Summary of Activities of the Working Group for Fish and Wildlife Consumption Restrictions for the Bay of Quinte Area of Concern 2013-2014

Final Report in support of the Fish Contaminant Working Group
for the
Bay of Quinte Restoration Council

by the
St. Lawrence River Institute of Environmental Sciences

June 2014

Status Report for the Fish and Wildlife Restrictions Beneficial Use Impairment for the Bay of Quinte Area of Concern

Report prepared for the Bay Quinte Restoration Council, Belleville, ON and Environment Canada.

Prepared by Jeff Ridal, St. Lawrence River Institute of Environmental Sciences, Cornwall, ON.

9 June 2014

This report has been prepared with funding from Environment Canada in support of the Bay of Quinte Remedial Action Plan. Such support does not indicate endorsement by Environment Canada of the contents of this material.

Executive Summary

The following report is submitted on behalf of the Fish Consumption Working Group (FCWG) which is tasked with the assessment of the fish and wildlife consumption beneficial use impairment (BUI #1) for the Bay of Quinte. The FCWG identifies and coordinates monitoring activities that are deemed necessary to assess the BUI against current fish consumption restrictions and contaminant levels, as well as assessing ancillary information such as trends in sediment concentrations.

The current recommendation is that the BUI #1 remains impaired. The 2013-2014 guidelines for consumption of Brown Bullhead (which is the preferred indicator fish) remain more restrictive along the Trenton waterfront than elsewhere in the upper Bay of Quinte due to elevated concentrations of dioxin-like PCBs and dioxins and furans. However, the consumption restrictions have been improving in recent years as concentrations in fish have declined appreciably over the past decade. Sediment concentrations have also apparently declined although recent data for the Belleville waterfront are limited. To fill this data gap, the FCWG coordinated with the MOE on a sediment collection in Nov 2013 and data from this collection are expected in the coming months.

Recommendations for future work for the FCWG include:

1. With the expected release of the 2015-2016 Guide to Eating Ontario Sports Fish in January 2015, perform a reassessment of the fish consumption restriction measure.
2. Provide an analysis of the trends in sediment concentrations at Belleville and Trenton when data becomes available from the MOE to ascertain that concentrations are declining. Brown Bullheads are benthivores therefore trends in sediment concentration are related to exposure of these fish through diet and contact with the sediments.
3. Provide collection and logistical support for the reassessment of a fish health effects study. Recently work (Simmons et al. 2014) has indicated measurable health effects for fish collected in 2004 near Trenton and Belleville compared to a reference site at Deseronto. These effects were linked to elevated dioxin-like PCB concentrations in the fish. Since the data collected by the FCWG has shown a decline in fish concentrations since that time, it is expected that these fish health effects have declined as well. If this can be demonstrated, it would demonstrate remediation of this impact as well as providing scientific context for other AOCs where fish health effects have been observed.

Current Status and Activities for 2013-2014

This report outlines the current status of the fish and wildlife consumption beneficial use impairment and the activities of the Fish Consumption Working Group for the Bay of Quinte RAP over the period April 2013 through March 2014.

With respect to this Beneficial Use Impairment (BUI) the following revised targets and measures were adopted by the Bay of Quinte Restoration Council (Nov 2008):

Targets

The BUI is to be delisted when it can be demonstrated that fish consumption restrictions are not significantly influenced by contaminant sources in the Bay of Quinte;
The contaminants of concern are PCBs, dioxin-like PCBs, TCDDs (dioxins), and TCDFs (Furans).

Measures

• Fish consumption restrictions in the upper, middle bay are stable or declining and comparable to the least restrictive of Lake Ontario reference zones 6 and 8 as defined in the provincial government's Guide to Eating Ontario Sport Fish; and

• Contaminant levels in the fish species Brown Bullhead and Yellow Perch (or similar sentinel species) collected in the area of the Trent River Mouth and the Belleville waterfront, near established sources of contamination result in the same consumption limits as the general population for these fish in the upper bay of the Bay of Quinte.
A sampling and analysis protocol will be developed in support of these criteria.

Current Status:

The most recent assessment report for this BUI was released in May 2013 (Ridal and Marty 2013). The status recommendation is that the BUI remains impaired since the 2013-2014 consumption guide for Brown Bullhead is more restrictive along the Trenton waterfront (Block 9a; Figure 1 and Table 1) than elsewhere in the upper Bay of Quinte. However, the 2013-2014 fish consumption guidance at Belleville (Block 9b) for Brown Bullhead has improved relative to the 2011-2012 Guide and is now similar to the guidance for the Upper Bay of Quinte (Table 1). Strictly speaking, this indicates that Block 9b has met the delisting criterion threshold. In addition, consumption restrictions in the Upper Bay of Quinte for other species such as Brown Bullhead, Walleye, and

Smallmouth Bass are comparable or below the consumption restrictions for the same fish in the Middle and Lower Bays (Ridal and Marty 2013).

The contaminants responsible for fish consumption restrictions at Trenton and Belleville are PCBs and dioxins and furans (expressed as total toxicity equivalent quotients (TTEQ)). A statistical comparison of the most recent available Brown Bullhead data (fish collected in September 2012) indicated that while contaminant levels in Brown Bullheads from Trenton remain elevated compared with those from the Deseronto reference site, fish from Belleville have intermediate values and are not statistically different from either Trenton or Deseronto fish (Figure 2). It should be pointed out that while the mean values for TTEQ of Belleville fish appear higher than Deseronto fish (2.3 vs 1.3 pg/g respectively), the smaller number of samples (n= 5) from Belleville limits our ability to detect differences that may be statistically significant if a larger sample size was available.

Overall, there is indication of an improving situation with respect to this beneficial use impairment. Continued collections and analysis of Brown Bullheads in sufficient numbers (n = 20 for each site would be ideal) are required to demonstrate with statistical certainty that the criterion has been achieved.

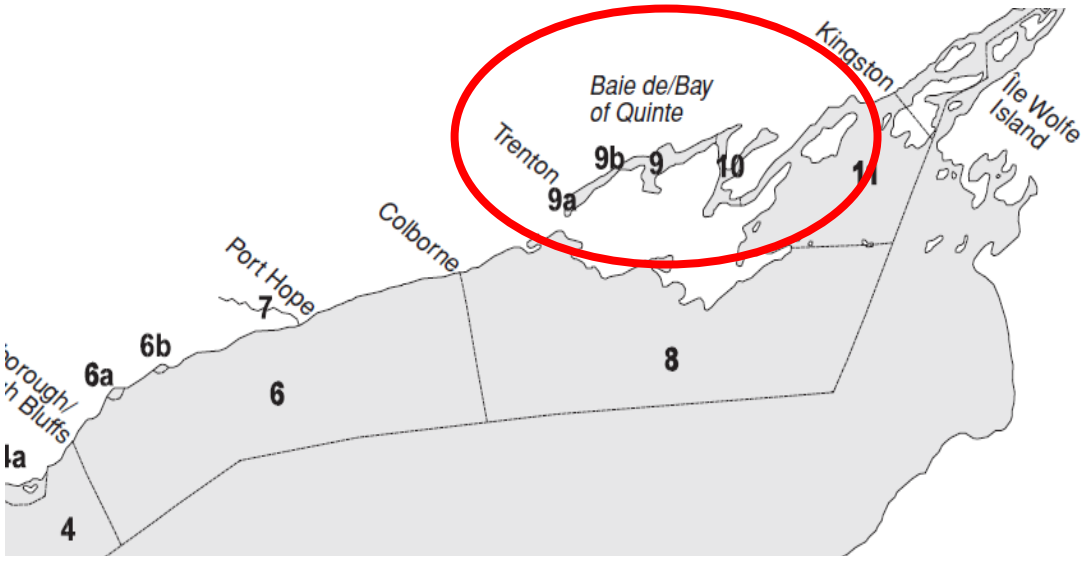

Figure 1. Sampling blocks for the Sports Fish Contaminant Monitoring program in Eastern Lake Ontario and the Bay of Quinte. Blocks 9a and 9b are nearshore areas in the Upper Bay of Quinte located at Trenton and Belleville

Table 1. Comparison of fish consumption limits at different length intervals for Brown Bullhead as listed in the 2013-2014 Guide to Eating Ontario Sport Fish Limits shown indicate acceptable fish meals per month for the General and Sensitive (shaded) populations. Sensitive populations are for children and women of child-bearing age. N/A indicates data not available for this length interval. Red shaded cells indicate the sites and fish lengths that do not meet the delisting criterion.

Area	Block	Meals per Month (2013-2014)				
Trenton nearshore	9a	8	8	4	N/A	N/A
		8	8	4	N/A	N/A
Belleville nearshore	9b	N/A	8	8	4	4
		N/A	8	8	4	4
Upper Bay of Quinte	9	N/A	8	8	4	N/A
		N/A	8	8	4	N/A
Middle Bay of Quinte	10	8	8	8	4	N/A
		8	8	8	4	N/A
Length Interval (cm)		**15-20**	**20-25**	**25-30**	**30-35**	**35-40**

General and Sensitive Populations

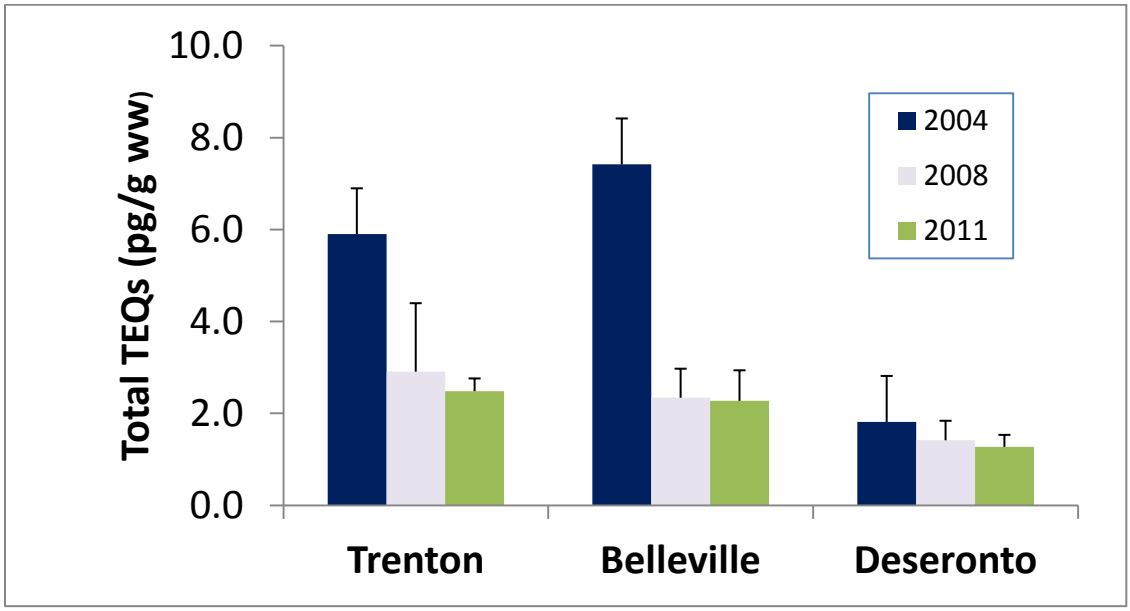

Figure 2. Comparison of total TEQ (pg/g ww, average±SE) in Brown Bullhead of 20-30 cm in length. The data identified as being collected in 2004 have been presented as 2005 data in previous reports (fish sampling was conducted by DFO in 2004 and 2005, the tissue residue data were measured in the 2004 fish as detailed in Simmons et al. 2014).

A small number of sediment samples taken in October 2012 at sites near the former Bakelite site in Belleville show that PCB concentrations have for the most part declined since 2002. Similarly, recent sediment data collected at Trenton also indicate a slow decline in TTEQs over the past 5 years, although laboratory tests indicate that the sediment contaminants at Trenton remain available for uptake into the food chain and could contribute to fish concentrations (Milani and Grapentine, 2013).

As the delisting criterion requires it to be shown "that fish consumption restrictions are not significantly influenced by contaminant sources in the Bay of Quinte". This evidence contributes to the assessment that fish consumption in the Upper Bay of Quinte are still influenced by contaminants sources within the Bay of Quinte but that the Bay is in a period of slow recovery.

The Ridal and Marty (2013) report recommended the following actions for 2013-2014:

(A) Continued collections and assessment of Brown Bullhead concentrations at the Trenton, Belleville and Deseronto sites to assess changes in fish concentrations and fish consumption restrictions.

(B) Additional sampling of surface sediments in the Belleville waterfront area to better characterize the changes in concentrations around this site since 2005.

A) Fish Collections

Collections of Brown Bullheads at Trenton, Belleville and Deseronto were coordinated through Jim Hoyle of the Ministry of Natural Resources at Glenora (Table 2).

Table 2: Fish collections obtained in 2013

Site	Species	Number Collected
Trenton	Brown Bullhead	3
Belleville	Brown Bullhead	6
Deseronto	Brown Bullhead	15

These samples have been forward to the MOEE's fish contaminant analysis group for the analysis of PCBs, TCDDS and TCDFs. Additional collections are proposed for 2014 in relation to fish health assessment and these are discussed in detail in Section C below.

B) Sediment Sampling

In Nov 2013, surface sediment samples were undertaken by the MOE to provide a more detailed characterization of the sediment concentrations and to investigate whether there are continuing fugitive sources from the former Bakelite site at Belleville (Figure 3 and Table 3). These samples were taken to augment a preliminary survey taken in October 2012 at 5 sites near the former Bakelite site in Belleville which has been a source of PCBs to Upper Bay of Quinte. The 2012 results indicate a decrease in sediment PCB

levels compared to samples taken in 2005 (Table 4). Data from the Nov 2013 samples have yet to be provided by the MOE.

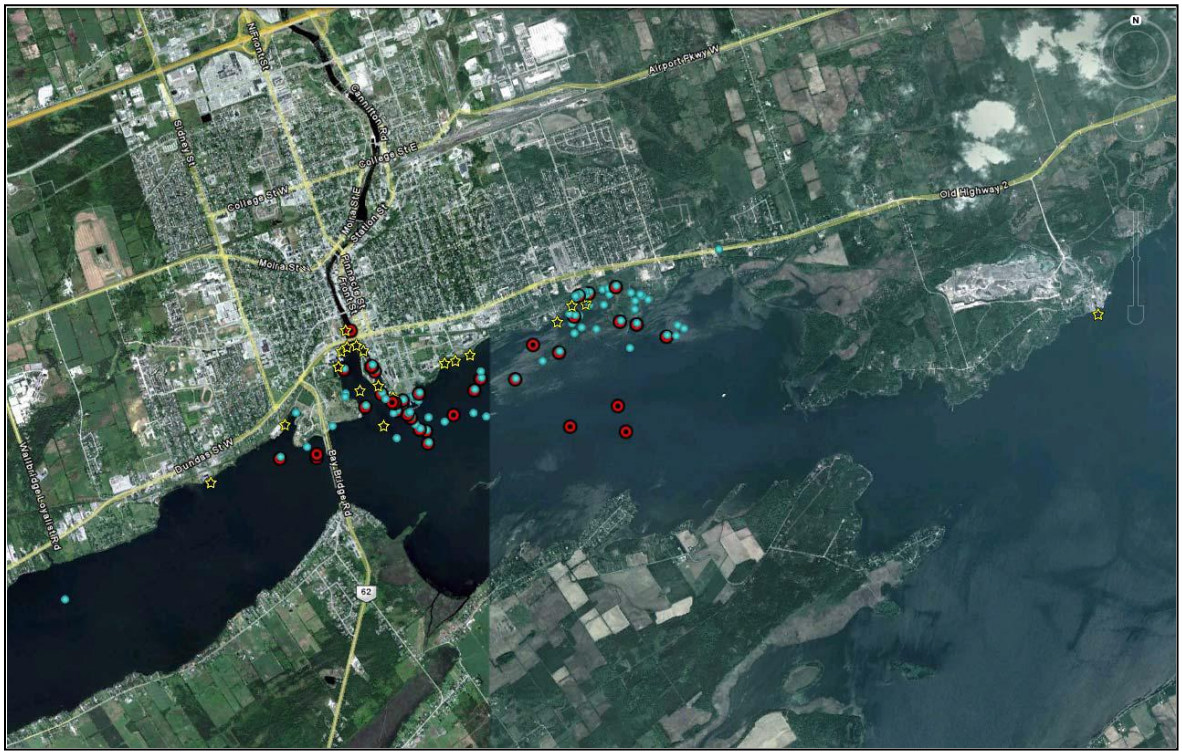

Figure 3. Sites at which surface sediment samples were collected in Nov 2013 (yellow stars) as well previous MOE sampling sites in the vicinity of Belleville.

Table 3. Description of the sampling site locations, rationale and parameters to be analysed for the sediment survey in 2013.

Site #	Location	Reasoning	Parameters
1	Dolan's Marina	boat maintenance - potential impacts	PCBs, PAHs, Heavy Metals survey
2	Sidney Street- WTP	stormswer outfall; upstream industry included Nortel, Rexcan Circuits	PCBs, PAHs, Heavy Metals survey
3	Morch Marine #1	former industrial property; proposed dredging and redevelopment	PCBs, PAHs, Heavy Metals survey
4	Morch Marine #2	former industrial property; proposed dredging and redevelopment	PCBs, PAHs, Heavy Metals survey
5	Dundas St. Bridge (West)	proposed dredging	PCBs, PAHs, Heavy Metals survey
6	Dundas St. Bridge (East)	proposed dredging	PCBs, PAHs, Heavy Metals survey
7	Corbin Lock	potential off-site impacts from former industry	PCBs, PAHs, Heavy Metals survey, **VOCs**
8	Victoria Harbour (North end)	delineation of previously identified impacts (closer to Coal Tar site)	PCBs, PAHs, Heavy Metals survey
9	Victoria Harbour (Mouth)	delineation of previously identified impacts (closer to marina)	PCBs, PAHs, Heavy Metals survey
10	River Mouth #1	delineation of arsenic presence, etc.	PCBs, PAHs, Heavy Metals survey
11	River Mouth #2 (further into Bay)	delineation of arsenic presence, etc.	PCBs, PAHs, Heavy Metals survey
12	Anchorage	former coal storage site	PCBs, PAHs, Heavy Metals survey
13	South Foster Park West Outfall	former industry in vicinity; delineation	PCBs, PAHs, Heavy Metals survey
14	South Foster Park East Outfall	former industry in vicinity; delineation; PCB detections by others	PCBs, PAHs, Heavy Metals survey
15	Bale-Eze Outfall	former industry in vicinity; delineation	PCBs, PAHs, Heavy Metals survey
16	Herchimer Boat Launch	alleged historic burial of transformers; delineation	PCBs, PAHs, Heavy Metals survey
17	Deloro Stellite West Pond Outfall	presence of historic slag dumping area; delineation	PCBs, PAHs, Heavy Metals survey
18	Deloro Stellite Central Pond Outfall	historic impacts from foundry operation; delineation	PCBs, PAHs, Heavy Metals survey
19	Deloro Stellite Central Pond- into Bay	historic impacts from foundry operation; delineation	PCBs, PAHs, Heavy Metals survey
20	McNally Marine	previously un-monitored industrial activity (boat sandblasting etc.)	PCBs, PAHs, Heavy Metals survey

Table 4. Total PCBs concentrations (ng/g dry wt) in surficial sediments from surveys taken in 1996 (Jaagumagi 1997), 2000 (Thorburn 2004), 2002 (Fletcher and Petro 2005) and 2012 (Ridal and Marty, 2013). For PCBs, the Lowest Effect Level = 70 ng/g and Severe Effect Level = 530,000 ng/g dry wt.

	Total PCBs (ng/g dry weight)			
Site	**1996**	**2000**	**2002**	**2012**
BQB4 (Within embayment by Central Pond and former Lagoon outlets)	n.s.	40	1128	430
BQB9a (West Marsh Outlet Bay)	n.s.	n.s.	1445	10
BQB10 (S. Foster Park, Background Reference Station)	n.s.	180	20	160
T8-1 (N.W. section of the West Marsh Outlet Bay)	80	200	n.s.	10
T7-2 ((Central section of the West Marsh Outlet Bay)	140	n.s.	n.s.	10

C) Fish Health Effects Study

The results of a comprehensive fish health effects study for the Upper Bay of Quinte have been recently published (Simmons et al. 2014). Brown Bullheads and Yellow Perch collected in 2004 and 2005 from the Trent River mouth, Belleville and Deseronto were examined using a suite of hormone assays and various measures of exposure and/or sublethal health effects. These measures were compared to concentrations of dioxin-like PCBs (dl-PCBs) and dioxins and furans in plasma and tissue (see 2004 data in Figure 2 for Brown Bullhead tissue concentrations which are approximately 3-4 times greater at Trenton and Belleville than at Deseronto).

Many of the fish health measures such as condition factor, thyroid activation, hepatosmatic index, circulating steroid and thyroid hormone levels, and plasma vitellogenin differed significantly amongst location in correspondence with tissue residue concentrations of the DL-PCBs for the Brown Bullheads. Several of the endpoints relate to sex hormone levels, for example male Brown Bullheads at Trenton had depressed circulating testosterone levels, their testes had greater luminal space and increased incidence of spematogonia (i.e. immature germ cell development, Simmons et al. 2014). Additional studies also indicated that the PCBs were being hydroxylated *in vivo*.

The results indicate that exposure of Brown Bullheads to dioxin-like substances was eliciting enhanced bioactivity at endocrine receptors and measureable health effects. Yellow perch were less likely to demonstrate these effects and the authors surmised that this pelagic species were not as likely exposed to the contaminants than the Brown Bullhead which as a benthivores would have a stronger dietary link and contact to contaminated sediments.

While the authors did not connect these biochemical health effects to potential long-term population health effects, there is strong interest based on a meeting of the FCWG and Dr. Jim Sherry in April 2014 to repeat the study given that concentrations of dioxin-like

substances in Brown Bullheads has decreased substantially since 2004 (Figure 2). In addition, Brown Bullheads at Deseronto were found to have un-expectantly elevated EROD responses that were related to highly elevated pentachlorophenol (PCP) concentrations in their plasma. PCP is a potent EROD inducer. The former Domtar wood preserving plant at Trenton was previously identified as the main source of PCP to the Bay of Quinte (BQRAP Stage 1 Report, 1990) however low levels of PCPs were measured in the effluent for the Deseronto sewage treatment plant as it was for the respective STPs at Trenton and Belleville. Further analysis of this chemical in the fish study would be warranted.

Conclusions and Recommendations

The recommended status of the fish and wildlife consumption beneficial use remains impaired as the fish consumption restriction measure has not yet been met, despite a decline in fish tissue concentrations in terms of total TEQs in recent years. In addition, the release of recent information showing measurable health effects for Bay of Quinte fish provides strong evidence linking environmental concentrations in resident fish to multiple metabolic and reproductive health endpoints.

Recommendations for further work assessing the fish and wildlife consumption restrictions BUI include:

1. Reassessment of the fish consumption restriction measure with the release of the 2015-2016 Guide to Eating Ontario Sports Fish in January 2015.
2. Analysis of the trends in sediment concentrations at Belleville and Trenton when data becomes available from the MOE to ascertain that concentrations are declining as suggested by declining Brown Bullhead fish consumption restrictions
3. Repeat collections of Brown Bullheads in fall 2014 in support of a reassessment of the fish health effects study conducted by Simmons et al. (2014). Field support for collecting and analysing fish in 2014 will be required by MOE, EC, and the St. Lawrence River Institute.

Glossary:
PCBs – polychlorinated biphenyls
dl-PCBs – dioxin-like PCBs
TEQs – toxicity equivalent quotients

References

Ridal, J.J. and Marty, J. 2013. Status Report for the Fish and Wildlife Restrictions Beneficial Use Impairment for the Bay of Quinte Area of Concern. Prepared for the Bay of Quinte Remedial Action Plan. Lower Trent Conservation Authority, Trenton, ON. 16 pp.