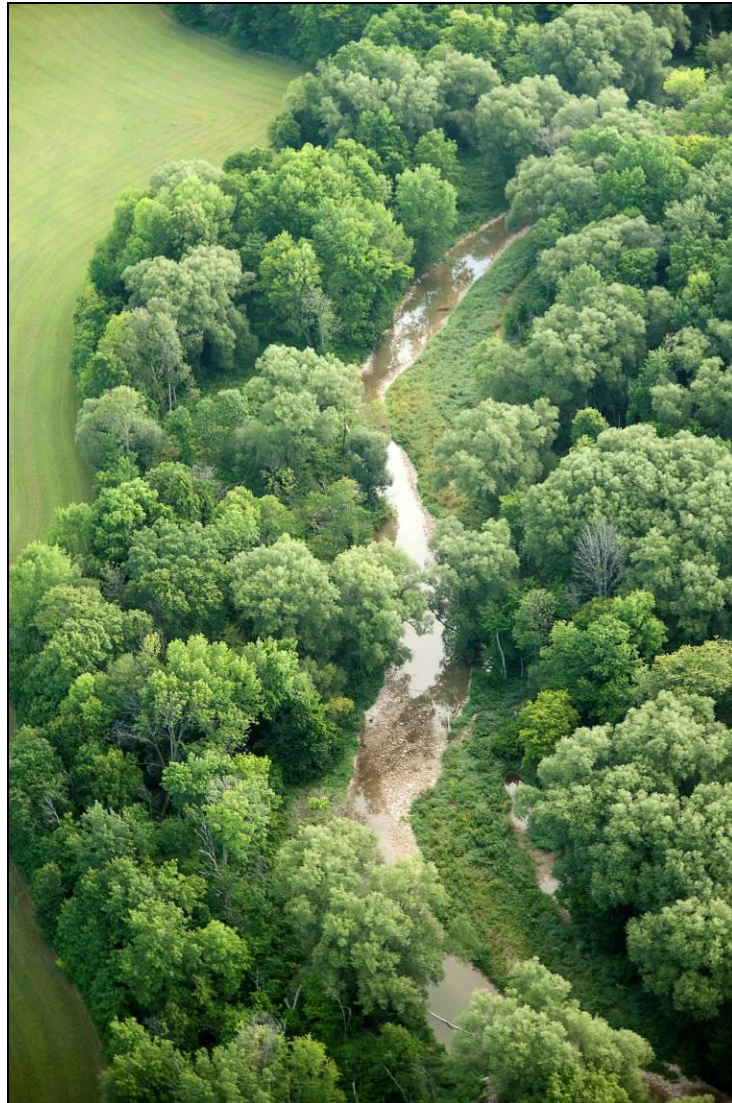


***Escherichia coli* Monitoring in the Main Bayfield River Watershed
- 2013 -**



Prepared for the Bayfield Ratepayers Association

by
Brynn Upsdell Wright
Ausable Bayfield Conservation Authority
71108 Morrison Line, R.R. #3, Exeter, Ontario, N0M 1S5

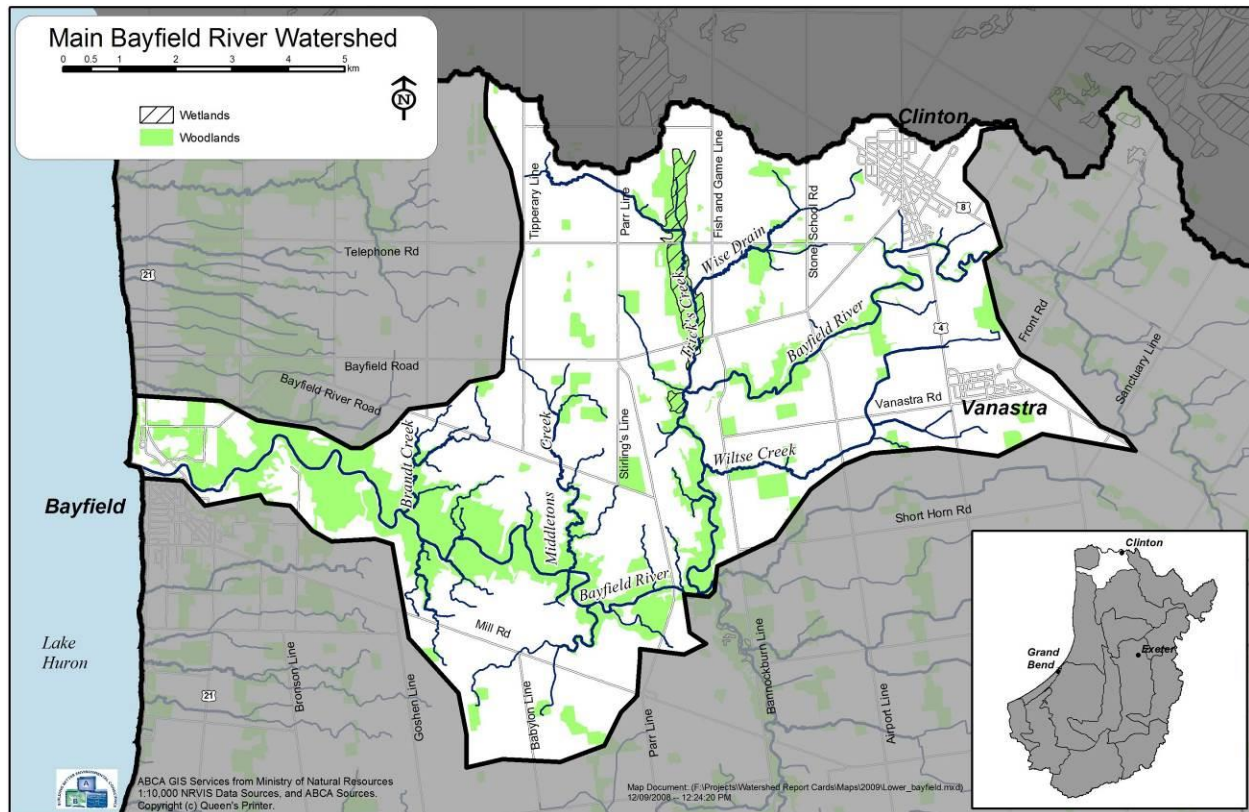
January 2, 2014



Aerial photo of the Bayfield River by Daniel Holm Photography, Courtesy of the Rural Stormwater Management Model Project of the Healthy Lake Huron: Clean Water, Clean Beaches Initiative.

Introduction

- The Main Bayfield River watershed is valued by both local residents and tourists for trout and salmon fishing along the Bayfield River and for recreation at beaches along the Lake Huron shoreline.



- Issues surrounding water quality have been ongoing around the Lake Huron shoreline for many years.
- The Bayfield community has been interested in reducing *Escherichia coli* (*E. coli*) concentrations in the Bayfield River in order to obtain and maintain a Blue Flag designation for the Bayfield Main Beach. This internationally-recognized designation assures the local community and visitors that beach water quality is good.
- Since 2008, the Bayfield Ratepayers Association (BRA) and the Ausable Bayfield Conservation Authority (ABCA) have collaborated to monitor *E. coli* in the Main Bayfield River watershed.
- The purpose of this report is to summarize the *E. coli* results from 2013 and to put them into context with the results from 2008 through 2012.

Methods

Water Sampling

- Water quality was monitored at ten sampling locations in the Main Bayfield River watershed, including two sites on the Bayfield River and eight sites on tributaries (streams or drains) flowing into the river.
- Water samples were collected every two weeks between June 25 and November 5, 2013.
- Additional samples were collected at a site on the Bayfield River (MB3) during June, July, and August when the ABCA was in the area for another monitoring program. This produced a larger dataset for the river that could be compared with data collected by the Huron County Health Unit from two beaches in Bayfield.
- The samples were analyzed by ALS Environmental in Waterloo, Ontario, to determine the concentration of *E. coli* in colony forming units per 100 millilitres of water (cfu/100 mL).

Data Interpretation

- *E. coli* concentrations were summarized in three ways:
 - 1) Geometric means – This reduces the effect of uncommonly high or low concentrations on a mean.
 - 2) Percentiles – For example, a 90th percentile is the concentration below which 90 per cent of the samples for a given site occur.
 - 3) Box plots – The horizontal line within each box represents the median (50th percentile) concentration. The box itself represents 50 per cent of the concentrations that were sampled, while the bars represent 80 per cent of the concentrations. The circles show outliers, or concentrations that are much higher or lower than the majority.
- The results were compared with the Ontario Ministry of Health and Long-term Care recreational guideline of 100 cfu/100 mL, which is typically applied to beaches and reservoirs used for swimming (MOEE 1994).
- Daily precipitation levels from a nearby rain gauge in Varna were helpful for understanding some of the variability in *E. coli* concentrations.
- Statistically significant differences between tributary sites were determined with the Kruskal-Wallis test and Dunn's post hoc test, using a significance level of 0.05.

Results and Discussion

- *E. coli* concentrations exceeding the 100 cfu/100 mL standard occurred at all ten sampling locations. This standard was exceeded more frequently at sampling sites located on tributaries of the Bayfield River (those with HB site codes) as opposed to sites located on the Bayfield River itself (those with MB site codes).
- The two Bayfield River sites (MB2, MB3) both exceeded concentrations of 100 cfu/100 mL on three sampling dates (Jul 30, Oct 8, 22). Each of these dates followed a period of rainfall sustained over a few to several days.
- In 2013, geometric means of *E. coli* concentrations exceeded the 100 cfu/100 mL standard at eight of the ten sampling locations, including one of the sites on the Bayfield River.

Site	<i>Escherichia coli</i> (cfu/100 mL) ^a											Geometric Mean	
	Jun 25, 2013	Jul 2, 2013	Jul 16, 2013	Jul 30, 2013	Aug 13, 2013	Aug 27, 2013	Sep 9, 2013	Sep 26, 2013	Oct 8, 2013	Oct 22, 2013	Nov 5, 2013		
HB1 ^b	110	130								300	350	110	175
HB2	1450	450	20	300	20	10	10	200	360	150	20	85	
HB3	1990	500	810	670	440	150	290	610	710	1070	210	534	
HB4	670	980	1330	850	1510	210	1100	660	290	320	50	523	
HB6	310	90	70	180	80	150	100	170	680	870	920	212	
HB7	130	120	140	250	160	220	360	190	560	440	40	192	
HB8	230	110	110	130	50	230	180	50	690	260	10	119	
HB9	100	130	160	150	110	100	40	90	440	480	30	121	
MB2	40	80	40	170	40	30	20	50	1280	590	90	85	
MB3	70	140	70	170	30	20	10	70	1050	900	90	109	

^a Concentrations exceeding Ontario Recreational Guideline (100 cfu/100 mL) are in bold font.

^b Site HB1 was dry from Jul 16 to Sep 26.

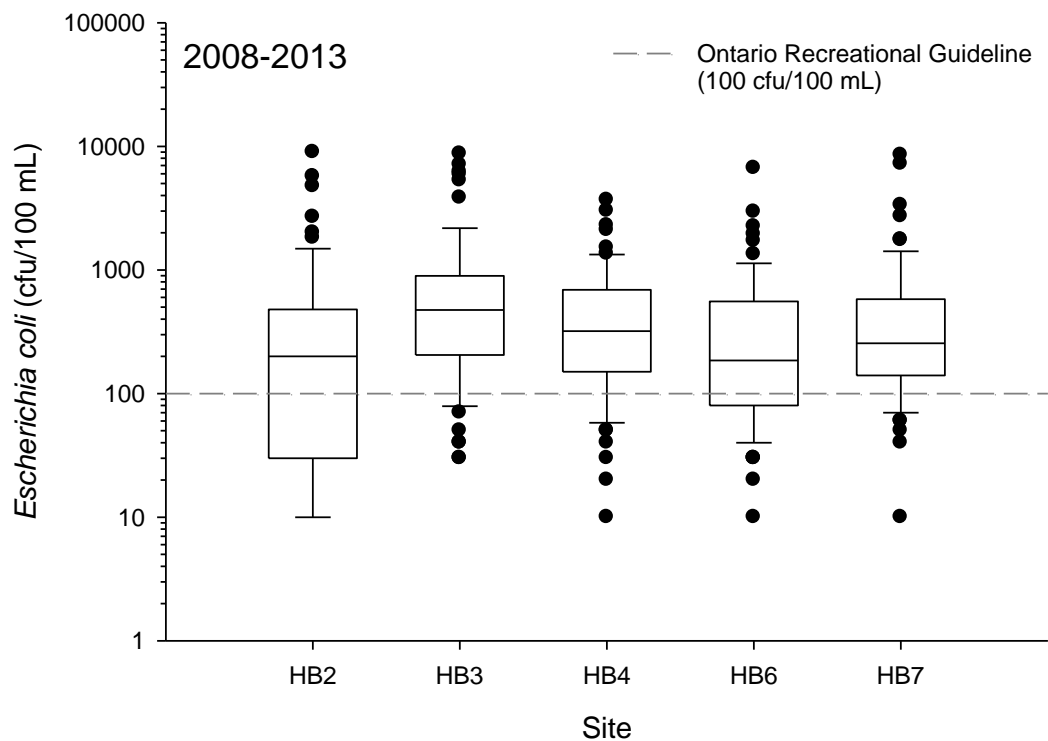
- The 90th percentile of *E. coli* concentrations was greater than 1000 cfu/100 mL at only two of the ten sites sampled in 2013. This is atypical, as at least five sites have had 90th percentiles exceeding 1000 cfu/100 mL each year since 2008.
- The 90th percentile at tributary site HB3 has consistently exceeded 1000 cfu/100 mL since 2008.

Site	<i>Escherichia coli</i> (cfu/100 mL)						Number of Samples					
	90 th Percentile											
	2008	2009	2010	2011	2012	2013	2008	2009	2010	2011	2012	2013
HB1	414	1870	2750	190	390	350	6	4	5	3	3	5
HB2	1667	3072	4672	1427	2530	850	8	11	11	12	11	11
HB3	5414	2708	7022	2325	2456	1438	8	11	11	12	11	11
HB4	1066	1254	2014	906	2842	1402	8	11	11	11	11	11
HB6	1145	3268	2060	1277	624	890	8	11	11	12	11	11
HB7	6268	570	3936	2899	1524	488	8	11	11	12	11	11
HB8*				951	1108	432				12	11	11
HB9*				2978	816	456				11	11	11
MB2	2294	252	1364	460	192	866	8	11	11	12	11	11
MB3*				976	296	960				12	11	11

* Monitoring at this site began in 2011.

Data sources: Upsdell and Veliz 2009a; Upsdell and Veliz 2009b; Upsdell and Veliz 2011; Upsdell and Veliz 2012; Gutteridge and Veliz 2013

- As of 2013, five of the tributary sites had been sampled consistently over a six-year period. There were some statistically significant differences in the *E. coli* concentrations between these sites, with site HB3 having significantly higher concentrations than sites HB2 and HB6.



Data sources: Upsdell and Veliz 2009a; Upsdell and Veliz 2009b; Upsdell and Veliz 2011; Upsdell and Veliz 2012; Gutteridge and Veliz 2013

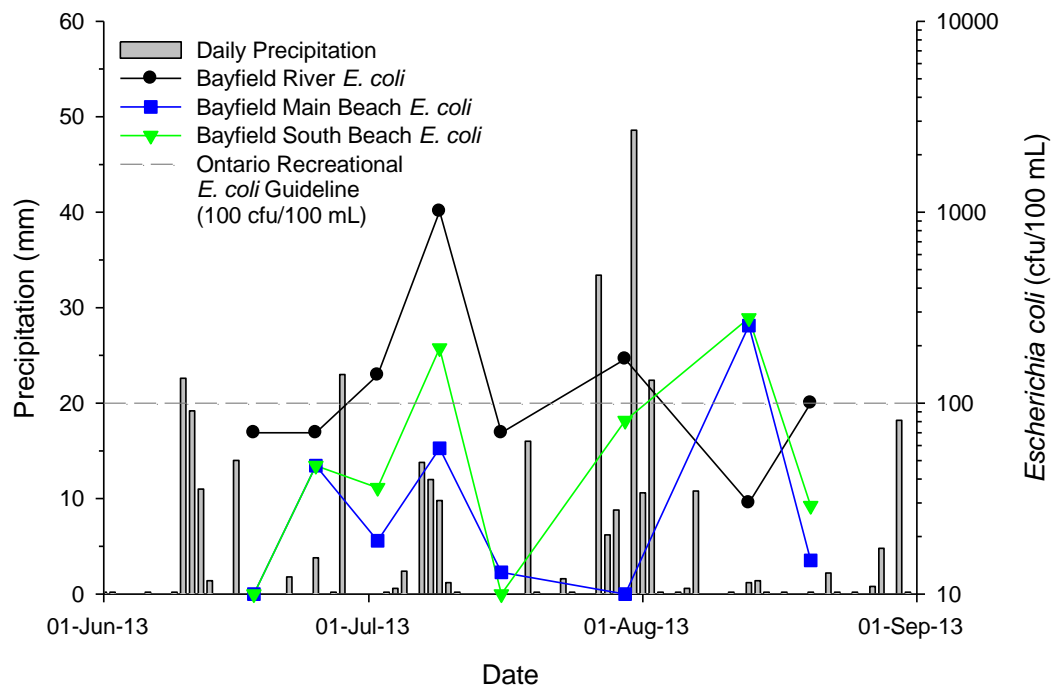
- In 2013, the geometric mean of the *E. coli* concentrations at a site on the Bayfield River (MB3) was higher than the geometric means for the two public beaches in Bayfield.
- Three of the river samples exceeded the 100 cfu/100 mL standard, compared with one sample from the Bayfield Main Beach and two samples from the Bayfield South Beach.

Date	<i>Escherichia coli</i> (cfu/100 mL)		
	Bayfield River (MB3)	Bayfield Main Beach	Bayfield South Beach
Jun 18, 2013	70	10	10
Jun 25, 2013	70	47	47
Jul 2, 2013	140	19	36
Jul 9, 2013	1010	58	194
Jul 16, 2013	70	13	10
Jul 30, 2013	170	10	81
Aug 13, 2013	30	255	279
Aug 20, 2013	100	15	29
Aug 27, 2013	20	no sample collected	no sample collected
Geometric Mean	92	27	46

Please note: Concentrations exceeding Ontario Recreational Guideline (100 cfu/100 mL) are in bold font.

Data source: Albert *et al.* 2013

- The three sampling dates during which *E. coli* concentrations in the river exceeded 100 cfu/100 mL (Jul 2, 9, 30) each followed a period of rainfall. On one of these dates (Jul 9), the South Beach also exceeded 100 cfu/100 mL. Rainfall and river inputs of *E. coli* to the lake may have contributed to this elevated concentration.
- On August 13, *E. coli* concentrations at the two beaches exceeded 100 cfu/100mL; however, the river concentration was much lower and there had been little rainfall preceding the sampling. At both beaches, the water was turbid and the wave height was the highest recorded all season (Albert *et al.* 2013). Wave action could have increased concentrations by stirring up sand and other materials along the shoreline.



Please note: Symbols (e.g., circles) represent samples collected. Lines between symbols display differences between sites and do not indicate concentrations of *E. coli* on days not sampled.

Data source: Albert *et al.* 2013

Next Steps

- 1) Continue to monitor water quality, specifically *E. coli*, in the Main Bayfield River watershed to capture changes over time.
- 2) Engage the local community in citizen science (monitoring of rainfall, water quality, or stream invertebrates); stormwater management (rain garden workshop, rain barrel blitz, or Stormwater Servicing Master Plan public meeting); and other stewardship activities that can improve water quality.
- 3) Pursue funding for further water quality monitoring and improvement projects in the Main Bayfield River watershed, in cooperation with Healthy Lake Huron partners and the local community.
- 4) Aim to consistently decrease the 90th percentile *E. coli* concentration for each sampling location to below 1000 cfu/100 mL (*i.e.*, 90 per cent of the samples collected from each location would have concentrations less than 1000 cfu/100 mL).

Acknowledgements

Thank you to:

- Several private landowners for access to sampling locations adjacent to their properties.
- Katie Stammler (University of Waterloo), Chantal Vis (Parks Canada), Mohamed Mohamed (Ministry of the Environment), and Jérôme Marty (Genivar Inc.) and for their advice and assistance with statistical analyses.
- The Municipality of Bluewater for funding support.

References

- Albert, J.-G., E. Clark, S. Little, and M. Park. 2013. Beach Water Monitoring Report. Retrieved December 20, 2013, from: http://www.huronhealthunit.com/?page_id=8282
- Gutteridge, A., and M. Veliz. 2013. *Escherichia coli* Monitoring in the Main Bayfield River Watershed 2012. Ausable Bayfield Conservation Authority. Exeter, Ontario. 9 pp.
- MOEE (Ministry of Environment and Energy). 1994. Water Management Policies, Guidelines, and Provincial Water Quality Objectives of the Ministry of Environment and Energy. Government of Ontario Publication No. 3303E.
- Upsdell, B., and M. Veliz, 2012. *Escherichia coli* Monitoring in the Lower Bayfield River Watershed 2011. Ausable Bayfield Conservation Authority. Exeter, Ontario. 8 pp.
- Upsdell, B., and M. Veliz. 2011. *Escherichia coli* Monitoring in the Lower Bayfield River Watershed 2010. Ausable Bayfield Conservation Authority. Exeter, Ontario. 7 pp.
- Upsdell, B., and M. Veliz. 2009a. *Escherichia coli* Monitoring in the Lower Bayfield River Watershed 2008. Ausable Bayfield Conservation Authority. Exeter, Ontario. 5 pp.
- Upsdell, B., and M. Veliz. 2009b. *Escherichia coli* Monitoring in the Lower Bayfield River Watershed 2009. Ausable Bayfield Conservation Authority. Exeter, Ontario. 7 pp.