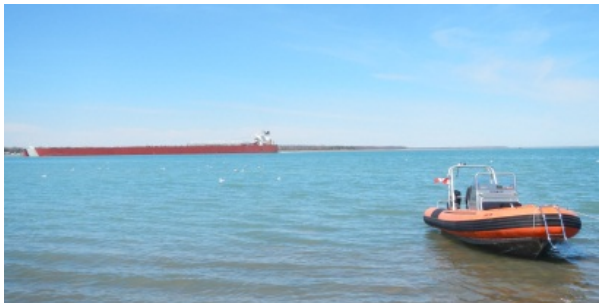
Environment Canada Environnement Canada

Canada

Assessment of the wildlife deformities and reproductive problems BUI: St. Marys River AOC

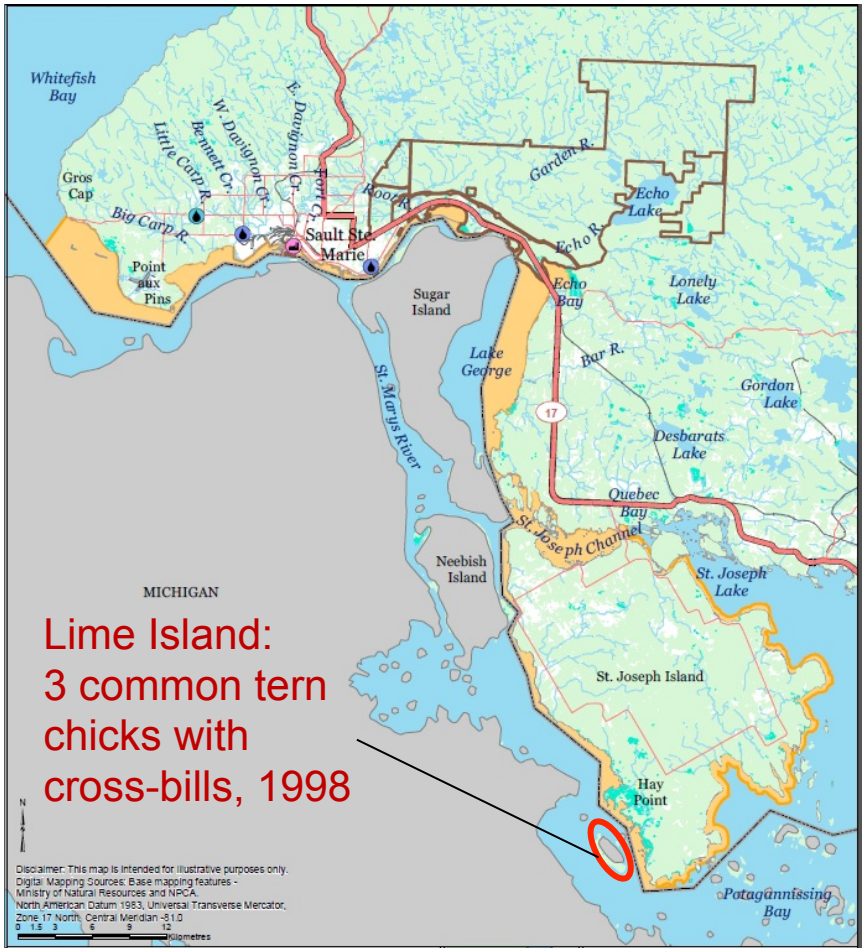


Doug Crump, Kim Williams, Kim Hughes, and Pamela Martin

Science and Technology Branch, Environment Canada

June 19, 2013

St. Marys River Area of Concern (AOC)



- 112 km international channel
- Discharges from industry (e.g. steel, pulp and paper) impaired water quality and contaminated sediments
- Wildlife deformities or reproduction problems BUI listed as “requires further assessment” in late 1990s
- Relates to contaminant exposure or other anthropogenic stressors on reproductive success or deformity rates

Environment Canada's Role in SMR AOC – 2011 & 2012

- Initiated a two-year field/lab study in 2011 to assess the wildlife deformities and reproduction problems BUI in the Canadian portion of the AOC
- **Objectives:**
  - Examine reproduction and development of herring gulls (*Larus argentatus*) and common terns (*Sterna hirundo*) breeding within the St. Marys River AOC to meet the recommendations of the Stage 2 Remedial Action Plan Report
  - Complement the research conducted by our U.S. colleagues in Michigan
- **Outcome:**
  - Clarify the status of this BUI (i.e. impaired or not) in terms of potential delisting


Image NOAA
© 2013 Cnes/Spot Image
© 2013 Google
Image © 2013 TerraMetrics
©2010 Google
The Cousins

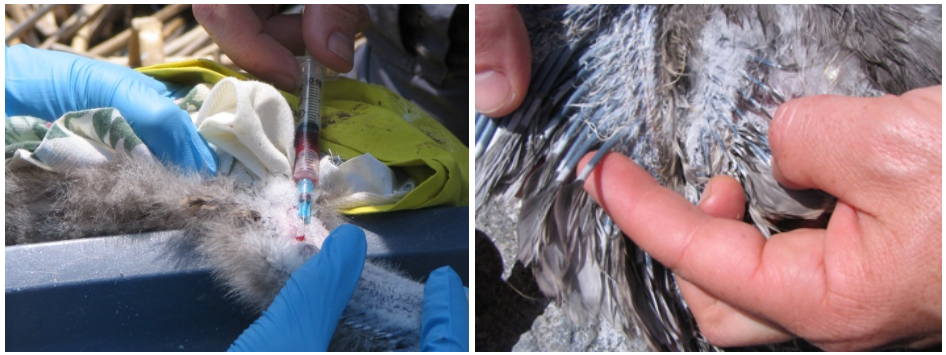
Multi-tiered Approach: Field study #1

- Late April – Gulls
  - Collect unincubated eggs (n=15-26) from single egg clutches for artificial incubation in the lab
  - Build enclosures (n=12) around 3-egg clutches
  - Measure 30 3-egg clutches
- Late May – Terns
  - Collect eggs (n=15-30) from single egg clutches for artificial incubation in the lab

Multi-tiered Approach: Field study #2 - Juveniles

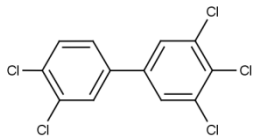
- Mid-June – Gulls
  - Productivity: # of > 21-day-old chicks/# of enclosures
  - Deformity survey
  - Banding, body measurements
  - Blood and feather collection

- Mid-July – Terns (2011 only)
  - Deformity survey
  - Banding, body measurements
  - Blood and feather collection

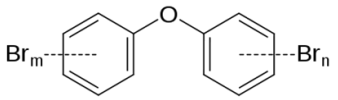


Multi-tiered Approach: Lab Study #1 - Embryos

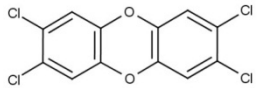
- Artificial incubation
  - Embryonic viability, deformities
- Contaminant analysis
  - OCs, PCBs, PBDEs, Mercury
  - Dioxins/furans/non-*ortho* PCBs (**data not yet available**)
- Biochemical endpoints
  - Stable isotopes of C and N to determine trophic position/diet



PCB 126



PBDE



TCDD

OR

Multi-tiered Approach: Lab Study #2 - Juveniles

- Feather corticosterone
  - Corticosterone (i.e. stress hormone) is deposited in growing feathers and provides insight into the physiology of stress during feather growth
  - Extraction and analysis were carried out using optimized lab procedures and a commercially-available kit
- Plasma thyroid hormone
  - Indicator of potential endocrine disruption of the thyroid hormone pathway
  - Whole blood is centrifuged in the field to separate red blood cells from plasma
  - Plasma thyroid hormone levels are determined using a commercially-available kit

Lab Results – Artificial Incubation

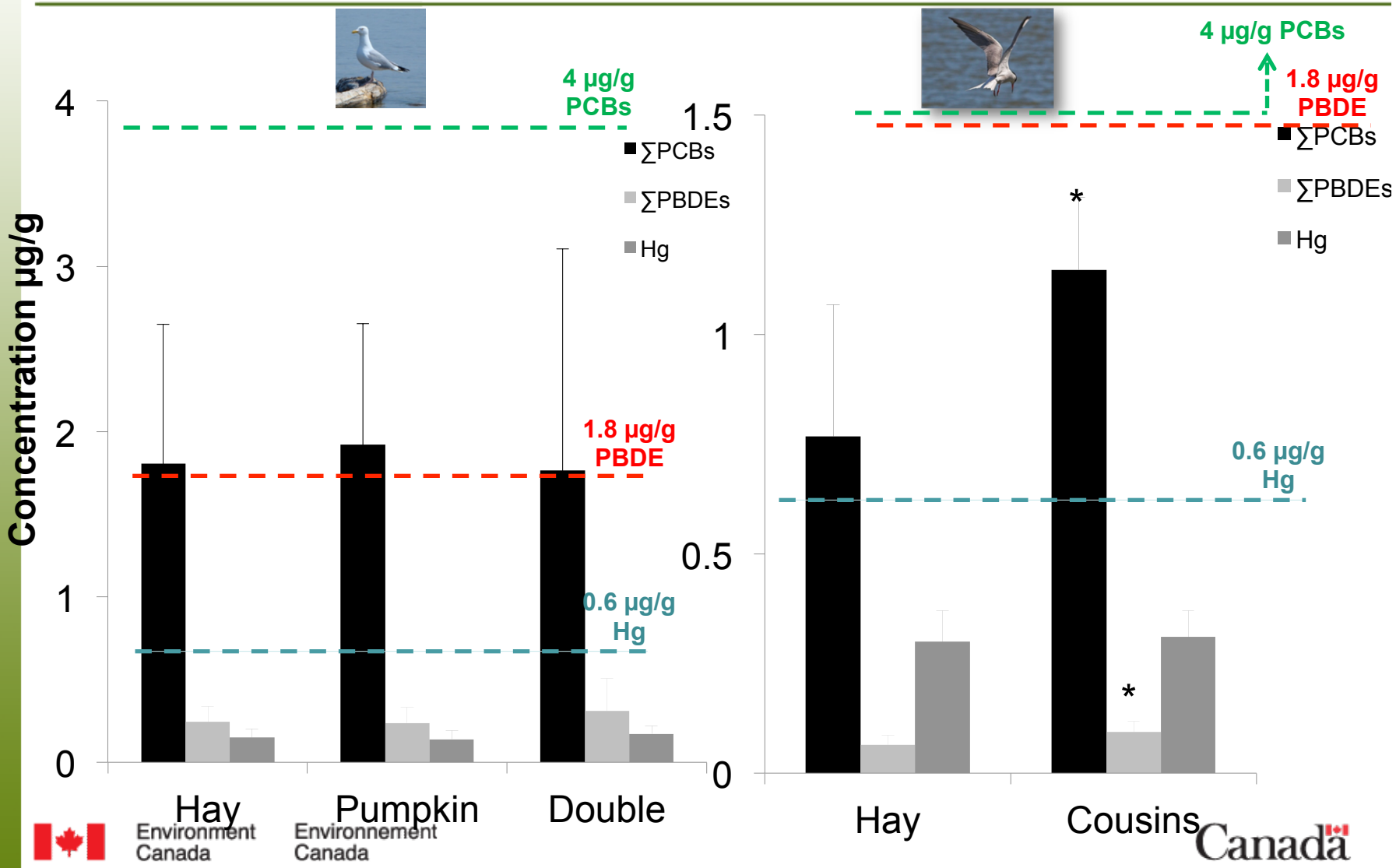
- Herring gulls

Colony	Year	N	% Viability	Deformities	% deformities
Hay	2011	15	93	1	8
	2012	15	100	0	0
Pumpkin	2011	17	94	1	6
	2012	15	92	1	8
Double	2011	23	86	0	0
	2012	26	96	0	0

- Common terns

Colony	Year	N	% Viability	Deformities	% deformities
Hay	2011	30	90	1	4
	2012	15	100	0	0
North Sister	2012	15	93	1	8
Cousins	2011	15	93	0	0
	2012	15	100	0	0

Lab Results – Contaminants (2011)



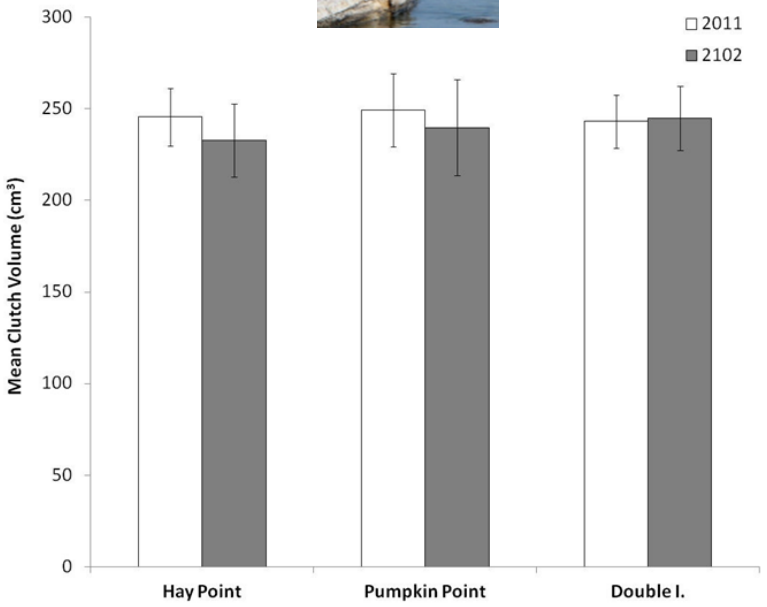
Environment Canada Environnement Canada Canada

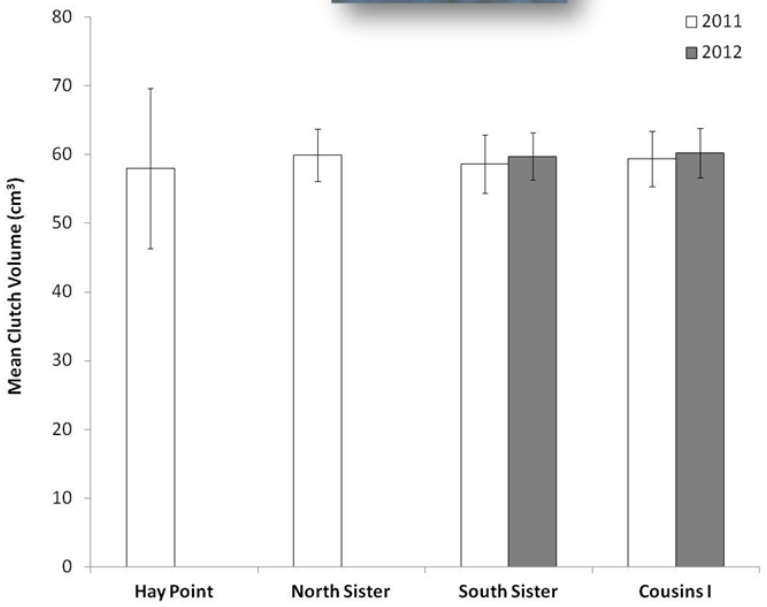
Lab Results – Stable Isotopes

- Herring gulls
  - $\delta^{15}N$ significantly greater in gulls from reference colony (Double) than AOC colonies
  - $\delta^{13}C$ significantly depleted at reference colony
  - **Take home message:** Double Island gulls feed at higher trophic level with a different carbon source than AOC gulls
- Common terns
  - Same pattern observed for terns; reference colony had significantly greater $\delta^{15}N$ and more depleted $\delta^{13}C$ than AOC colonies

DIETARY DIFFERENCES APPARENT BETWEEN REFERENCE AND AOC COLONIES

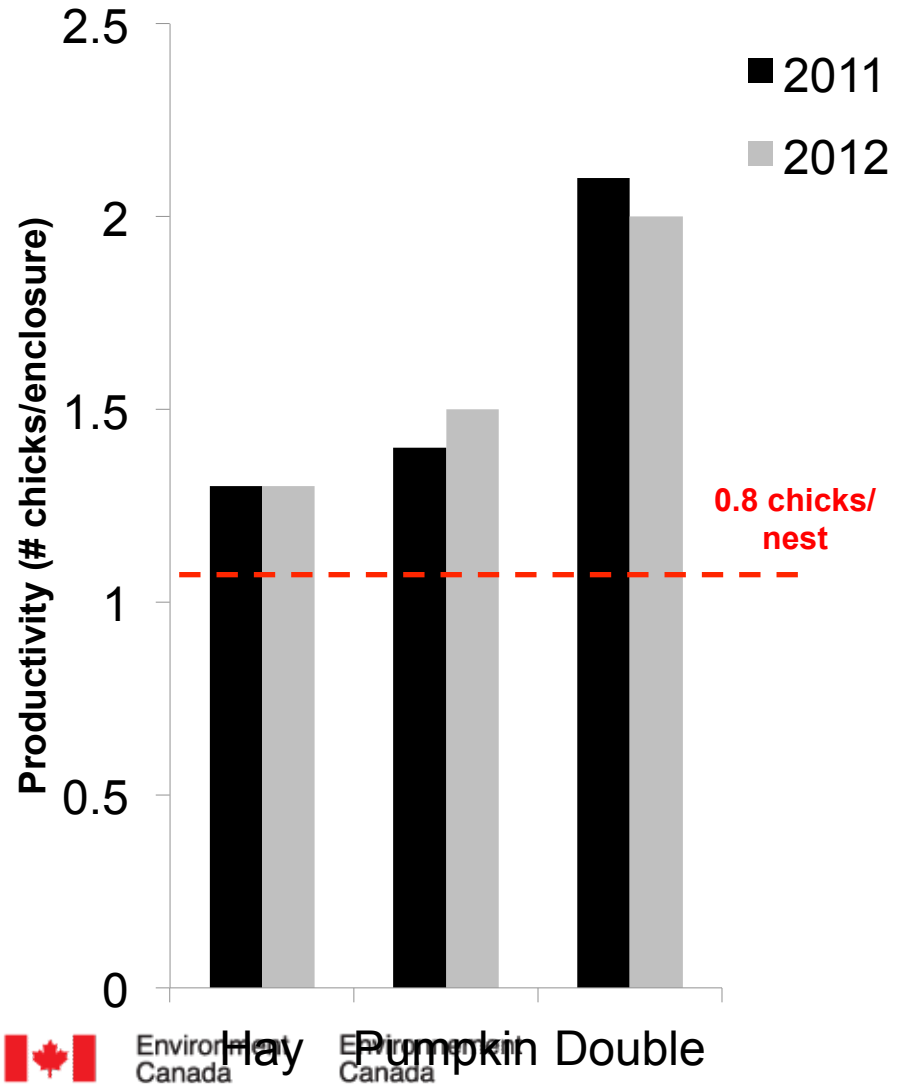
Field Results – Clutch Volume





Tern data from EC study by
Moore and Weseloh

Field Results – Productivity



- Productivity: # of ≥ 21-day-old chicks / # of enclosures
- To maintain a stable herring gull population → 0.8-1.4 chicks/nest (Kadlec and Drury, 1968)
- Productivity estimates of the AOC colonies and the reference colony exceeded this threshold in both years of study

NOTE:

- Tern productivity more difficult to estimate given poor site tenacity (nest abandonment), severe weather events and predation (Moore and Weseloh)

Field results - Deformities

Colony	Year	No. Chicks Examined		% Deformities
		Enclosed Nests	Non-enclosed Nests	
Hay Point	2011	19	20	0%
	2012	16	-	0%
Pumpkin Point	2011	23	40	0%
	2012	15	-	0%
Double I.	2011	31	45	0%
	2012	14	-	0%

NO DEFORMED GULL CHICKS WERE OBSERVED AT ANY OF THE COLONIES IN 2011 (N=39-76) OR 2012 (N=14-16)

NO DEFORMED TERN CHICKS WERE OBSERVED AT AOC OR REFERENCE COLONIES IN 2011 (N=10-13)

Biochemical results

- Herring gulls
  - No significant differences in feather corticosterone concentrations or plasma thyroxine levels between AOC and reference colonies
- Common terns
  - Significantly elevated corticosterone concentrations in feathers of juvenile terns sampled at North Sister Island within the AOC compared to the reference colony

Conclusions – Thumbs up or down

- Based on current available data, no evidence of contaminant-induced impairment of reproduction for colonial waterbirds within the SMR AOC 
- **0%** deformity rate in field-sampled herring gull and common tern chicks within SMR AOC in both study years 
- Low incidence of embryonic deformities in gulls and terns from SMR AOC following artificial incubation 
- Limited differences in contaminant concentrations (of those measured to date) between AOC and reference colonies 
- Contaminant concentrations below thresholds established to protect avian fish-eating wildlife 

The Path Forward

- Repeat the artificial incubation study for both species to determine rate of embryonic deformities
- Compare these results to on-going studies at other AOCs (e.g. Thunder Bay, Hamilton Harbour)
- Individual dioxin/furan/non-*ortho* PCB analysis of deformed embryos; compare to pools of non-deformed embryos for each colony and to TEQ thresholds associated with embryotoxicity in colonial waterbirds
- OC/PCB/PBDE analysis of 2012 embryos
- Submission of final report

A big thanks goes to….

Field team:

•Kim Williams, Lewis Gauthier, Wouter Gebbink, Eric Pelletier, Lukas Mundy, Laird Shutt; Dave Moore and Chip Weseloh (tern study)

Lab analyses:

•Kim Williams, Tissue Prep/Lab Services at NWRC, University of Ottawa stable isotope lab

Data analysis and report preparation:

•Kim Hughes, Kim Williams, Pam Martin

Mark Chambers and Kate Taillon – Great Lakes AOC, EC

Bi-National Public Advisory Council
For the St. Marys River Area of Concern

Funding: Great Lakes Action Plan (GLAP)

Environment Canada Environnement Canada

Canada

QUESTIONS????

Contact info: doug.crump@ec.gc.ca

Examples of deformities in SMR AOC embryos

Hay - COTE

PUM - HERG