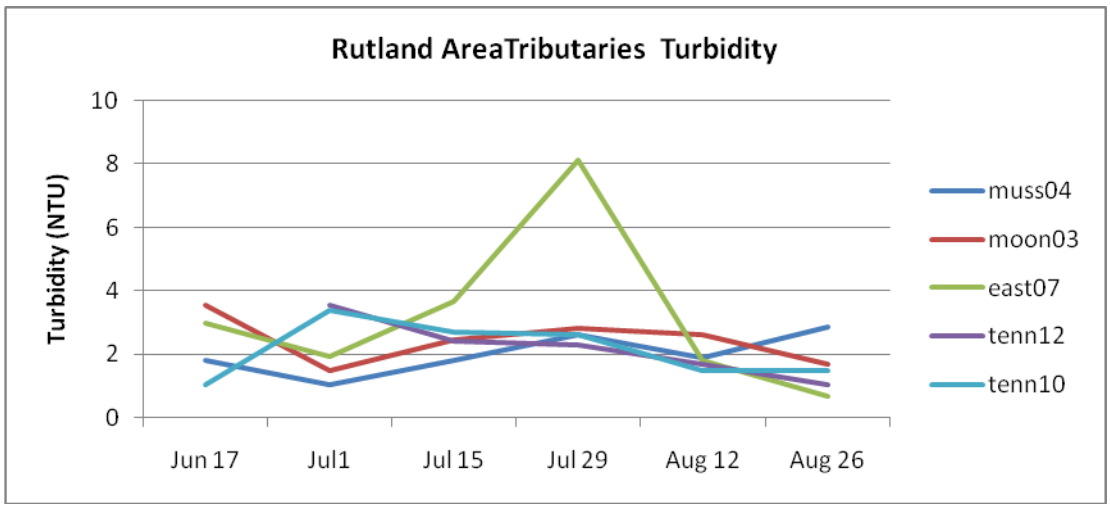
All of the streams in this study area are listed as cold water fish habitat (WQS, Appendix A, p. 56-57). Note: Otter Creek from the outfall of the Proctor wastewater treatment facility in Proctor, to its confluence with Lake Champlain, except that portion between the Beldens Dam and the Huntington falls, is listed as a warm water habitat, and according to Ethan Swift, fishery biologists consider this portion of Otter Creek as 'mixed' water habitat (cold and warm), but no samples were collected in this area.

While no streams even reached the 10 NTU threshold for cold water streams, both Cascade Brook (Cook04) and East Creek (East07) approach it, on July 15th and July 29th respectively. All other streams are well below the standard, even during the July 15 high flow event.






Cascades Brook Turbidity
Turbidity (NTU)
10
8
6
4
2
0
Jun 17
Jul1
Jul 15
Jul 29
Aug 12
Aug 26
cook05
cook04
cook03
cook01


Rutland AreaTributaries Turbidity
Turbidity (NTU)
10
8
6
4
2
0
Jun 17
Jul1
Jul 15
Jul 29
Aug 12
Aug 26
muss04
moon03
east07
tenn12
tenn10

APPENDIX A- DATA VALIDATION

Data Validation

Volunteers collected two types of quality control samples for the summer 2010 water quality monitoring project. The first were field blanks. These 'blank,' or de-ionized water, samples were carried in the cooler with the actual samples to check for cross contamination between samples or contamination from lab or volunteer sampling methodology. Volunteers carried a field blank on each sampling date. All of the field blank sample results were below detection, indicating that cross contamination was not significant.

The other quality control samples were field duplicates. For each sampling event, duplicate samples were collected at one site. The results of these duplicates are then compared and the relative percent difference analyzed. The goal for our samples was to maintain an average relative percent difference of less than %125. For each of our (the lab's) analytical methods, the relative percent difference goal for QA samples was met.

Table 1: Field Duplicate results and Relative Percent Difference for summer 2010 Upper Otter Creek E. coli samples

Site ID	Date	Sample Result	Duplicate	RPD
Cook01	6/17/10	62	105	51
Tenn10	7/01/10	37	32	14
East07	7/15/10	378	727	63
Moon03	7/29/10	1986	1733	14
Baker20	8/12/10	2	12	143
Weath19	8/26/10	866	144	143
Average RPD				**71**

Table 2: Field Duplicate results and Relative Percent Difference for summer 2010 Upper Otter Creek Total Nitrogen samples

Site ID	Date	Sample Result	Duplicate	RPD
Cook01	6/17/10	0.49	0.46	6
Tenn10	7/01/10	0.35	0.36	3
East07	7/15/10	0.36	0.35	3
Moon03	7/29/10	0.53	0.5	6
Baker20	8/12/10	0.38	0.4	5
Weath19	8/26/10	0.38	0.35	8
Average RPD				**5**

Table 3: Field Duplicate results and Relative Percent Difference for summer 2010 Upper Otter Creek Total Phosphorus samples

Site ID	Date	Sample Result	Duplicate	RPD
Cook01	6/17/10	37.4	37.5	3
Tenn10	7/01/10	26.9	26.5	1.5
East07	7/15/10	26	25.3	2.7
Moon03	7/29/10	30.4	29.4	3.3
Baker20	8/12/10	38.6	39.1	1.3
Weath19	8/26/10	8.09	7.98	1.4
Average RPD				**2.2**

Table 4: Field Duplicate results and Relative Percent Difference for summer 2010 Upper Otter Creek Turbidity samples

Site ID	Date	Sample Result	Duplicate	RPD
Cook01	6/17/10	2.52	2.59	2.7
Tenn10	7/01/10	3.4	3.57	4.9
East07	7/15/10	3.68	3.61	1.9
Moon03	7/29/10	2.83	2.43	15.2
Baker20	8/12/10	0.33	0.37	11
Weath19	8/26/10	<0.2	0.45	77
Average RPD				**18.8**

References

Follett, Ronald R. September 1995. Fate and Transport of Nutrients: Nitrogen. Working Paper No. 7, U.S. Department of Agriculture, Agricultural Research Service, Soil-Plant-Nutrient Research Unit, Fort Collins, Colorado

Vermont Water Quality Standards, Vermont Department of Environmental Conservation, http://www.nrb.state.vt.us/wrp/publications/wqs.pdf

Ethan Swift, Watershed Coordinator, Vermont DEC; Monitoring, Assessment, and Planning Division, general communication, August 2011

Kristen Underwood, principal hydrologist/geologist, South Mountain Research and Consulting, general communication, June 2011

US Geologic Survey, archived streamflow data, www.usgs.gov

Weather Underground, archived rainfall data, www.weatherunderground.com

We would like to thank all of our dedicated volunteers who made this Water Quality Monitoring program possible for the past 7 years.

Special thanks to Joe Przypek and Hilary Solomon for putting this report together!