Avian Interim Status Report

Avian Habitat, Populations, Reproduction and Contaminants In and Near the Massena/Akwesasne St. Lawrence River Area of Concern (AOC)

USEPA GLRI Project ID: GL-97221310

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March 2013, Revised Final September 2014

Suggested citation:
Harper L.H. and J.L. Jock. September 2014. Avian Interim Status Report: Avian Habitat, Populations, Reproduction and Contaminants In and Near the Massena/Akwesasne St. Lawrence River Area of Concern (AOC). GL-97221310. 41 pp.

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1.0 INTRODUCTION

The international section of the St. Lawrence River was identified as one of five Bi-National Areas of Concern (AOC) by the International Joint Commission (IJC) under the 1987 amended Great Lakes Water Quality Act (GLWQA). The boundaries of interest under this Great Lakes Restoration Initiative (GLRI) funded project (GL-97221310) are the upstream and southern portion of the Bi-National St. Lawrence River Area of Concern (AOC), primarily located in St. Lawrence County and the Mohawk Territory of Akwesasne (also called Massena/Akwesasne AOC). The Massena/Akwesasne AOC includes the Grasse (04150304), Raquette (04150305), and St. Regis (04150306) tributaries, Power Canal on the Grasse River, and portions of the St. Lawrence River itself.

The AOC was identified due to discharge of hazardous industrial byproducts to nearby tributaries, land, and the St. Lawrence River itself, thus causing ecological impairments and impaired water quality. Avian populations may have been historically impacted by persistent organochlorine chemicals (POCs) such as polychlorinated biphenyls (PCBs), mercury, dichlorodiphenyldichloroethylene (DDE), mirex, nutrients and metals released through discharges.

Several efforts have occurred to remove contamination sources and improve water and sediment quality in and around the AOC between 1995-2009, but sources of contaminated sediments are still present in areas such as the Grasse River. The Grasse River will be remediated in accordance with the Record of Decision (ROD) of the U.S. Environmental Protection Agency (USEPA). Remediation design and implementation activities are expected to start in 2015 (USEPA 2013).

This interim status report details the findings of existing data related to birds in and near the Massena/Akwesasne AOC and identifies data gaps to facilitate and plan 2013 field work.

2.0 EXISTING DATA REVIEW METHODS

2.1 Investigation Area

The investigation area for the existing data review included the Massena/Akwesasne AOC and wetlands, rivers, and other habitats along the St. Lawrence River within 25 miles upstream and downstream of the AOC. This area extends approximately from Cardinal, Ontario on the north shore of the St. Lawrence River and Lisbon Beach, New York on the south shore of the river, downstream to a point beyond the east end of the Akwesasne Mohawk Territory in the vicinity of Bainsville, Ontario on the north shore of the St. Lawrence River and Saint-Anicet, Quebec, on the south shore of the St. Lawrence River. The AOC itself is depicted in Figure 1.

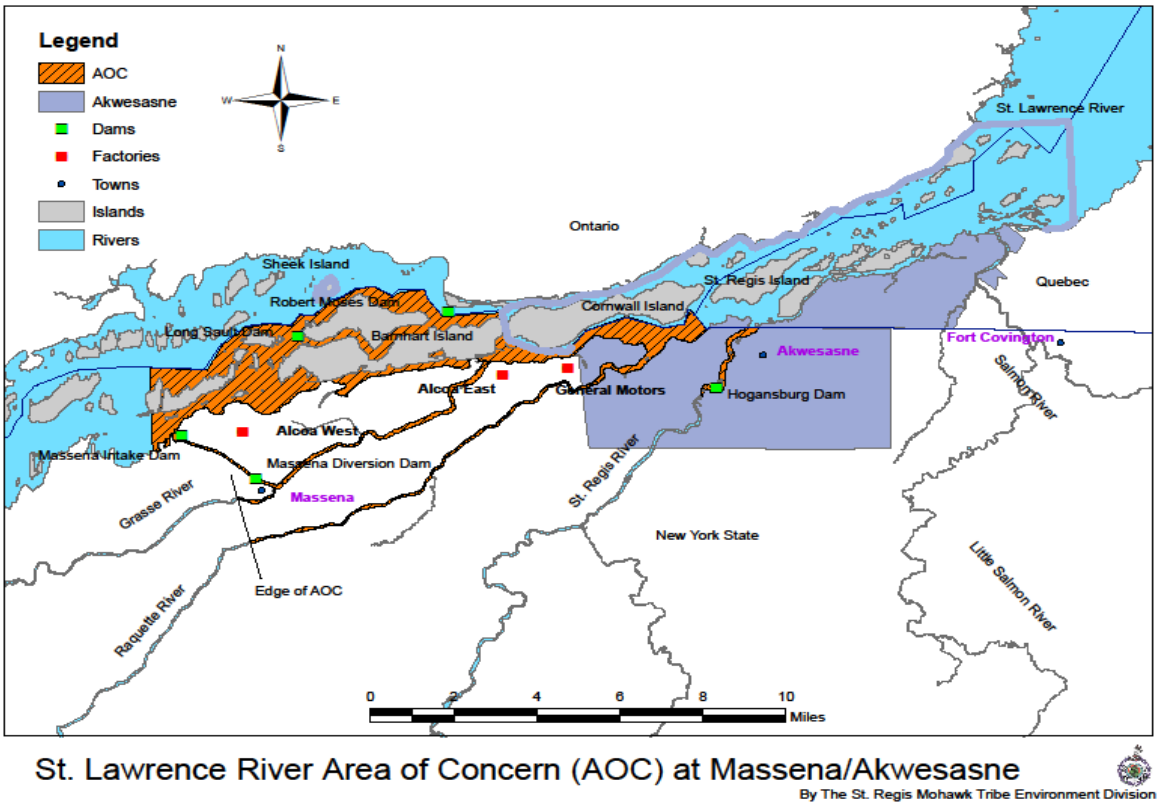

Figure 1. Map of Massena/Akwesasne AOC.

2.2 Type of Existing Data Needed

The existing data needed to address the objectives include known nesting locations of sentinel bird species, potential habitat for sentinel species, and reproductive data and contaminant level data. The requirements relating to the type, age, and representativeness of data are described in the table below.

Table 1. Types of existing data needed.

Type of Data	**Habitat** • personal experience, knowledge, or communication • sightings, photos, reports • database records • unpublished field notes • gray literature (agency reports) • previously published records
	Contaminant Data • database records • previously published records
Age of data	• Population, habitat, reproductive data: 20 years old or less • Contaminant data: All, regardless of age
Geographical representation	• Inside the AOC: all data • Outside the AOC: data within 25 miles of AOC boundary
Temporal representation	• All

2.3 Sources of Existing data

Potential data sources included the databases, reports, and libraries of the Saint Regis Mohawk Tribe Environment Division (SRMTED), New York State Department of Environmental Conservation (NYSDEC), United States Environmental Protection Agency (USEPA), Canadian Wildlife Service (CWS), Ontario Ministry of Natural Resources (OMNR),

recognized local experts, University researchers, and others with direct personal experience or expertise in and adjacent to the Massena/Akwesasne AOC. Of particular importance are the personal communications, unpublished field notes, and direct personal knowledge of habitats and species from local individuals and researchers. Considerable local knowledge was available from Riveredge's local experience and field notes from previous work with SRMT and the Mohawk Council of Akwesasne Environmental Department including previous surveys conducted in Snye Marsh and downstream to the eastern extent of the survey. Because of the general paucity of data for the Massena/Akwesasne AOC, all data sources were considered. No hierarchy of data sources was proposed or used.

2.4 Evaluation Approach to Existing Data

All gathered existing data was evaluated for relevance and applicability to the stated data needs and objectives as outlined in the table below.

Table 2. Evaluation criteria for existing data.

Habitat, Population, and Reproductive Data	• Of appropriate type • Of appropriate age • Of appropriate geographic representation
Contaminant Data	• Includes contaminants of interest to Massena/Akwesasne AOC (e.g. polychlorinated biphenyls (PCBs), dioxins, furans, mercury, dichlorodiphenyldichloroethylene (DDE), mirex, metals) • Data were collected under an approved QAPP, Data Collection Plan (DCP) (under the Comprehensive Environmental Response, Compensation and Liability Act [CERCLA] of 1980, as amended), or other appropriate QA/QC program, and analyzed with appropriate standardized analytical methods.

Riveredge's Data Collection Team collected all available data. Team Leader Christopher Baird was responsible for database searches, data gathering, maintaining a complete list of literature cited, and all other documentation and records management. He oversaw all recording, management, and GIS mapping of GPS locations, habitats, sampling sites, and other suitable data following the methodologies outlined in the existing data QAPP. All existing data collected was reviewed by the Team Leader prior to submission to Project Manager Lee Harper for an additional QA/QC check. This interim status report was prepared by team member Joel Danko with additional contributions from Christopher Baird and QA/QC review by Project Manager Harper.

For contaminant data, the project quality objective was to compile and analyze scientifically sound data on contaminant levels in birds following the procedures detailed in the existing data QAPP. Contaminant data were accepted if the data acceptance criteria for each matrix and measurement (analytical) parameter were met. These acceptance criteria included appropriate precision (i.e. relative percent differences of field duplicates and laboratory duplicates), accuracy (relative percent difference of spiked control samples), comparability (conducted in accordance with USEPA Methods), and sampling methods (sampling SOPs used by trained personnel with appropriate training documentation).

3.0 RESULTS AND DISCUSSION

Existing data were gathered from published sources, unpublished sources, and through interviews with knowledgeable individuals. In addition, the comprehensive review of published literature related to the BUIs of the Massena/Akwesasne AOC completed in 2011 by Tetra Tech (2011) was consulted. The Tetra Tech (2011) review was summarized in a 256 page report that examined existing data sources to address the BUIs of the Massena/Akwesasne AOC. Data for habitat and population (e.g. nesting locations) of sentinel species in and near the AOC in Tetra Tech (2011) were largely lacking, limited to a single note about the general location of an osprey nest site. More recent data were obtained through a review of unpublished literature, personal field records, and through conversations with knowledgeable individuals.

3.1 Sentinel Species

Grove *et al.* (2009) defined a sentinel species as an organism used to evaluate environmental contamination and its implications on environmental health based on its chemical sensitivity, position in the biotic community, exposure potential, and geographic distribution or abundance. An ideal sentinel species would have certain characteristics, including: 1) widespread distribution, 2) nonmigratory status, 3) position at the top of the food web, 4) ability to bioaccumulate contaminants, 5) restricted home range, 6) well known biology and natural history, 7) sensitivity to contaminants, 8) sufficient population numbers, and 9) ability to be maintained and studied in captivity (Grove *et al.*, 2009).

In the Great Lakes, bald eagle (*Haliaeetus leucocephalus*), osprey (*Pandion haliaetus*), herring gull *(Larus argentatus)*, great blue heron (*Ardea herodias*), black-crowned night-heron (*Nycticorax nycticorax*), and tree swallow (*Tachycineta bicolor*) have been used as a sentinel species to monitor contaminants (Bishop *et al.*, 1995; Bishop *et al.*, 1999; Fox, 2001; Champoux *et al.*, 2002, 2006, 2010; Hughes *et al.* 2010; Mayer *et al*., 2011; Weseloh *et al.*, 2011; Custer and Custer, 2013).

Herring gulls make an excellent sentinel species for the Great Lakes but unfortunately do not breed in the Massena/Akwesasne AOC. A potential surrogate species for the Massena/Akwesasne AOC might be common tern, which is known to breed both inside and outside of the AOC (Riveredge Associates, 2013). Baird *et al.* (2012) have examined mercury in common tern feathers collected inside and outside of the Massena/Akwesasne AOC. Contaminants in common terns have been

examined in other areas (French *et al.*, 2001; Mierzykowski, 2008) and have been (or are being) used as an indicator species in the Great Lakes (Weseloh *et al.*, 1989) and on the Detroit River-Western Lake Erie Basin Indicator Project (Szczechowski *et al.*, 2013). Another tern, the black tern (*Chlidonias niger*), is not uncommon in the Snye Marsh downstream of the AOC in Akwesasne, but is not known to breed elsewhere on the St. Lawrence River at any site upstream of the AOC. Other species that could potentially be used as indicator species in or near the AOC include ring-billed gull *(Larus delawarensis)*, double-crested cormorant (*Phalacrocorax auritus*), and red-winged blackbird (*Agelaius phoeniceus*) and tree swallow. The last two species have been used to assess contaminant levels in eggs or nestling birds to examine the bioaccumulation of contaminants and avian health in the Massena/Akwesasne AOC (Bishop *et al*. 1995; Bishop *et al.* 1999; Martinovic *et al.,* unpublished; Martinovic *et al.,* 2003a & 2003b).

In the Massena/Akwesasne AOC, Tetra-Tech (2011) identified fish-eating birds such as bald eagle, osprey and herons as the sentinel bird species of primary interest. Some of these species are known to nest in and near the AOC (see Section 3.2 below). Bald eagles are known to nest inside and outside the AOC, but in very low numbers. Osprey are known to nest inside and outside the AOC (both upstream and downstream), and they are a good candidate sentinel species for this work. Herons, such as great blue heron, nested historically in the AOC (Harper et al. 2006), and contaminant levels in herons were previously examined by Champoux *et al*. (2010). A review of known nesting sites of these species was conducted to identify which were known to nest in and near the AOC and could be used as sentinel species for this AOC in field studies (Section 3.2). In addition, the general habitat requirements of these species and potential surrogate species were examined to identify potential additional nesting locations in and near the AOC (Section 3.3).

3.2 Data for Sentinel Species Populations and Habitat

Our review of existing data identified a number of known nesting locations of potential sentinel species within the AOC and within 25 miles of the AOC (Table 3). In addition, the nesting locations of several other species of interest were documented (Table 4). Very few of these species are known to nest both inside and outside the AOC (Tables 3 and 4). The legal status of these species (e.g. threatened or endangered at the state, provincial, tribal, or federal level) is listed in Table 5. Based on this review, there are four bird species considered sentinel species known to nest currently or historically both within and near the Massena/Akwesasne AOC and are of selected interest. These four species are:

- Bald Eagle (*Haliaeetus leucocephalus*)
- Osprey (*Pandion haliaetus*)
- Great Blue Heron (*Ardea herodias*)
- Common Tern (*Sterna hirundo*)

The common tern is a New York State Department of Environmental Conservation (NYSDEC) listed threatened species (NYSDEC 1999). Osprey are considered Species of Special Concern, and bald eagles are listed as threatened (NYSDEC 1999). None of these species are listed as threatened or endangered by the United States Fish and Wildlife Service (USFWS) or by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (Table 5).

Population trends for three of these species are positive. Populations of bald eagle, osprey, and common tern are increasing. Populations of herons in and near the AOC are unknown, although a historical nesting site in the AOC is known (Harper *et al.*, 1996). Three eagle nests were active in 2012, and a fourth is thought to have been active but was unconfirmed. At least eight osprey nests are known to occur in and near the AOC, and there are likely several others that have not been recently surveyed or documented. Osprey are increasing in the area as a result of a Habitat Improvement Project (HIP) being conducted by the New York Power Authority that consists of installing nesting platforms (Riveredge 2010). The last aerial survey of osprey nests by NYSDEC in 2008 identified 55 active nests, double what was present only five years earlier. NYSDEC intended to conduct another aerial survey for osprey and eagle nests in 2013, but this was not done (B. Town, personal communication).

Table 3. Known nesting sites of sentinel species in and near the AOC.

Species	Nesting Site	Inside Massena-Akwesasne AOC?	Within 25 miles of AOC?	Number of nests in 2012 (or recent year), if known	Source
Osprey	Dickerson Is., S of	No	Yes	Historical	L. Harper, pers. obs. 1999
	Hog Is.	No	Yes	Historical	L. Harper, pers. obs. 1999
	Buoy R8	Yes	-	1	L. Harper, pers. obs. 2012
	131 S-curves	Yes	-	1 (fledged 2)	M. Morgan, NYSDEC
	Massena Intake (NYPA)	Yes	-	Not occupied	M. Morgan, NYSDEC
	Massena Intake (MED)	Yes	-	1 (fledged 2)	M. Morgan, NYSDEC
	Wilson Hill Causeway	No	Yes	1 (fledged 2)	M. Morgan, NYSDEC
	Bradford Point	No	Yes	1 (0 fledged)	M. Morgan, NYSDEC
	Coles Creek-Tiernan Rd	No	Yes	1 (fledged 2)	M. Morgan, NYSDEC
	Whitehouse Point	No	Yes	1 (fledged 2)	M. Morgan, NYSDEC
	Iroquois Dam	No	Yes	1	M. Morgan, NYSDEC
Bald Eagle	Town of Massena	Yes	Yes	1 (fledged 2)	B. Town, NYSDEC
	Town of Louisville	No	Yes	1 (fledged 2)	M. Morgan, NYSDEC
	Town of Waddington	No	Yes	1	B. Town, NYSDEC
	Town of Norfolk	No	Yes	unconfirmed	J. Wilkins, SRMT
Great Blue Heron	Wiley-Dondero Canal	Yes	-	Unknown	Harper *et al.* 1996
	Dickerson Is.	No	Yes	Unknown	D. Moore, CWS
	Dodens Is.	No	Yes	69 (2008)	D. Moore, CWS
Common Tern	Christatie Island	No	Yes	7 (1999)	L. Harper, pers. obs. 1999
	Navigation island D50	No	Yes	0	L. Harper, pers. obs. 2012
	Eisenhower Mooring Cells	Yes	-	202	Riveredge Associates 2013
	Navigation cell 51	No	Yes	57	Riveredge Associates 2013
	Wilson Hill range light	No	Yes	70	Riveredge Associates 2013
	Navigation cell 57	No	Yes	26	Riveredge Associates 2013
	Navigation cell 58	No	Yes	61	Riveredge Associates 2013
	Cat Island steering light	No	Yes	110	Riveredge Associates 2013
	Navigation cell 73	No	Yes	56	Riveredge Associates 2013
	Navigation cell 75	No	Yes	72	Riveredge Associates 2013
	Navigation cell 79	No	Yes	68	Riveredge Associates 2013
	Navigation cell 85	No	Yes	102	Riveredge Associates 2013

Table 4. Known nesting sites of other species of interest near the AOC.

Species	Nesting Site	In Massena-Akwesasne AOC?	Within 25 miles of AOC?	Number of nests in 2012 (or recent year), if known	Source
Ring-billed Gull	Murphy Island	No	Yes	~750	M. Morgan, NYSDEC
	Strachan Island	No	Yes	11,693 (2009)	D. Moore, CWS
	Sheek Is. Island W of	No	Yes	775 (2008)	D. Moore, CWS
	Bergin Island	No	Yes	3.975 (2009)	D. Moore, CWS
	Island W of Bergin	No	Yes	0	D. Moore, CWS
	D-50	No	Yes	<500	Harper, pers. obs. 2012
	D-41	No	Yes	<250	Harper, pers. obs. 2012
Herring Gull	Murphy Island	No	Yes	20 (2008)	D. Moore, CWS
	Strachan Island	No	Yes	63	D. Moore, CWS
	Sheek Is. Island W of	No	Yes	8 (2008)	D. Moore, CWS
	Bergin Island	No	Yes	Unknown	D. Moore, CWS
	Island W of Bergin	No	Yes	Unknown	D. Moore, CWS
	D-50	No	Yes	~2	Harper, pers. obs. 2012
	D-41	No	Yes	~12	Harper, pers. obs. 2012
Double-crested Cormorant	Spencer Island Pier	No	Yes	13	Harper, pers. obs. 2012
	Murphy Island	No	Yes	94	M. Morgan, NYSDEC
	Sheek Is. Island W of	No	Yes	115 (2008)	D. Moore, CWS
	Island SW of Bergin	No	Yes	165	D. Moore, CWS
	Bergin Island	No	Yes	486	D. Moore, CWS
	Strachan Island	No	Yes	234	D. Moore, CWS
	Dickerson Is.	No	Yes	0	D. Moore, CWS
	D-41	No	Yes	89	Harper, pers. obs. 2012
	Dodens Is.	No	Yes	232	D. Moore, CWS
	Butternut Is.	No	Yes	49	D. Moore, CWS
	D-41	No	Yes	43	Harper, pers. obs. 2012

Table 5. Avian species occurring in and near the AOC and their conservation status.
E=Endangered, T = Threatened, V= Vulnerable, SC = Special Concern, P=Protected.

Scientific Name	Common Name	New York Status	Species of Greatest Conservation Need (SGCN) in New York	Akwesasne at Risk Birds[1]	Ontario Status	Quebec Status
Haliaeetus leucocephalus	Bald eagle	T	✓	SC	SC	V
Pandion haliaetus	Osprey	SC	✓			
Ardea herodias	Great blue heron	P				
Sterna hirundo	Common tern	T	✓			
Chlidonias niger	Black tern	E	✓	SC	SC	
Larus argentatus	Herring gull	P				
Nycticorax nycticorax	Black-crowned night-heron					
Tachycineta bicolor	Tree swallow					
Aquila chrysaetos[2]	Golden Eagle	E	✓	E	E	V

Notes:

1. Based on Mohawk Council of Akwesasne (MCA) designation.
2. Anecdotal reports and communications with MCA staff list observed sightings of this bird in Akwesasne.

Photo 1. Bald eagle is a sentinel species.

3.3 General Habitat Requirements of Sentinel Species

Bald Eagle *Haliaeetus leucocephalus*

Suitable nesting sites for bald eagles include accessible, mature trees with abundant sturdy limbs capable of holding large, heavy branches and sticks. Mature trees provide good flight access to the nest and excellent visibility of the surrounding area. Nests are usually constructed below the crown of the tree, often at the highest point where large branches join the trunk of the tree. Nearby sticks are collected from the ground or extracted from nearby trees and placed in an interwoven pattern to provide a nest foundation. The addition of finer woody materials such as grass, moss, corn stalks, sprigs of greenery; and ultimately downy feathers from the adults complete the initial nest. Additional materials are regularly added to the nest throughout the year, including daily additions during the breeding season, so that nests used for multiple years might achieve enormous dimensions. Nests are usually six feet across, eight or more feet deep, and weigh hundreds of pounds (Buehler, 2000).

Osprey *Pandion haliaetus*

Ospreys prefer nesting sites which offer easy access and safety from ground predators with a sufficiently wide and stable base to accommodate the large nest as well as proximity to water and good feeding areas. Islands, flooded trees and channel markers are ideal sites. Historically, ospreys built their nests atop trees, rocky cliffs and promontories, and—on a few islands free of mammalian predators— on the ground. While some continue to use such natural sites, many have shifted to artificial sites, including channel markers in harbors and along busy waterways; radio and cell-phone towers; utility lines, and nesting poles. This shift has been dramatic in many regions, with 90–95% of pairs choosing artificial sites (Poole *et al.*, 2002). In and near the Massena/Akwesasne AOC, osprey are known to nest on artificial platforms installed by NYPA's Osprey Nesting Platform Habitat Improvement Project (HIP). The goal of this project was to increase osprey nesting in the area.

Photo 2. Osprey is a sentinel species and widely used for contaminant monitoring throughout the world.

Great Blue Heron *Ardea heroides*

On average, great blue heron colonies are located 2.3 to 6.5 km from their primary foraging location. Important factors determining nest site selection include sufficient buffering habitat in proximity to human activity (vegetation or water), low road density and the presence of large woodlands. However, sometimes herons nest closer to humans than expected, presumably to take advantage of foraging opportunities. Colony site selection is also predator-driven; where mammalian predators are common, herons usually select nest sites that are difficult to reach (Vennesland and Butler, 2011).

When building nests, great blue herons gather sticks and other materials from the ground, nearby trees and shrubs, or from unguarded and abandoned nests (including nests of their predators such as bald eagles). Stick gathering is done primarily by males and primarily females place them on the nest. Nest building can take from 3 days to 2 weeks. Completed nests consist of a platform of twigs with a saucer-shaped interior lined with pine needles, moss, reeds, dry grass, mangrove leaves, or small twigs. Nesting material is generally added throughout the nesting period (Vennesland and Butler, 2011).

Common Tern *Sterna hirundo*

Common terns nest in coastal or lake island areas on the ground. They prefer open areas with loose substrate (mostly gravel or cobble), but with scattered vegetation or other cover in which chicks can seek shelter from the elements and predators. Most nests are 0–5 m above high-water mark, with the highest sites occupied first. Later arriving birds tend to settle at or below the high-water mark. At some sites early-nesting birds select nest-sites before vegetation starts to emerge, presumably using knowledge of vegetation from previous years (Nisbet, 2002). When preferred partially vegetated areas are not available for nests, terns will nest on islands that are mostly rocky, open sand or gravel, or fully vegetated (preferably with grazed or otherwise stunted vegetation). Where natural sites are not available for nesting, terns nest on artificial sites, including dredge spoil islands, confined disposal facilities, derelict piers and barges, breakwaters, bridge abutments, navigation cells, and floating rafts (Nisbet, 2002). On Lake St. Lawrence, common tern nesting sites have been monitored and managed for over 20 years by NYSDEC. More recently, the NYPA Common Tern HIP has initiated habitat improvements aimed at increasing the number

of nesting pairs of this threatened species to 1,400 on Lake St. Lawrence. Current nesting pair nest counts as of 2013 on Lake St. Lawrence are at 729, with a 3-year average of 817 total nests (Riveredge 2013).

Photo 3. Common terns nest in the AOC and have been used as a sentinel species on the St. Lawrence River.

3.4 Data Related to Contaminants, Breeding and Deformities

Contaminant data for avian sentinel species in and near the AOC are largely lacking.

Bald Eagle

NYSDEC (1981), NYSDEC (1990), and Skinner (1992) reported a bald eagle carcass that was tested for contaminants in the study area. The brain and liver of the bald eagle collected January 10, 1981 contained 126 and 234 mg/kg (ppm) PCBs respectively. No additional contaminant data for bald eagles in or near the Massena/Akwesasne AOC were found during this review of existing data.

The Draft Bald Eagle Conservation Plan in preparation by NYSDEC proposed the sampling of unhatched eggs, feathers, or blood from bald eagles on the St. Lawrence River (B. Town, NYSDEC, personal communication). At present, the known eagle nests in and near the AOC appear to be producing 1-2 chicks annually with no obvious signs of reproductive impairment (B. Town, NYSDEC, personal communication; M. Morgan, NYSDEC, personal communication).

Osprey

NYSDEC (1981), NYSDEC (1990), and Skinner (1992) reported an osprey carcass that was tested for contaminants in the study area. The brain and liver of an osprey collected October 7, 1978 contained 0.67 and 1.05 mg/kg (ppm) PCBs respectively. No additional contaminant data for osprey in or near the Massena/Akwesasne AOC were found during this review of existing data. Ospreys are known to be sensitive to many bioaccumulative contaminants, including *p,p'*-dichlorodiphenylethylene (DDE) and other organochlorine pesticides, PCB, PCDD, PCDF, and mercury (Hg) (Grove *et al.*, 2009).

Martin *et al.* (2003), measured levels of organochlorines (PCB's and DDE) in osprey eggs of the upper St. Lawrence River (near Mallorytown, Ontario; approximately 55 miles upstream of the AOC) to determine if the recovering population was affected by these compounds. Populations of osprey in the Great Lakes basin declined dramatically in the 1950's – 1970's largely due to the high levels of organochlorine contaminants. From 1991-1995 Martin *et al.* (2003) monitored osprey populations in the Great Lakes region, including Georgian Bay and St. Mary's River in Lake Huron

and the St. Lawrence Islands National Park. DDE levels averaged 1.2-2.9 µg /g even in the most contaminated lake, and were found to be lower than the levels that are associated with birth defects (4.2 µg /g). However, some eggs from each area studied exceeded this level. Levels of PCB's rarely exceeded 5µg/g except for inland Kawartha Lakes which had an average PCB level of 7.1 µg /g and a high of 26.5 µg /g. The average reproductive output of all ospreys in the study was 0.78-2.75 chicks per nest, which is higher than the 0.8 young per nest thought needed to maintain a stable population. The researchers concluded that even though osprey eggs are an effective way of showing local contaminant levels, the ospreys themselves appeared to be are largely unaffected on a population stability scale (Martin *et al.* 2003).

Tree Swallow

Tree swallows are a sentinel species, often used for contaminant analysis to examine PCB burdens in insectivores living near contaminated soil or sediment. Tree swallows are easy to work with because they readily use nest boxes, nest in high density, feed close to their nest boxes (within 400 meters), and feed on emergent macroinvertebrates (Bishop et al. 1999). Bishop et al. (1999) placed tree swallow nesting boxes in six AOCs of the Great Lakes and one reference site to examine the hatching and fledgling success of tree swallows related to contaminants burdens in eggs and nestlings. No significant difference was found in hatching success or fledgling success among the sites, although Akwesasne had the highest levels of PCBs in tree swallow eggs at 11.1µg/g (n=3) and in chicks at 5.46 µg/g (ppm).

Martinovic *et al*. (unpublished; 2003a; and 2003b) measured reproductive success and organochlorine contaminants in 16-day old tree swallows (n=66) in 1999 and 2000 from nine sites along the St. Lawrence River AOC in Canada and USA. Data analysis compared results from sites Inside the AOC (i.e. Grasse River, Raquette River, Turtle Creek, Cornwall Island in Massena, NY and Akwesasne) to reference locations Outside the AOC (i.e. Hoasic Creek and Coopers Marsh, Ontario). Chicks were collected for analysis of organochlorine pesticides, PCBs, total mercury, PCDDs, and PCDFs. Highest total PCBs and PCDDs were detected in Grasse River tree swallow nestlings at 69.13µg/g w.w. and 79.51 ng/kg w.w., respectively. Highest total PCDFs in nestlings were collected from Turtle Creek at 128.50 ng/kg w.w. Authors also report no significant impacts on reproduction, but concentrations of contaminants in tree swallow nestlings in the Massena/Akwesasne AOC are

some of the highest reported for Canada and the United States, thus causing concern for potential adverse health effects.

Martinovic *et al.(*2003a) evaluated tree swallows immune response capabilities. In 1999 and 2000, basal corticosterone levels were negatively correlated with Total PCDFs (4.8-120.5 ng/kg w.w.). The authors concluded organochlorines in the St. Lawrence River AOC may be interfering with hormone function in tree swallows.

As part of the same study, Martinovic *et al.* (2003b) reported retinol to retinyl palmitate (forms of vitamin A) were significantly, and positively correlated with measured Total PCDDs. The results suggest levels of organochlorine contaminants in the St. Lawrence River AOC may be interacting with vitamin A pathways, and higher tissue concentrations of retinols may contribute to compromised immune function and reproduction success in adults.

Great Blue Heron

Contaminants in great blue herons in the fluvial and estuary region of the St. Lawrence River have been studied by Champoux *et al.* (2002, 2006, 2010). They collected great blue heron and black-crowned night-heron eggs and fledglings along the St. Lawrence River. Results confirmed that colonies in fresh or brackish water had higher levels of contaminants than estuarine or gulf colonies. Significant differences in plasma thyroid hormones, retinol, liver retinoids, ethoxy-o-resorufin deethylase (EROD), and porphyrins were found between colonies. The findings of this study suggest that plasma, retinoids, and thyroid hormones make good biomarkers for exposure and effects of contaminants. Along with the measuring of contaminants in eggs and plasma, these non-invasive biomarkers can act as important criteria for long term monitoring of populations. This study also confirms that the great blue heron is a good sentinel species for surveillance work on the St. Lawrence River.

Results suggest that great blue heron fledglings in these inland, freshwater colonies were more contaminated with PCB's and other organochlorines than fledglings from estuarine colonies. Levels of mercury, total PCBs, PCB congeners and organochlorines in the eggs did not indicate significant differences among colonies, although there was a tendency for PCBs and Mirex to decrease downstream. In blood, however, most of these chemicals indicated significant differences among

colonies, with total PCBs highest in herons from Dickerson Island on the Mohawk Territory at Akwesasne (27.3 μg/kg w.w.). Heron eggs collected in three pools of three eggs from Dickerson Island, St. Lawrence River AOC, contained a mean (SD) of 6.1 μg/g w.w. (6.5 μg/g) total PCBs. When looking at plasma retinal concentrations, herons on Dickerson island (near the AOC) were significantly lower than those on Grande Ile ($p<0.05$) and Steamboat Island ($p<0.001$). Overall, the results of this study concluded that the health of the great blue heron population in the St. Lawrence River is acceptable, but some colonies did have positive responses to contaminants.

Common Tern

Weseloh *et al.* (1989) collected common tern eggs from four colonies in the three lower Great Lakes in 1981 to determine if levels of contaminants had changed in the last decade. DDE and PCB's were found in every egg tested and more than 25%-45% of the eggs contained other organochlorine pesticides. Comparisons with previous similar studies show that PCB and DDE levels have decreased from 80-90% from 1969-73 to 1981. Eggs taken from colonies in Lake Ontario were usually the most contaminated. When compared to other species it was found that common terns had significantly lower levels of organochlorine compounds than did Caspian terns or herring gulls. This could potentially be due to a difference in diet or migratory patterns among the three species. High contaminant levels in the 1970's could have been partially to blame for the low population of Great Lakes terns. Weseloh *et al.* (1989) surmised that the stabilization of the Great Lakes tern population might suggest that organochlorine compounds are no longer a factor in the population.

Karwowski (1992) collected 41 common tern egg from several sites on the St. Lawrence River upstream of the AOC from 1986 to 1989. PCBs and dieldrin were detected in every egg collected in every year with a maximum concentration of 9.6 μg/g PCBs. He concluded that common terns were a good indicator of local contamination, and found that levels of PCBs, DDE, dieldrin, and mercury may be related to low reproductive success at some colonies and to the types and rates of abnormalities observed in chicks (Karwowski, 1992).

Deformities have been found in common tern chicks hatched on the St. Lawrence River by Karwowski (1992) and by Harper (unpublished data). Karwowski (1992) observed two types of chick deformities between 1986 and 1990. In 1986 and 1987, the abnormalities observed were of curved

mandibles. In 1990 deformities of the toes were observed. The percent prevalence of chick deformities in 1986, 1987, and 1990 were 0.40, 0.25, and 0.22 respectively (Karwowski, 1992).

Harper (unpublished data) also observed chick deformities in terns hatched on the St. Lawrence River. Since 1990, Harper has banded 701 common tern chicks in the AOC, and another 13,842 common tern chicks within 25 miles upstream of the AOC on Lake St. Lawrence (Table 5). While handling these tern chicks, Harper found two with crossed bills (Figure 2). The two chicks found with crossed bills were upstream of the AOC on Lake St. Lawrence. This observed rate of deformity is 0.014% (Tables 6 and 7). No deformities were observed in tern chicks banded inside the AOC.

Table 6. Number of common terns banded in and near the Massena/Akwesasne AOC.

Number of Years of Banding	Year of Banding	Number of Terns Banded Inside AOC	Number of Terns Banded Outside AOC but Within 25 miles of AOC Boundary
1	1990		312
2	1991		562
3	1992		417
4	1993		528
5	1994		532
6	1995		532
7	1996		597
8	1997		640
9	1998		439
10	1999		626
11	2000		526
12	2001		590
13	2002		554
14	2003		445
15	2004	2	487
16	2005	3	400
17	2006	3	660
18	2007	3	639
19	2008	34	831
20	2009	106	667
21	2010	41	388
22	2011	178	1,119
23	2012	331	1,351
	Totals	701	13,842

Table 7. Number of deformities observed in common tern chicks inside and outside the AOC.

	Terns Banded Inside AOC	Terns Banded Outside AOC but Within 25 miles of AOC Boundary
Number of terns banded	701	13,842
Number of terns with observable deformities	0	2
Percent of terns banded with observable deformities	0.0%	0.014%

Photo 4. Photo of a common tern chick with crossed bill found near the AOC.

Other Species

Herring Gull

The herring gull (*Larus argentatus*) is a well-studied, non-migratory species on the Great Lakes that forages in the Massena/Akwesasne AOC and provides important information on contaminant exposure from local sources (see review in Hughes *et al.* 2010; Weseloh *et al.*, 2011). Herring gulls have been assessed through population surveys (nest counts), contaminant analysis, sex determination, and stress response studies. The Great Lakes Herring Gull Monitoring Program provides important spatial and temporal information on contaminant exposure of herring gulls feeding in the Great Lakes using eggs collected from 15 herring gull nesting sites known as Annual Monitor Colonies (AMCs) (Hughes *et al.,* 2010). Annual collections at many AMCs have been ongoing since the mid 1970s but commenced at Strachan Island, just upstream of the AOC, in 1986 (Hughes *et al.,* 2010).

Hughes *et al*. (2010) and Weseloh *et al.* (2011) reported the levels of total mercury (Hg) ranged from 0.064 µg /g at Chantry Island (Lake Huron) to 0.246 µg /g at Middle Island (Lake Erie). There was a decline in mercury levels in 14 of the 15 colonies tested. This decrease in mercury ranged from 23% to 86%. There was a significant decrease in 10 of the 15 colonies. There has been no significant change in any of the mercury levels for these 15 colonies in the last 15 years. Previously the concentrations of mercury in gulls followed the mercury levels in rainbow smelt. The break from this pattern could be caused by a change in the gull's diet.

Hughes *et al*. (2010) and Weseloh *et al.* (2011) also reported the mean values of eight different contaminants known in herring gulls. The sites were ranked according to the concentrations of seven compounds relative to fish criteria and a single overall rank of contamination was calculated for each site. Results reported that the sum of PCB's, dioxin, and DDE counted the most (60.2%, 30.5%, and 8.5%) within the overall rankings. The ranking scheme used showed that eggs from Channel-Shelter Island (Lake Huron), Strachan Island (St. Lawrence River), and Gull Island (Lake Michigan) were the three most contaminated. Agawa Rocks (Lake Superior), Chantry Island (Lake Huron), and Port Colborne (Lake Erie) ranked as the three least contaminated sites. Two of the three most contaminated

sites were in Areas of Concern, while none of the least contaminated sites were in any Area of Concern.

For all compounds measured at all 15 sites in the CWS AMC program, Strachan Island was generally ranked as intermediate to low of all AMCs, with the exception of mirex and mercury where this AMC was ranked second of 15 AMCs (Hughes *et al.,* 2010). Mercury concentrations in herring gull eggs from Strachan Island from 2003 to 2007 did not approach the threshold level of 0.5 ug/g typically associated with adverse reproductive effects in birds (range=0.16 to 0.25 µg/g; Thompson 1996).

Photo 5. Herring gulls are used to monitor contaminants throughout the Great Lakes.

Black Tern

Black terns are not monitored regularly, and are known to nest in the St. Lawrence River AOC, downstream the United States border, in the Mohawk Territory of Akwesasne (Snye Marsh and Ile Christatie, an island on Lake St. Francis in Akwesasne) Black terns are a listed species of Special Concern status in Akwesasne and Ontario, and Endangered in New York State (Table 5).

Black tern eggs were collected between 1989-1996 from thirteen colonies in southern Ontario (N=5) and southern Quebec (N=8) then tested for organochlorines (OC): PCBs, DDE, chlordanes, dieldrin, mirex, B-HCH, heptachlor epoxide, and HCB. In addition, eggs from Quebec were analyzed for lead, mercury, and cadmium, and eggshell thickness was measured (Weseloh *et al*., 1997). One of the collection sites (Site 1) in Quebec was from Ile Christatie (i.e. Akwesasne). Note, this study did not collect data within the same temporal year, which may have introduced some bias in the comparison results.

There was no significant difference in OC levels between eggs from Ontario and eggs from Quebec, except for PCBs. PCBs reported were significantly higher in eggs from Quebec (2.82 µg/g, w.w., N=8) compared to Ontario (1.44 ng/g, w.w., N=5). Total PCBs for all samples ranged from 0.46 to 3.72 µg/g (ppm) w.w., with the highest concentration of PCBs (3.72 µg/g, w.w.) found on Ile Christatie (Site 1). Elevated PCBs detected in the downstream, Canadian portions of Akwesasne indicate transboundary impacts from Massena, NY industrial facilities. Results for contaminants measured in black tern eggs (n=11, composite sample) at Ile Christatie (Site 1) are reported as: lipids (7.6%), DDE (0.41 µg/g, w.w.), DDT (ND), Mirex (0.044 µg/g w.w.), and Total PCBs (3.72 µg/g, w.w.).

Overall organochlorine levels found in these black tern eggs were lower than those reported in previous 1970s-80s studies. Egg shells in Ontario and Quebec when compared to pre-1947 values, were thinner by 3.2% and 9.0%, respectively. The concentrations (µg/g w.w.) of metals found were as follows: total mercury = 0.24-0.40, methyl mercury = 0.24-0.37, lead = 0.09-0.65, cadmium = 0.02-0.11. Overall, the contaminant levels found in this study were lower than those known for other colonial nesting water birds. However, biological effects of contaminants to black terns are not well studied, and species sensitivity should be evaluated (Weseloh *et al.*, 1997).

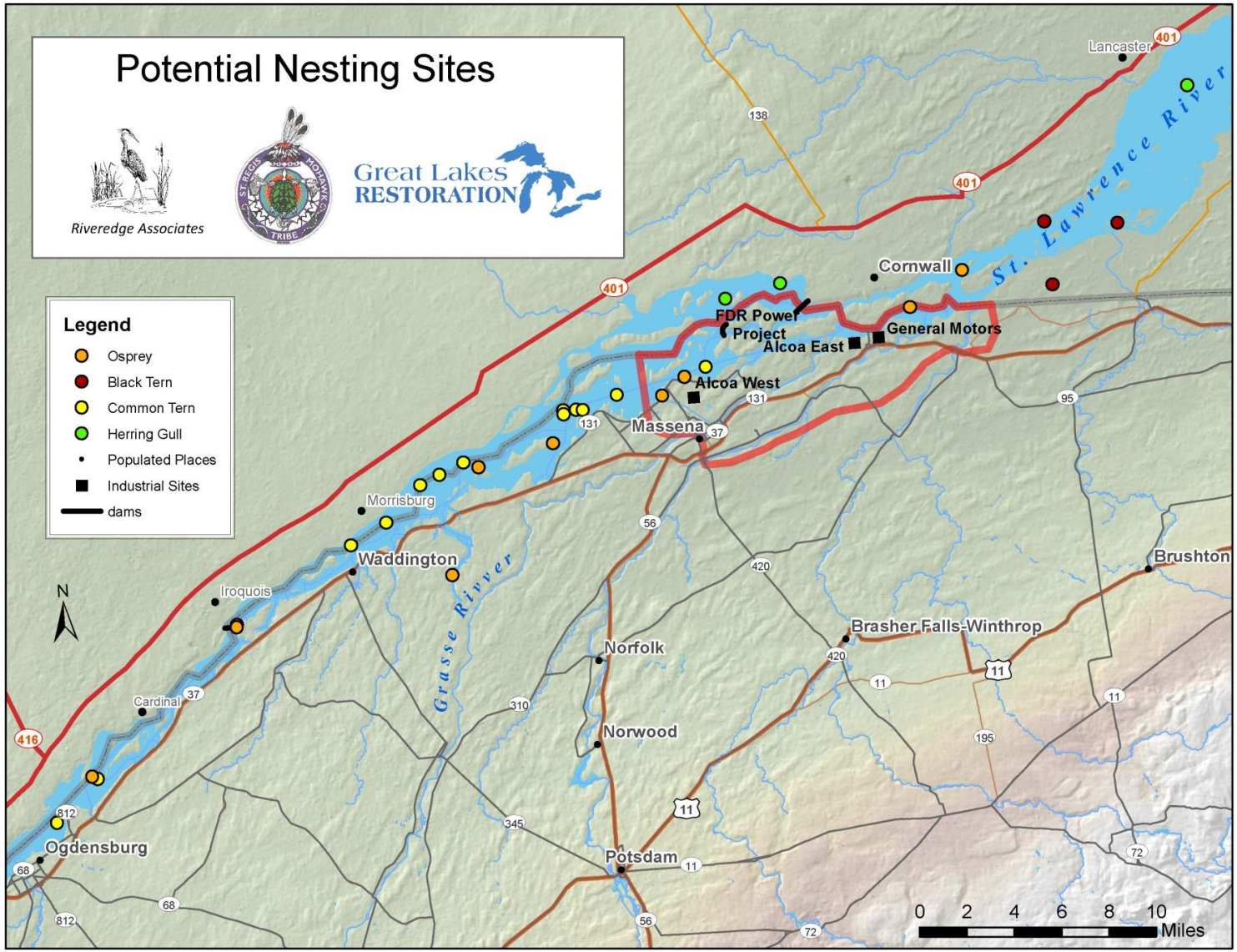

Figure 2. Nesting sites of potential sentinel species in and near the Massena/Akwesasne AOC.

3.5 Quality Control

Data validation for this secondary review concerned the verification of location data for nesting sites and the review of contaminant data to determine if the avian egg sample data sets met established acceptance criteria.

GPS data, where available, were entered into an Excel database, transferred to ArcGIS, and plotted on digital orthophotos of the study area. If GPS data were not available, nesting locations were visually determined by reviewing navigation charts and/or digital orthophotos. Locations of species occurrence records were visually scanned to verify they were plotted in the appropriate location as described from original field notes or local knowledge. Team Leader Christopher Baird performed this initial verification, followed by a second verification by Project Manager Lee Harper. Unpublished field notes and personal communications were accepted without hierarchy since all would be field checked for accuracy during field surveys.

Contaminant data were reviewed to determine if the criteria were met and the results are presented in tabular form (Table 8). All of the literature reviewed and included met acceptance criteria by being a study performed under a QAPP or equivalent and by being published in a peer-reviewed journal. No additional contaminant references were reviewed that were rejected.

Table 8. Quality review of contaminant data.

Report Title	Author	Date	Peer Reviewed (Y/N)	File name
Toxic substances in fish and wildlife 1979 and 1980	NYSDEC 1981	1981	Y	NYSDEC 1981
Organochlorine contaminants in eggs of common terns from the Canadian Great Lakes, 1981	Weseloh et al. 1989	1989	Y	Weseloh et al. 1989
Natural resource damages preassessment screen for the St. Lawrence, Grasse, and Raquette rivers and environs, Massena, New York	NYSDEC 1990	1990	Y	NYSDEC 1990
Chemical contaminants in wildlife from the Mohawk Nation at Akwesasne and the vicinity of the General Motors Corporation/Central Foundry Division, Massena, New York	Skinner 1992	1992	Y	Skinner 1992
Biomonitoring and assessment of environmental contaminants in breeding common terns (*Sterna hirundo*) of the St. Lawrence River	Karwowski 1992	1992	Y	Karwowski 1992
Contaminant concentrations in eggs of Black Terns (*Chlidonias niger*) from Southern Ontario and Southern Quebec, 1989-1996	Weseloh et al. 1997	1997	Y	Weseloh et al. 1997
Organochlorine contaminants in Herring Gull eggs from the Great Lakes, 1974–1995: change point regression analysis and short-term regression	Pekarik and Weseloh 1998	1998	Y	Pekarik and Weseloh 1998
Assessment of contamination and biomarker responses in two species of herons on the St. Lawrence River	Champoux et al. 2002	2002	Y	Champoux et al. 2002
Chlorinated Hydrocarbon Contamination in Osprey eggs and nestlings from the Canadian Great Lakes Basin, 1991-1995	Martin et al. 2003	2003	Y	Martin et al. 2003
Contaminant levels and reproductive success in tree swallows (*tachycineta bicolor*) nesting along the St. Lawrence River, Canada and USA	Martinovic et al. unpublished	NA	Y[1]	Martinovic et al. unpublished

Health of tree swallow (*Tachycineta bicolor)* nestlings exposed to chlorinated hydrocarbons in the St. Lawrence River basin. Part I. Renal and hepatic vitamin A concentrations.	Martinovic et al. 2003a	2003	Y	Martinovic et al. 2003a
Health of tree swallow *(Tachycineta bicolor)* nestlings exposed to chlorinated hydrocarbons in the St. Lawrence River Basin. Part II. Basal and stress plasma corticosterone concentrations.	Martinovic et al. 2003b	2003	Y	Martinovic et al. 2003b
Contamination and biomarkers in the Great Blue Heron, an indicator of the state of the St. Lawrence River	Champoux et al. 2006	2006	Y	Champoux et al. 2006
Spatial patterns and rankings of contaminant concentrations in Herring Gull eggs from 15 sites in the Great Lakes and connecting channels, 1988–2002	Weseloh et al. 2006	2006	Y	Weseloh et al. 2006
Environmental contaminants in tern eggs from Monomoy National Wildlife Refuge and Seal Island National Wildlife Refuge	Mierzykowski 2008	2008	Y	Mierzykowski 2008
Osprey: Worldwide sentinel species for assessing and monitoring environmental contamination in rivers, lakes, reservoirs, and estuaries	Grove et al. 2009	2009	Y	Grove et al. 2009
Polybrominated diphenyl ethers, toxaphenes, and other halogenated organic pollutants in great blue heron eggs	Champoux et al. 2010	2010	Y	Champoux et al. 2010
Current status and trends of aquatic wildlife in the St. Lawrence River (Cornwall) Area of Concern	Hughes et al. 2010	2010	Y	Hughes et al. 2010
Current concentrations and spatial and temporal trends in mercury in Great Lakes Herring Gull eggs, 1974-2009	Weseloh et al. 2011	2011	Y	Weseloh et al. 2011

Notes:

1. Although not found in a peer reviewed journal publication, contaminant data assumed to have been peer reviewed during publication of Martinovic et al. 2003a and 2003b, and as part of her thesis.

4.0 DATA GAPS

This review of existing data compiled and evaluated sources of data concerning avian populations, habitat, deformities, and contaminant burdens within the AOC and within 25 miles of the AOC along the St. Lawrence River and environs.

Habitat and population data were best known for bird species of specific interest, such as the state-listed threatened species common tern, and for colonial waterbirds subject to Great Lakes decadal censuses such as ring-billed gull, herring gull, and double-crested cormorant. Also well known are the habitat and populations of sentinel species such as osprey and bald eagle.

Data for contaminant burdens and deformities in birds in and near the AOC are more limited. Contaminant data sets are available for herring gulls from the Cornwall AOC, tree swallows from the Massena/Akwesasne AOC, and limited data on black terns in Akwesasne. No significant contaminant data set exists to assess reproductive health and avian populations for avian sentinel species such as; bald eagle, osprey, and common tern, in the Massena/Akwesasne AOC. Contaminants in common tern eggs from New York waters upstream of the AOC were examined in the late 1980s by Karwowski (1992) but have not been examined since, nor include Inside AOC sites. Herons have been examined downstream (e.g. Champoux *et al*. 2010), and contaminants in herring gulls were documented adjacent to the AOC (Weseloh *et al*. 2011).

Few sentinel species are known to nest in and near the Massena/Akwesasne AOC. Three species that do are bald eagle, osprey, and common tern. In 2013, field work will be conducted to investigate habitat, populations, reproduction, and contaminants in sentinel bird species in the Massena/Akwesasne AOC that have not been previously tested to address data gaps.

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