Status Recommendation for the *Degradation of fish and wildlife populations* in the St. Clair River Area of Concern

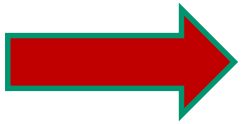
October 20, 2021

Session #2 in the Science Symposium Series

Presented by: April White, ECCC

St. Clair River Remedial Action Plan

St. Clair River Area of Concern



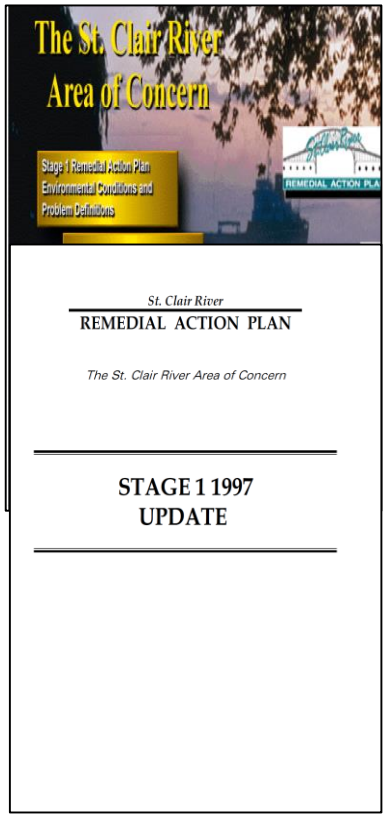
BUI Assessment Guidance for BUI 3
Degradation of fish and wildlife populations

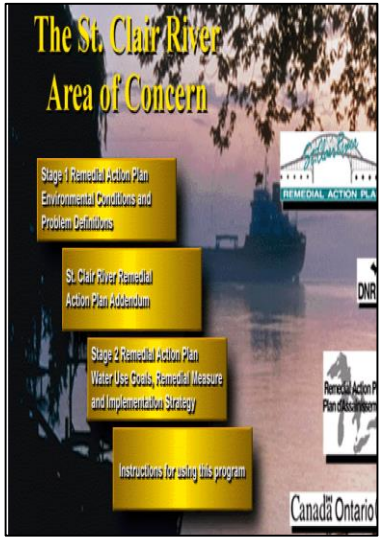
Impaired when…

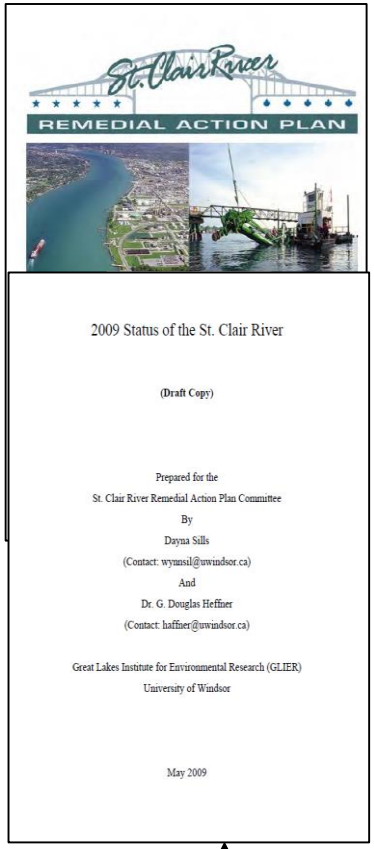
…there is sufficient toxicity in water or sediments to negatively affect the ability of fish and wildlife species to reproduce and grow normally.

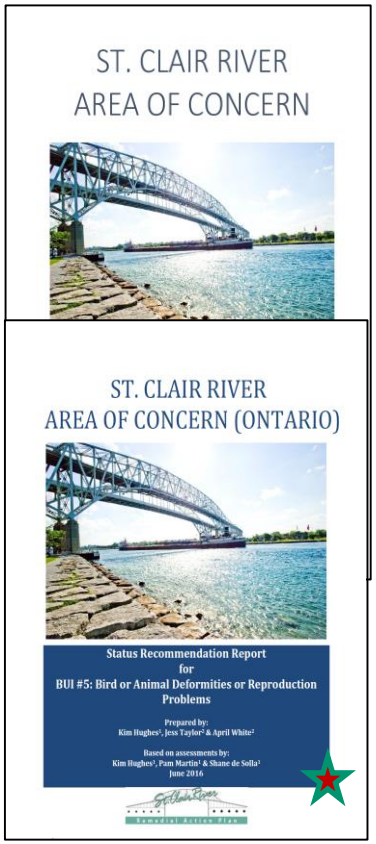
Not Impaired when…

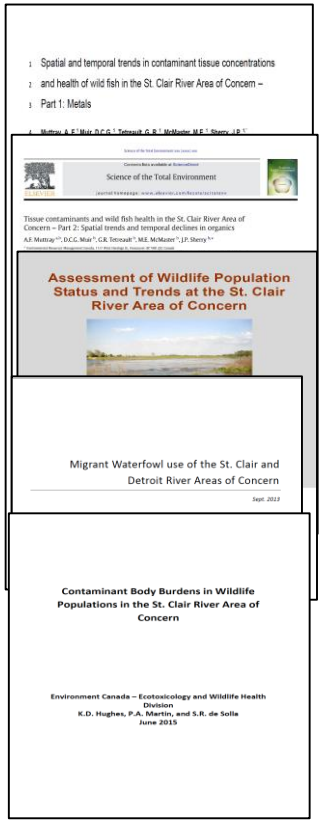
When environmental conditions support healthy, self-sustaining communities of desired fish and wildlife at predetermined levels of abundance that would be expected from the amount and quality of suitable physical, chemical and biological habitat present. And, in the absence of community structure data, this use will be considered restored when fish and wildlife bioassays confirm no significant toxicity from water column or sediment contaminants.











1987 — **Today**

1991 Stage 1 Report
1997 Stage 1 Update

1995 Stage 2 Report
of recommendations

2006 and 2009
Update Reports

2018
Not Impaired
For BUI 4 and 5

Compilation of
Reports on
BUI 3

Requires Further Assessment (RFA)

History of –*Degradation of Fish and Wildlife Populations* BUI

1991 Stage 1 Report -

Described Conditions within the AOC and deemed the BUI as "requires further assessment (RFA)"

Contaminants of concern:

- hexachlorobenzene (HCB)
- octachlorostyrene (OCS)
- polychlorinated biphenyls (PCBs)
- and mercury

1995 Stage 2 Report –

Recommended Actions to address impaired and assess RFA BUIs

2006 RAP Progress* and *2009 RAP Update Report

- recommended comparing body burdens temporally (over time) and where appropriate, to current scientific guidelines such as those developed in 1999 by the Canadian Council of Ministers of the Environment (CCME)
- BUI remained RFA

The collection of these early reports, provided direction for the assessment of BUI 3.

BUI 3 – Degradation of Fish and Wildlife Populations
Assessment questions

For Fish:

1. Potential effects of contaminants on fish populations to be self-sustaining.
   - Can they successfully grow and reproduce?
2. Have contaminant levels decreased since 1991? And how do they compare to relevant scientific guidelines?

For Wildlife:

1. Potential effects of contaminants on wildlife to be self-sustaining.
   - Can they successfully grow and reproduce? (BUI 5)
2. Is the abundance and diversity of wildlife within the AOC comparable to outside the AOC?
3. Have contaminant levels decreased since 1991? And how do they compare to relevant scientific guidelines?

Spatial and temporal trends in contaminant tissue concentrations and health of wild fish in the St. Clair River Area of Concern – Part 1: Metals

Muttray, A. F.[1], **Muir, D.C.G.**[1], **Tetreault, G. R.**[1], **McMaster, M.E.**[1], **Sherry, J.P.**[1,*]

[1] Aquatic Contaminants Research Division, Environment Canada, Water Science & Technology Directorate, 867 Lakeshore Rd, Burlington, ON, L7R 4A6 Canada.

*Corresponding Author: jim.sherry@canada.ca

Keywords: St. Clair R
perch, shiner, tempo

Abstract

The St. Clair River is
First Nations commu
petrochemical facili
fish tissue metal con
redhorse (*Moxostom*
the river's industrial
(Chenal Écarte) were
Lake Huron, located
collections were rep
industrial and downs
temporal trends in ti
most heavy metals
shiners had the high
perch. The highest
metals at Chenal Éc
trend of elevated tis

Spatial and temporal trends in contaminant tissue concentrations and health of wild fish in the St. Clair River Area of Concern – Part 2: Organics

Muttray, A. F.[1], **Muir, D.C.G.**[1], **Tetreault, G.R.**[1], **McMaster, M.E.**[1], **Sherry, J.P.**[1,*]

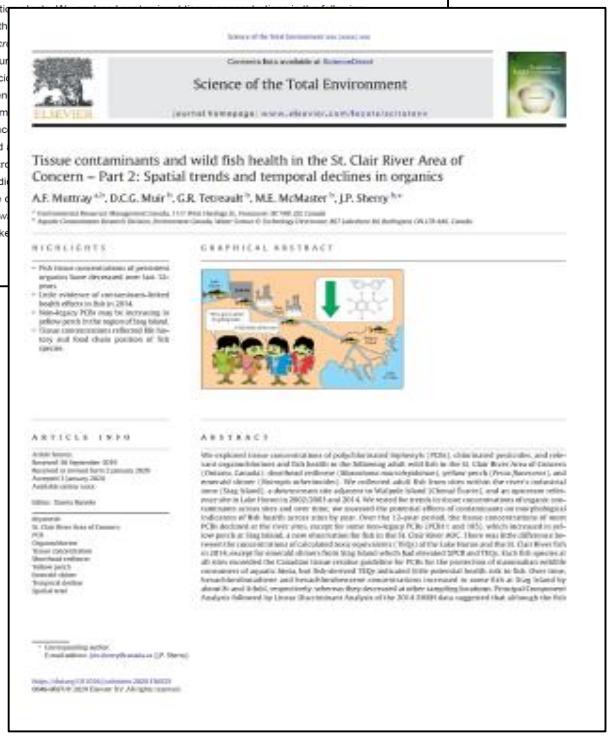
[1] Aquatic Contaminants Research Division, Environment Canada, Water Science & Technology Directorate, 867 Lakeshore Rd, Burlington, ON, L7R 4A6 Canada.

*Corresponding Author: jim.sherry@canada.ca

Keywords: St. Clair River Area of Concern, PCB, organochlorine, tissue concentration, shorthead redhorse, yellow perch, emerald shiner, temporal trend, spatial tend

Abstract

The St. Clair River downstream of Sarnia and Port Huron is home to First Nation communities, small towns, and numerous petroleum refineries, petrochemical facilities, and, until recently, coal fired generati
adult wild fish in th
(*Moxostoma macr*
atherinoides). Our
chlorinated pesticid
hexachlorobenzen
(Stag Island), from
upstream referenc
in 2014. We used
contaminants, acr
morphological indi
period, the tissue
PCB data, there w
(TEQs) of the Lake



Science of the Total Environment

Tissue contaminants and wild fish health in the St. Clair River Area of Concern – Part 2: Spatial trends and temporal declines in organics

A.F. Muttray [a,b], D.C.G. Muir [b], G.R. Tetreault [b], M.E. McMaster [b], J.P. Sherry [b,*]

HIGHLIGHTS

GRAPHICAL ABSTRACT

ARTICLE INFO

ABSTRACT

FISH

2014 Fish Health Study

Study Objectives:

Do fish shape and size measurements (morphometric variables) suggest effects on growth or reproduction from fish collected within the AOC (compared to LH fish?

Have body burden contaminants declined in wild fish since 2002/3 in vicinities of Stag Island and Walpole Island?

Study Methods:

- Shorthead redhorse sucker (2002/3/6/14):
  - 20 adult male & female fish caught by trap nets in Lake Huron
  - 20 adult male & female fish caught by electrofishing at Stag Island
  - 20 adult male & female fish caught by electrofishing, trap nets, and gill nets at Chenal Ècarte/Walpole Island
- Yellow perch (2002/3/6/14):
  - by electrofishing at Stag Island & Chenal Ècarte/Walpole Walpole Island
  - 20 adult male & female fish caught by trap nets at Lake Huron
- Emerald shiner (2014):
  - 120 g of adult fish caught by beach seines at Lake Huron and Port Lambton (mouth of Chenal Écarte)
  - 120 g of adult fish caught by electrofishing at Stag Island

Morphometric (body measurements) for the Shorthead Redhorse Sucker

	Male			Female		
Variable	**Lake Huron (2014)**	**Stag Island (2014)**	**Walpole (2014)**	**Lake Huron (2014)**	**Stag Island (2014)**	**Walpole (2014)**
n	20	19	20	20	20	19
Age (years)	6.7±2.9[a]	6.7±2.7[a]	7.6±2.7[a]	9.0±3.9[a]	8.7±3.3[a]	7.2±2.4[a]
Fish weight (g)	727.9±32.90[a]	670.8±33.75[a]	744.6±32.90[a]	1155.5±49.99[a]	858.6±49.99[b]	917.2±51.28[b]
Condition factor index (K) (body weight/fork length^3 X 100)	1.381±0.0219[a]	1.380±0.0225[a]	1.392±0.0219[a]	1.475±0.0225[ab]	1.415±0.0225[b]	1.511±0.0231[a]
Body weight adjusted for fork length^3 (ANCOVA)	718.6±12.13[a]	709.59±12.61[a]	717±12.21[a]	985.4±17.57[ab]	947.6±16.34[b]	1002.5±16.70[a]
Liver weight (g)	8.74±0.564[b]	7.63±0.594[b]	11.09±0.564[a]	15.11±0.998[ab]	12.48±0.998[b]	17.43±1.024[a]
Liver somatic index (LSI) (liver weight/body weight X 100)	1.191±0.0496[b]	1.131±0.0523[b]	1.496±0.0496[a]	1.301±0.0672[b]	1.426±0.0672[b]	1.924±0.069[a]
Liver weight adjusted for body weight (ANCOVA)	8.6±0.4[b]	8.2±0.4[b]	10.7±0.4[a]	12.1±0.1[b]	13.8±0.2[b]	18.2±0.2[a]
Gonad weight (g)	48.764±1.0747[a]	41.639±1.0767[a]	46.036±1.0747[a]	104.520±1.0824[a]	51.168±1.0824[b]	86.139±1.0847[a]
Gonad somatic index (GSI) (gonad weight/body weight X 100)	6.975±1.0181[a]	6.413±1.0186[a]	6.297±1.0181[a]	9.423±0.4009[a]	6.330±0.4009[b]	9.715±0.4113[a]
Gonad weight adjusted for body weight (ANCOVA)	51.4±1.9[a]	45.1±2.0[ab]	44.6±1.9[b]	88.4±4.7[a]	63.5±4.3[b]	94.1±4.3[a]
Estimated fecundity (Egg count per g of gonad)	-	-	-	242.21±5.26[a]	344.75±7.48[b]	233.88±5.51[a]
Absolute Fecundity (eggs per fish)	-	-	-	25322±648[a]	17640±452[b]	21409±595[ab]
Fecundity adjusted for body weight (ANCOVA)	-	-	-	23340±812[a]	20964±812[a]	NA

No difference between sites

DELL: Shorthead Redhorse Sucker
Deformities, Erosions, Lumps and Lesions

	Male			Female			Male & Female Combined		
Variable	**Lake Huron (2014)**	**Stag Island (2014)**	**Walpole (2014)**	**Lake Huron (2014)**	**Stag Island (2014)**	**Walpole (2014)**	**Lake Huron (2014)**	**Stag Island (2014)**	**Walpole (2014)**
n (# sampled)	20	19	20	20	20	19	40	39	39
Deformities	0 ^{a}	1 ^{a}	0 ^{a}	0 ^{a}	0 ^{a}	1 ^{a}	0 ^{a}	1 ^{a}	1 ^{a}
Erosions	0 ^{a}	0 ^{a}	1 ^{a}	0 ^{a}	0 ^{a}	1 ^{a}	0 ^{a}	0 ^{a}	2 ^{a}
Lesions and necrotic livers	1 ^{a}	0 ^{a}	2 ^{a}	3 ^{a}	0 ^{a}	0 ^{a}	4 ^{a}	0 ^{a}	2 ^{a}
Lumps	5 ^{a}	0 ^{b}	7 ^{a}	2 ^{a}	1 ^{a}	4 ^{a}	7 ^{ab}	1 ^{a}	11 ^{b}
∑DELLs	6 ^{ab}	1 ^{b}	10 ^{a}	5 ^{a}	1 ^{a}	6 ^{a}	11 ^{a}	2 ^{b}	16 ^{a}
Mottled liver	1 ^{a}	0 ^{a}	0 ^{a}	0 ^{a}	0 ^{a}	0 ^{a}	1 ^{a}	0 ^{a}	0 ^{a}
Parasites	0 ^{a}	0 ^{a}	0 ^{a}	1 ^{a}	0 ^{a}	0 ^{a}			

Condition of fish in AOC sites samples are not different from Lake Huron

Heavy metals: temporal trends in Shorthead Redhorse Sucker

	Fold change (2014/2002(3))					
	Lake Huron		Stag Island		Chenal Écarte/Walpole	
Analyte	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Metals:						
Aluminum	5.16↓*	3.28↓*	1.00	1.69↓	1.37↑	1.92↑
Barium	1.85↑	1.03↑	1.91↓	3.22↓*	3.61↓*	3.78↓*
Chromium	25.02↓*	3.50↓	5.35↓*	6.42↓*	1.32↑	1.68↓
Cobalt	1.17↑	1.18↑	1.86↓*	1.34↓	1.33↓	2.00↓*
Iron	2.32↓*	1.14↑	1.75↓*	1.61↓*	3.70↓*	8.88↓*
Magnesium	1.34↑	1.04	1.68↓*	1.31↓	1.43↓*	1.79↓*
Manganese	1.92↑	1.39↑	2.10↓	1.90↓	3.76↓*	7.45↓*
Mercury	**1.51↑**	**1.02**	**1.92↓***	**1.46↑**	**1.77↓***	**1.67↓***

Table: Fold change in concentrations of select heavy metals in shorthead redhorse sucker from sites in the St. Clair Area of Concern over the period 2002 to 2014. Arrows indicate direction of change; * : the change was statistically significant (Tukey's HSD $p<0.05$).

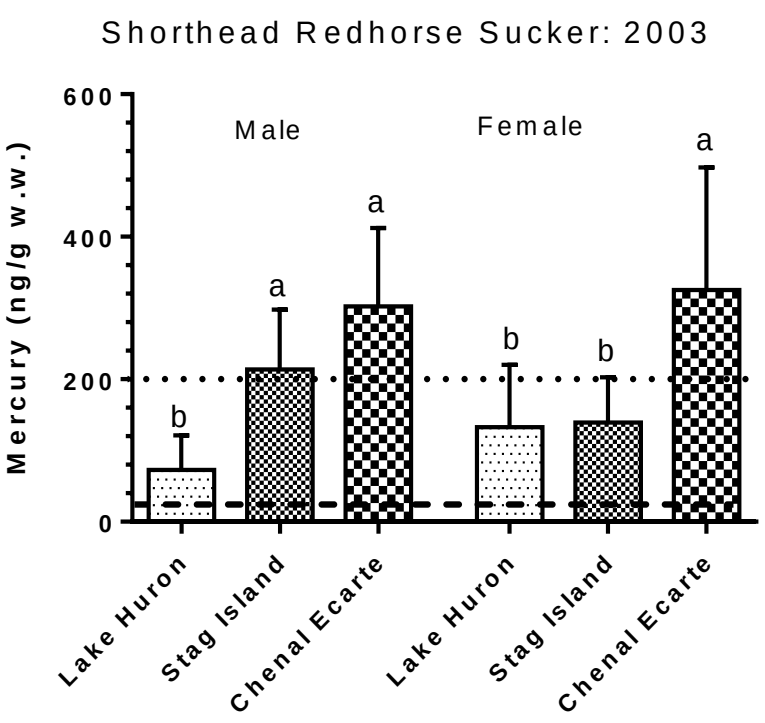
PCBs and Organochlorines: temporal trends in Shorthead Redhorse Sucker

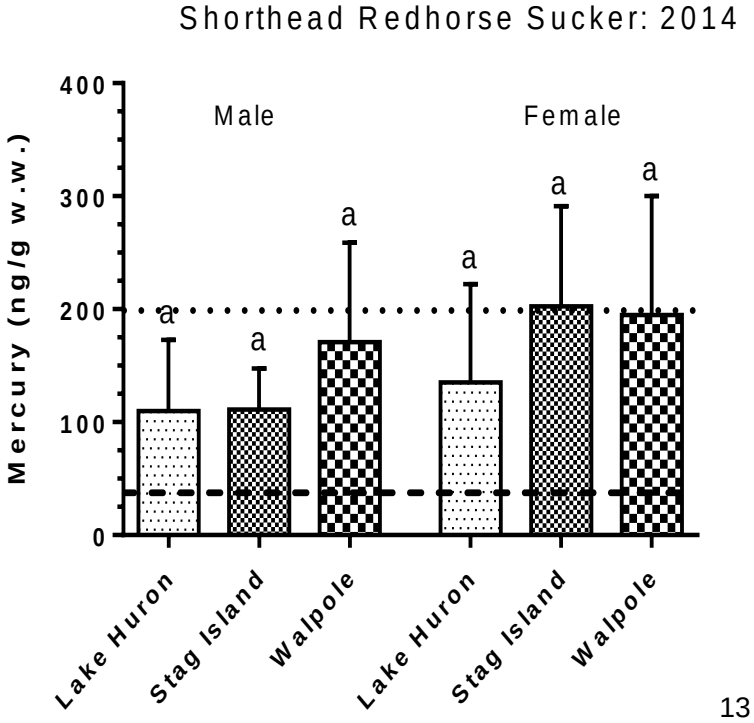
Contaminant	Fold change (2014/2002(3))					
	Lake Huron		Stag Island		Chenal Écarte/Walpole	
	Male	Female	Male	Female	Male	Female
∑PCB	1.01↑	1.28↓	2.33↓*	1.44↓	3.19↓*	3.86↓*
Organochlorine contaminants:						
Hexachlorobenzene (HCB)	1.86↓*	1.45↓	1.03	1.06	1.22↓	3.34↓*
Hexachlorobutadiene	4.96↓*	5.94↓*	2.69↑	8.15↑*	5.49↓*	6.41↓*
Octachlorostyrene (OCS)	1.31↑	1.03↑	1.16↓	2.03↑	3.32↓*	7.17↓*
4,4'-DDE	1.02	2.12↓*	3.24↓*	1.67↓*	2.57↓*	4.09↓*
44'-DDD	1.92↓*	2.35↓*	3.52↓*	1.48↓	3.42↓*	4.04↓*
4,4'-DDT	1.2↑	2.21↓*	2.62↓*	1.02	3.04↓*	2.68↓*
Dieldrin	1.38↓*	2.14↓*	2.22↓*	2.26↓*	2.99↓*	2.71↓*

Fold change in the concentrations of PCBs and organochlorine contaminants in SHRH from sites in the St. Clair Area of Concern over the period 2002 to 2014. Arrows indicate direction of change; *, change was statistically significant (Tukey's HSD $p<0.05$).

Mercury Body Burdens in Shorthead Redhorse Sucker

The dashed line are the CCME guidelines and dotted is a threshold associated with the protection of fish health.





BUI 3 – Degradation of Fish and Wildlife Populations
Requires Further Assessment

Assessment approach findings…

For Fish (e.g. Shorthead Redhorse Sucker)

1. Can they successfully grow and reproduce?	**Yes,** fish from the AOC can grow and reproduce based on the various morphometric variables, there is no evidence of obvious, consistent, or significant adverse effects on growth and reproduction of SHRH, YP, or ES.
2. Have contaminant levels decreased since the Stage 1 Report?	**Yes** and either below or near conservative guidance for the protection of fish health.

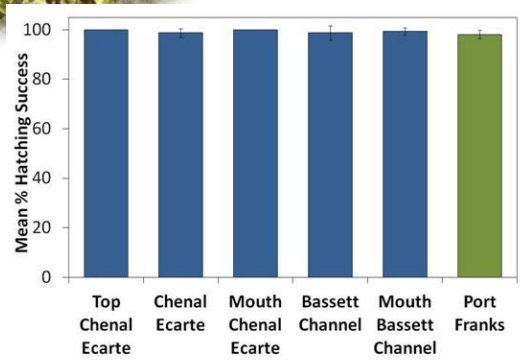

Assessment of Wildlife Population Status and Trends at the St. Clair River Area of Concern
Assessment of wildlife status and trends within the St. Clair River and Detroit River Areas of Concern Using Bird Studies Canada Data
Final Report
Produced for: Environment Canada
Migrant Waterfowl use of the St. Clair and Detroit River Areas of Concern
Sept. 2013
Contaminant Body Burdens in Wildlife Populations in the St. Clair River Area of Concern
Environment Canada – Ecotoxicology and Wildlife Health Division
K.D. Hughes, P.A. Martin, and S.R. de Solla
June 2015

Wildlife

BUI 3 – Degradation of Fish and Wildlife Populations
Requires Further Assessment

Assessment questions …

For Wildlife:



1. Potential effects of contaminants on wildlife to be self-sustaining. Can they successfully grow and reproduce? (Yes – as per BUI 5 – bird or animal deformities or reproductive problems
2. Is abundance and diversity within the AOC similar to area outside the AOC?
3. Have contaminant levels decreased?

BUI 3 – Degradation of Fish and Wildlife Populations
Requires Further Assessment

Wildlife assessment …

To distil the complexity of wildlife communities into a few key metrics and to use various long-term datasets to identify diversity and abundance within the AOC compared to outside the AOC.

1. Marsh birds = marsh nesting obligate species
2. Waterfowl = dabbler and diver ducks use-days and total waterfowl use-days in spring and fall (+4 specific species)
3. Amphibians = chorus, mink, northern leopard and spring peeper which represents “richness”
4. Mammals = muskrat harvests

Bird Studies Canada (BSC) contracted to assess the status and/or trends of wildlife within the AOC using 5 data sets from ECCC, BSC and OMNRF.

Trend indicates whether the change in abundance or diversity of a particular wildlife group within the AOC.

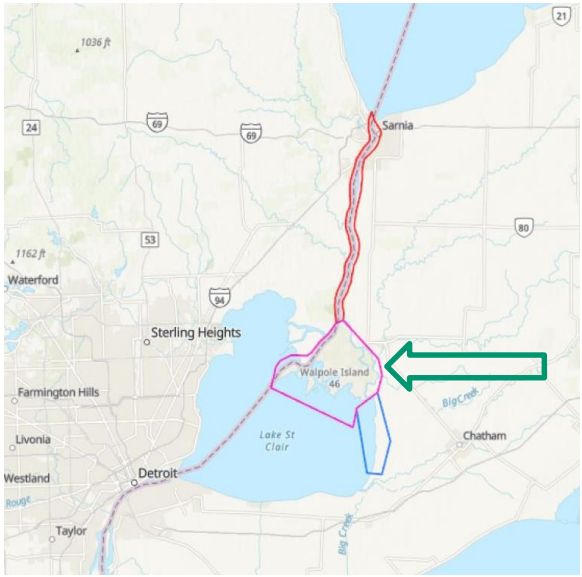
So, if the abundance and diversity trend within the AOC is…

i. increasing more than the surrounding region = not impaired/ “good”
ii. the same as the surrounding region = no apparent impairment/ ”fair”
iii. decreasing more than the surrounding area = impaired/ ”poor”

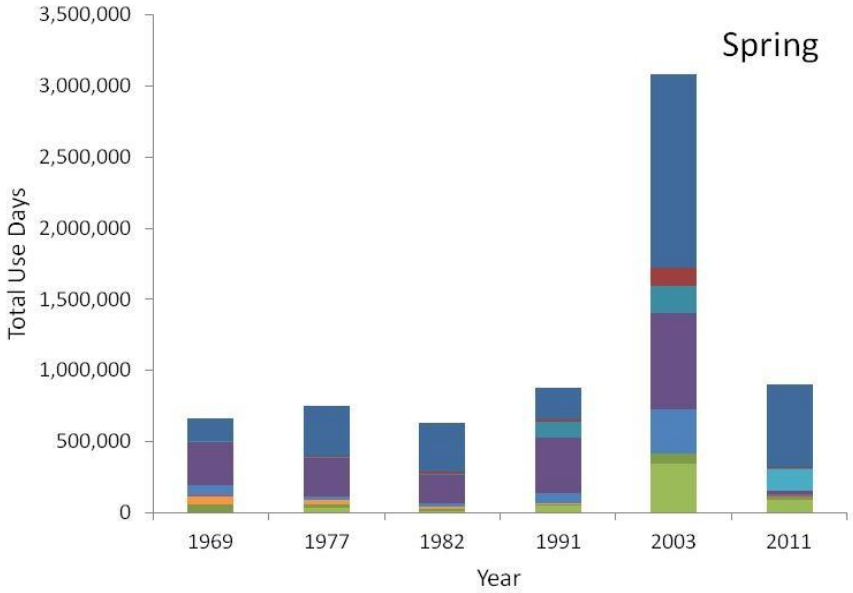
Results – Waterfowl -Trends and Status within the AOC compared to broader region outside the AOC

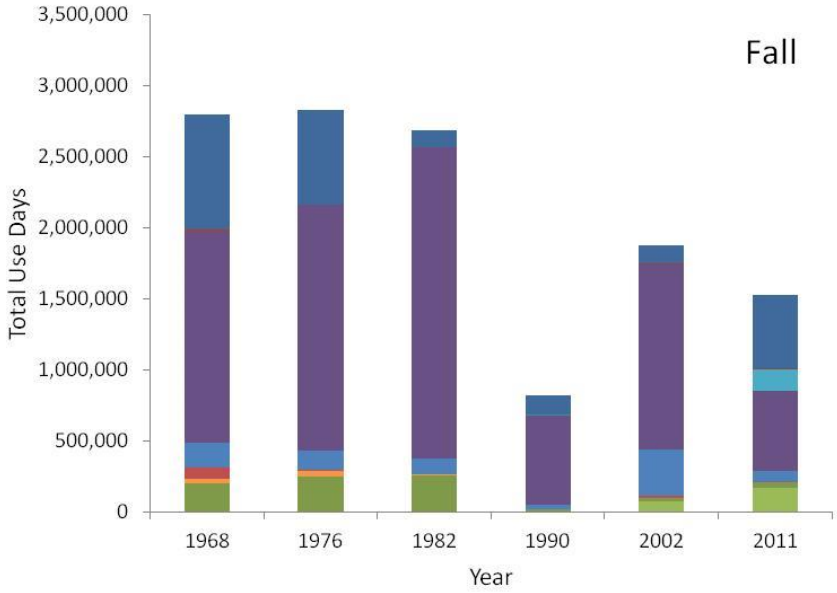
Compared abundance of 4 species from within AOC (Sector 16) to 6 other sectors including 2 from southern LSC and 4 from the north shore of LE

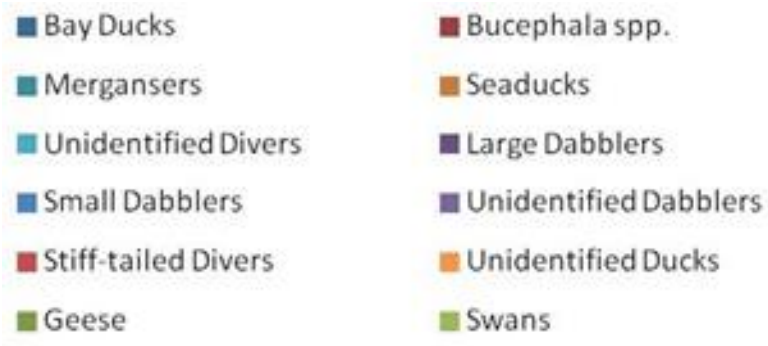
Metric	Season	AOC Trend	Regional Trend	Status Assessment
Canvasback use-days	Spring	+	+	NA
Common Goldeneye use-days	Spring	+	+	NA
Common Merganser use-days	Spring	+	+	Good
Redhead use-days	Spring	+	+	Fair
total species use-days	Spring	+	+	NA
Dabbler use-days	**Spring**	**+**	**-**	**NA**
Diver use-days	**Spring**	**+**	**+**	**NA**
Canvasback use-days	Fall	-	-	Fair
Common Goldeneye use-days	Fall	-	-	NA
Common Merganser use-days	Fall	+	-	Good
Redhead use-days	Fall	-	-	Fair
total species use-days	Fall	-	-	Fair
Dabbler use-days	**Fall**	**-**	**-**	**NA**
Diver use-days	**Fall**	**-**	**-**	**Fair**



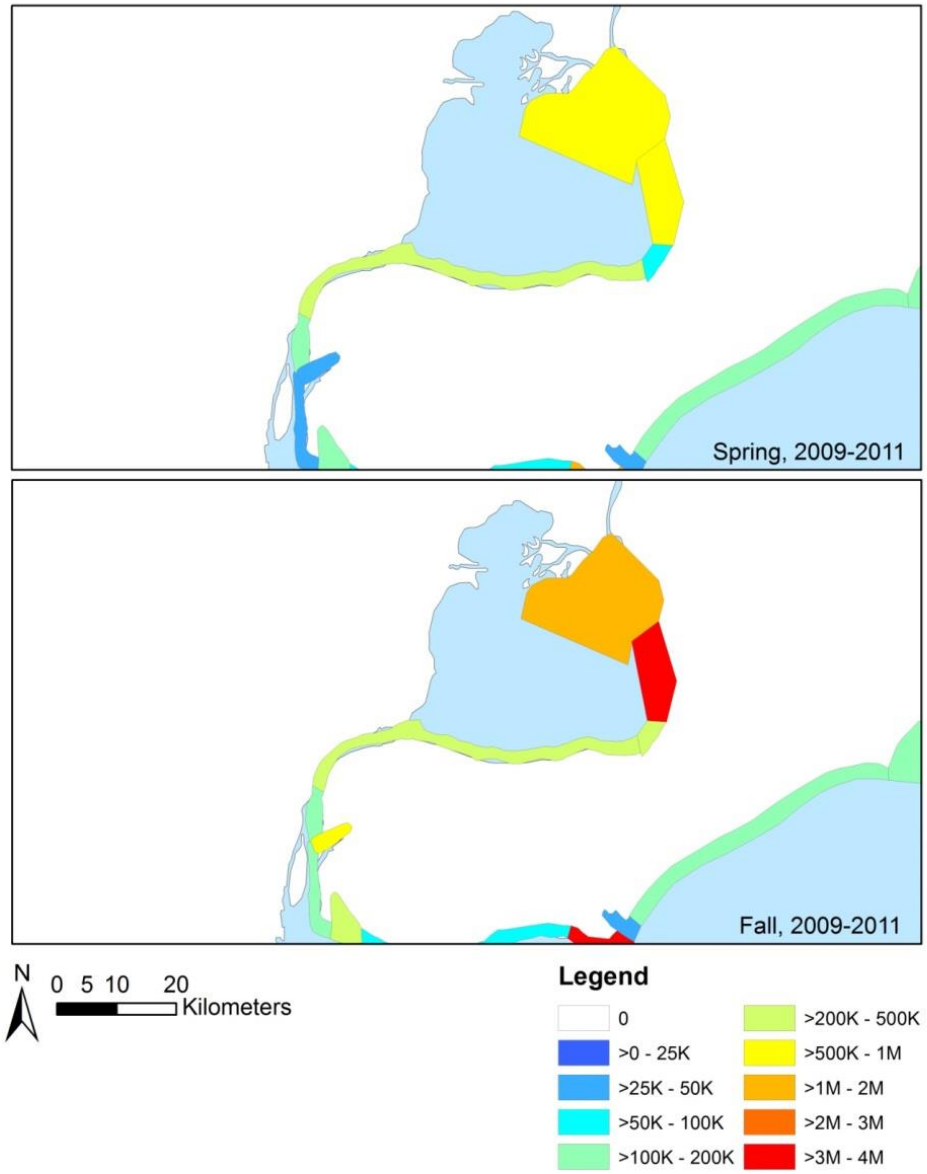
Waterfowl Abundance over time







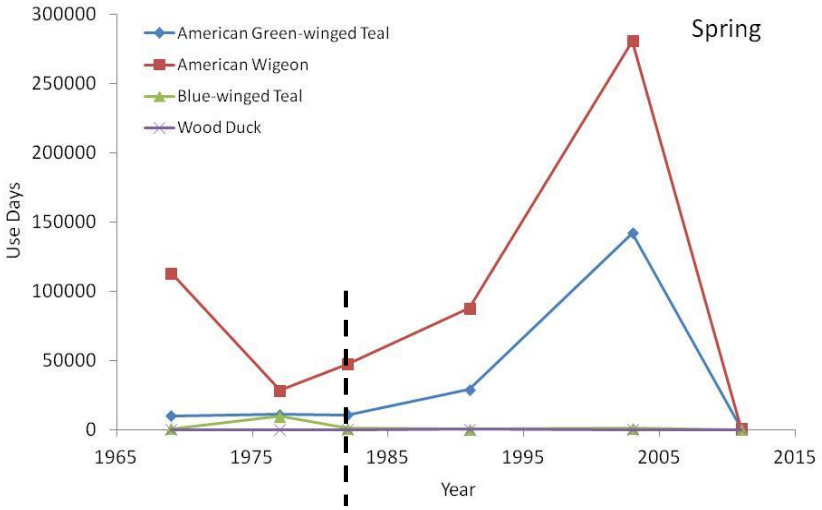
Waterfowl Abundance 2009/11



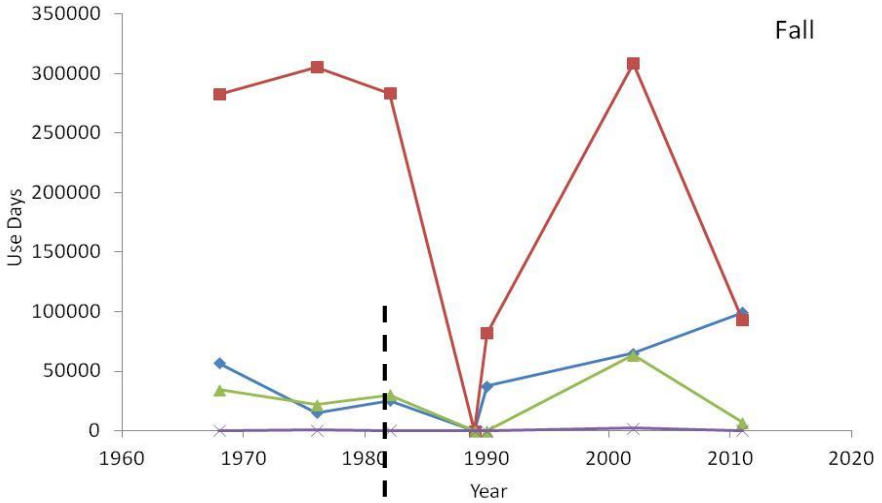
Spring abundance:
500k – 1 million

Fall abundance:
1 – 4 million

What happened since 1982 to the 4 duck species that declined?



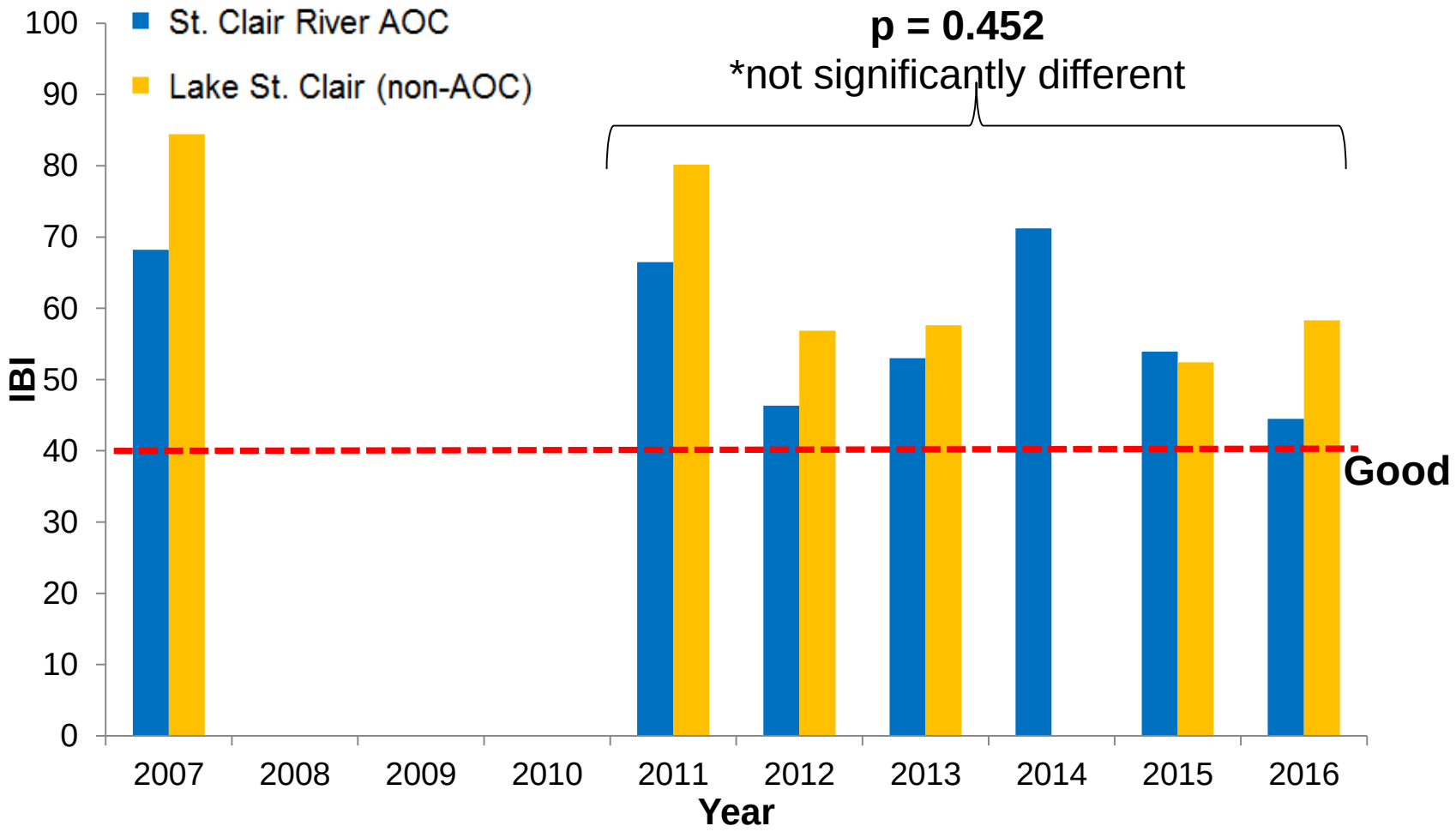
1982



1982

- 4 species recovered but abundance declined again.
- 4 species were a very small percentage (4%) of total waterfowl abundance.
- Several factors contributed to their decline including availability of food and disturbance

Marsh Bird IBI Scores 2007-16



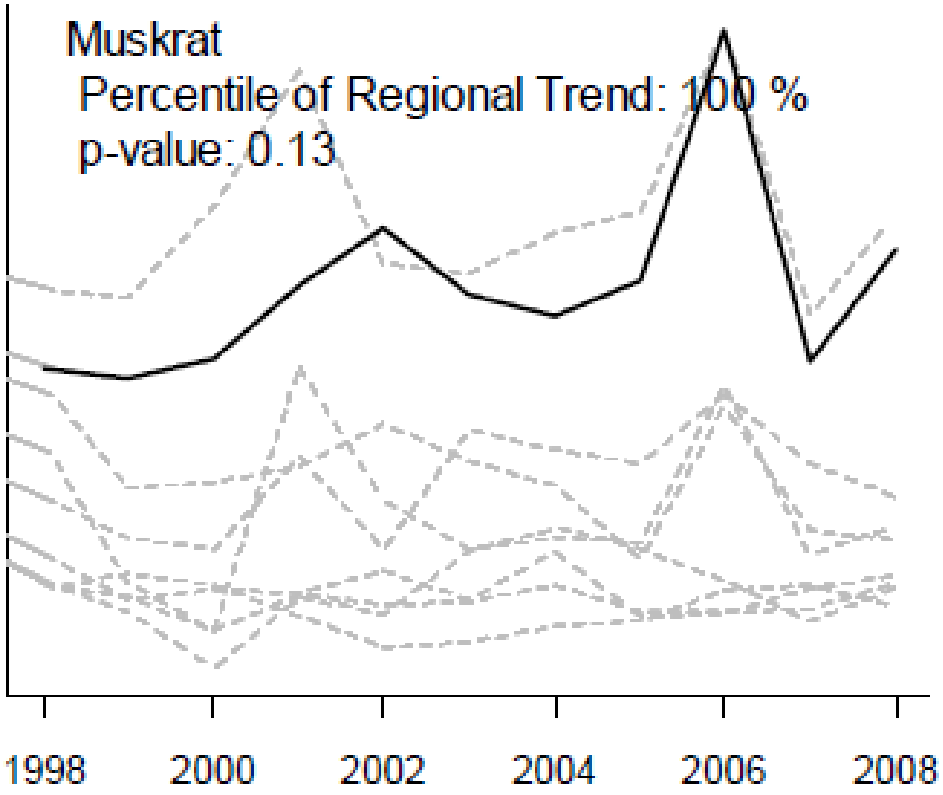
*St. Clair River AOC and non-AOC wetlands typically demonstrated **good** to **excellent** conditions and support some of the highest quality marsh bird communities on the Lower Great Lakes.*

Amphibians

- Report by Bird Studies Canada (BSC) on 18 years of surveys across the Great Lakes from 1995-2012.
- Frog populations across the Great Lakes basin remained stable.
- For the St. Clair River AOC, data suggests that frog abundance and diversity is higher in the AOC than outside the AOC.

Metric	Richness (AOC vs. Region)	p-value (AOC vs. Region)	Percentile	Assessment
Total species richness	+	N.S.	72.35	fair
Indicator species richness	+	N.S.	56.46	fair
Non-tolerant species richness	+	N.S.	60.79	fair

Muskrats



Bold line is for muskrat harvest levels in townships adjacent to the St. Clair River AOC vs those in surrounding counties.

Traditional knowledge supported high abundance of muskrats in the delta.

Wildlife Diversity and Abundance Findings

Waterfowl

Surveys indicate waterfowl abundance in AOC is high; compared to outside AOC, same or better.

Marsh birds

Marsh bird community surveys indicate overall ranking of very good.

Amphibians

AOC community inside AOC more diverse and abundant than outside the AOC.

Frog studies = No evidence of reproductive impairment.

Muskrats

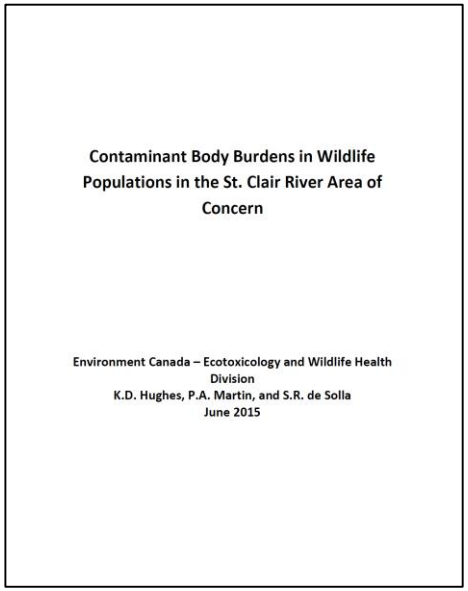
High harvests in townships adjacent to AOC compared to townships outside the AOC.

BUI 3 – Degradation of Fish and Wildlife Populations
Requires Further Assessment

With respect to contaminant burdens…

Hg (Mercury)	Mean ug/g ww	Reproduction effects concentration	Survival Effects concentration
Canvasback	0.19	2.0	20.0
Mallard	0.11	2.0	20.0
Average concentration of mercury in livers of overwintering collected were all below concentrations associated with adverse effects on reproduction and survival.			

Contaminant / mallard livers	1985/86 – Pooled Samples*		2010 – Individuals	Percent Decline From 1985/86 (pool 2) and 2010
	No. 1	No. 2	3	
Sum PCBs	434.56**	82.32**	4.51 (1.81)	94.5%
Sum DDT	49.00	20.00	1.43 (1.64)	92.9%
HCB	311.00	11.00	0.05 (0.06)	99.5%
OCS	493.00	41.00	0.06 (0.04)	99.9%


Contaminant Body Burdens in Wildlife Populations in the St. Clair River Area of Concern

Environment Canada – Ecotoxicology and Wildlife Health Division
K.D. Hughes, P.A. Martin, and S.R. de Solla
June 2015

BUI 3 – Degradation of Fish and Wildlife Populations
Requires Further Assessment

Assessment findings…

For Wildlife:

1. Is abundance and diversity within the AOC consistent with the area outside the AOC?

Yes - Based on survey data and local knowledge, abundance and diversity of aquatic wildlife within the AOC is similar to the surrounding area.

2. Have contaminant levels decreased?

Yes – Significant declines in PCBs, OCS, HCB and Hg although it persists, below thresholds associated with adverse effects on growth and reproduction and survival in ducks studied.

Not Impaired

Surveys and studies suggest aquatic wildlife populations are self-sustaining and comparable or better than outside the AOC and contaminants have declined, with no evidence of adverse effects on growth or reproduction in local fish and wildlife.