Contaminants in Snapping Turtle Eggs
Indicator #4506

Overall Assessment

Status: **Mixed**
Trend: **Undetermined**
Rationale: **Contaminants at Great Lakes Areas of Concern (AOCs) exceeded concentrations at reference sites. Dioxin equivalents and DDE concentrations in eggs exceeded the Canadian Environmental Quality Guidelines, and sum PCBs from some sites exceeded partial restriction guidelines for consumption.**

Lake-by-Lake Assessment

Contaminant levels in snapping turtle eggs from Lake Superior, Lake Michigan and Lake Huron were not assessed*, and their trend was* undetermined *due to insufficient data.*

Lake Erie
Status: Mixed
Trend: Undetermined
Rationale: Contaminants at AOCs exceeded concentrations at reference sites. Dioxin equivalents and DDE concentrations in eggs exceeded the Canadian Environmental Quality Guidelines, and sum PCBs from some sites exceeded partial restriction guidelines for consumption.

Lake Ontario
Status: Mixed
Trend: Undetermined
Rationale: Contaminants at AOCs exceeded concentrations at reference sites. Dioxin equivalents and DDE concentrations in eggs exceeded the Canadian Environmental Quality Guidelines, and sum PCBs from some sites exceeded partial restriction guidelines for consumption.

Purpose
- To assess the accumulation of organochlorine chemicals and mercury in snapping turtle eggs
- To assess contaminant trends and physiological and ecological endpoints in snapping turtles
- To obtain a better understanding of the impact of contaminants on the physiological and ecological health of the individual turtles and wetland communities

Ecosystem Objective
Snapping turtle populations in Great Lakes coastal wetlands and at contaminated sites should not exhibit significant differences in concentrations of organochlorine chemicals, mercury, and other chemicals, compared to turtles at clean (inland) reference site(s). This indicator supports Annexes 1, 2, 11 and 12 of the Great Lakes Water Quality Agreement (United States and Canada 1987).

State of the Ecosystem
Background
Snapping turtles inhabit (coastal) wetlands in the Great Lakes basin, particularly the lower Great Lakes. While other Great Lakes wildlife species may be more sensitive to contaminants than snapping turtles, there are few other species that are as long-lived, as common year-round, inhabit such a wide variety of habitats, and yet are limited in their movement among wetlands. Snapping turtles are also at the top in the aquatic food web and bioaccumulate contaminants. Plasma and egg tissues offer a nondestructive method to monitor recent exposure to chemicals as well as an opportunity for long-term contaminant and health monitoring. Since they inhabit coastal wetlands throughout the lower Great Lakes basin, they allow for multi-site comparisons on a temporal and spatial basis. Consequently, snapping turtles are a very useful biological indicator species of local wetland contaminant trends and the effects of these contaminants on wetland communities throughout the lower Great Lakes basin.

Status of Contaminants in Snapping Turtle Eggs

For more than 20 years, the Canadian Wildlife Service (CWS) has periodically collected snapping turtle eggs and examined the species' reproductive success in relation to contaminant levels on a research basis. More recently, from 2001 to 2005, CWS has examined the health of snapping turtles relative to contaminant exposure in Canadian Areas of Concern (AOCs) of the lower Great Lakes basin. American researchers have also recently used snapping turtles as indicators of contaminant exposure (Dabrowska *et al*. 2006).

The work by the CWS has shown that contaminants in snapping turtle eggs differ over time and among sites in the Great Lakes basin, with significant differences observed between contaminated and reference sites (Bishop *et al*. 1996, 1998). Snapping turtle eggs collected at two Lake Ontario sites (Cootes Paradise and Lynde Creek) had the greatest concentrations of polychlorinated dioxins and number of furans (Bishop *et al*. 1996, 1998). Eggs from Cranberry Marsh (Lake Ontario) and two Lake Erie sites (Long Point and Rondeau Provincial Park) had similar levels of PCBs and organochlorines among the study sites (Bishop *et al*. 1996; 1998). Eggs from Akwesasne (St. Lawrence River) contained the greatest level of PCBs tested (Bishop *et al*. 1998). From 1984 to 1990/1991, levels of PCBs and DDE increased significantly in eggs from Cootes Paradise and Lynde Creek, and levels of dioxins and furans decreased significantly at Cootes Paradise (Struger *et al*. 1993; Bishop *et al*. 1996).

Eggs with the greatest contaminant levels also showed the poorest developmental success (Bishop *et al*. 1991, 1998). Rates of abnormal development of snapping turtle eggs from 1986 to 1991 were highest at all four Lake Ontario sites compared to other sites studied (Bishop *et al*. 1998).

Lake Erie and connecting channels

From 2001 to 2003, CWS collected snapping turtle eggs at or near three Canadian Lake Erie or connecting channels AOCs: Detroit River, St. Clair River, and Wheatley Harbour, as well as two reference sites. Mean sum PCBs ranged from 0.02 µg/g at Algonquin Provincial Park (a reference site) to 0.93 µg/g at Detroit River. Sum PCB levels were highest at Detroit River (Turkey Creek), followed by Wheatley Harbour, then St. Clair National Wildlife Area (near the St. Clair River AOC) and lastly, Algonquin Provincial Park (Figure 1). Dioxin equivalents of sum PCBs in eggs from the Detroit River, Wheatley Harbour, and St. Clair River AOCs, and DDE levels in eggs from the Wheatley Harbour and the Detroit River AOCs exceeded the Canadian Environmental Quality Guidelines. Sum PCBs in eggs from the Detroit River and Wheatley Harbour AOCs exceeded partial restriction guidelines for consumption (de Solla and Fernie 2004).

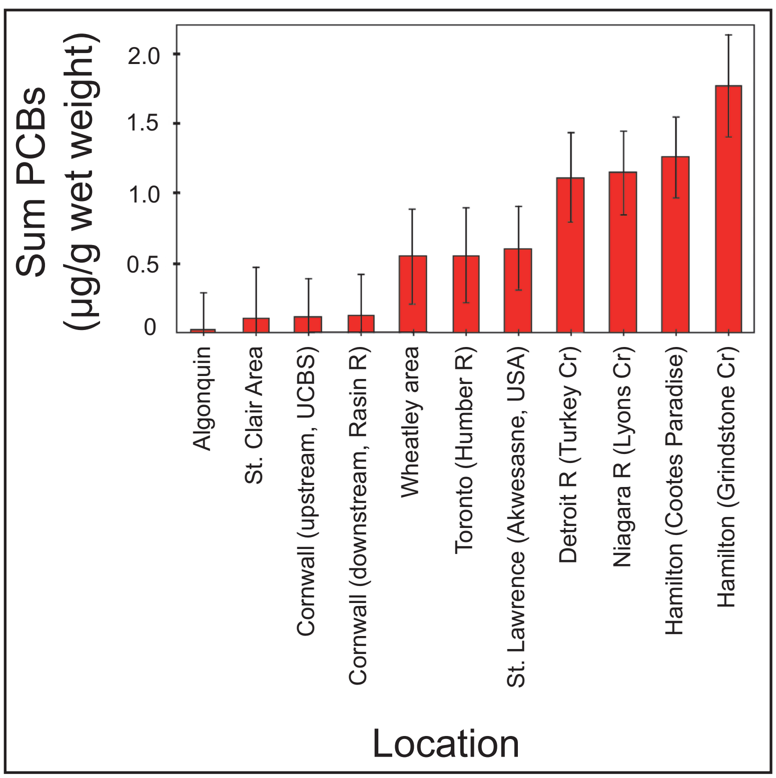

Figure 1. Sum PCB concentrations in snapping turtle eggs from various Canadian locations throughout the lower Great Lakes basin, 2001 through 2003.

Means ± standard errors are presented.

Source: Canadian Wildlife Service

An American study in 1997 funded by the Great Lakes Protection Fund found that sum PCBs in snapping turtle tissues and eggs appeared to be higher in the American AOCs in Ohio, where concentrations ranged from 0.18 to 3.68 µg/g. Concentrations were highest in turtles from the Ottawa River AOC, followed by the Maumee River AOC, Ashtabula River AOC, and the Black River within the Maumee River AOC (Dabrowska *et al*. 2006). The reference sites used near the American AOCs may have higher contaminant exposure than the Canadian reference sites.

Lake Ontario and connecting channels

From 2002 to 2003, CWS collected snapping turtle eggs at or near seven Lake Ontario and connecting channel AOCs: Hamilton Harbour (2 sites), Niagara River (ON), St. Lawrence River (ON), and Toronto, as well as two reference sites. Mean sum PCB levels ranged from 0.02

µg/g at Algonquin Park (the reference site) to 1.76 µg/g at Hamilton Harbour (Grindstone Creek). Sum PCB levels were highest at Hamilton Harbour (Grindstone Creek), followed by the second site at Hamilton Harbour (Cootes Paradise), then Niagara River (Lyons Creek) (Figure 1). There is evidence that PCB levels in snapping turtle eggs have been declining at the inland reference site of Algonquin Park (from 1981 to 2003) and at the heavily contaminated Hamilton Harbour AOC (from 1984 to 2003). Long term trends at the St. Lawrence River AOC are difficult to determine due to the high degree of variability of contaminant sources in the area. PCB levels have been reported as high as 738 µg/g at Turtle Creek, Akwesasne (de Solla *et al*. 2001).

Flame retardants (PBDEs) are one of the chemicals of emerging concern because they are bioaccumulative and may potentially affect wildlife and human health. Sum PBDE concentrations varied, but they were an order of magnitude lower than sum PCBs in snapping turtle eggs collected from the seven AOCs (2001 to 2003). Sum PBDE levels were lowest at Algonquin Park (6.1 ng/g), where airborne deposition is likely the main contaminant source, and greatest at the Hamilton Harbour (Cootes Paradise: 67.6 ng/g) and Toronto (Humber River: 107.0 ng/g) AOCs. This is indicative of urban areas likely being the main source of PBDEs.

Pressures

Future pressures for this indictor include all sources of toxic contaminants that currently have elevated concentrations (e.g., PCBs and dioxins), as well as contaminants whose concentrations are expected to increase in Great Lakes wetlands (e.g., PBDEs). Non-bioaccumulative compounds in which there are chronic exposures (e.g., PAHs) also pose a potential threat. Snapping turtle populations face additional pressures from harvesting of adult turtles, road-side killings during the nesting season in June, and habitat destruction.

Management Implications

The contaminants measured are persistent and bioaccumulative. Diet is the primary source of exposure to contaminants for snapping turtles, and thus levels of contaminants in turtle tissue or eggs reflect contamination that is available throughout the aquatic food web. Although commercial collection of snapping turtles has ceased, collection for private consumption persists. Therefore, consumption restrictions are required at selected AOCs. Currently, only eggs are routinely sampled for contaminants, but body burdens of females could be estimated using egg burdens, and thus used for determining if consumption guidelines are needed. At some AOCs (i.e., Niagara River (Lyons Creek), and Hamilton Harbour), there are localized sediment sources of contaminants that may be rehabilitated through dredging or capping. Mitigation of contaminant sources should eventually reduce contaminant burdens in snapping turtles.

Comments from the author(s)

Contaminant status of snapping turtles should be monitored on a regular basis across the Great Lakes basin where appropriate. Once the usefulness of the indicator is confirmed, a complementary U.S. program is required to interpret basin-wide trends. This species offers an excellent opportunity to monitor contaminant concentrations in coastal wetland populations. Newly emerging contaminants also need to be examined in a long-term monitoring program. As with all long-term monitoring programs, and for any indicator species used to monitor persistent bioaccumulative contaminants, standardization of contaminant data is necessary for examining temporal and spatial trends or combining data from different sources.

Acknowledgments

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Special thanks to Drs. Robert Letcher, Shugang Chu, and Ken Drouillard for chemical analyses, particularly of the PBDEs. Thanks also go to other past and present CWS staff (Burlington, Downsview, National Wildlife Research Centre), the wildlife biologists not associated with the CWS, and private landowners.

Sources

Bishop, C.A., Brooks, R.J., Carey, J.H., Ng, P., Norstrom, R.J., and Lean, D.R.S. 1991. The case for a cause-effect linkage between environmental contamination and development in eggs of the common Snapping Turtle (*Chelydra s. serpentina*) from Ontario, Canada. *J. Toxic. Environ. Health* 33:521-547.

Bishop, C.A., Ng, P., Norstrom, R.J., Brooks, R.J., and Pettit, K.E. 1996. Temporal and geographic variation of organochlorine residues in eggs of the common Snapping Turtle (*Chelydra serpentina serpentina*) (1981-1991) and comparisons to trends in the herring gull (*Larus argentatus*) in the Great Lakes basin in Ontario, Canada. *Arch. Environ. Contam. Toxicol.* 31:512-524.

Bishop, C.A., Ng, P., Pettit, K.E., Kennedy, S.W., Stegeman, J.J., Norstrom, R.J., and Brooks, R.J. 1998. Environmental contamination and developmental abnormalities in eggs and hatchlings of the common Snapping Turtle (*Chelydra serpentina serpentina*) from the Great Lakes-St. Lawrence River basin (1989-1991). *Environ. Pollut.* 101:143-156.

Dabrowska, S., Fisher, W., Estenik, J., Kidekhel, R., and Stromberg, P. 2006. Polychlorinated biphenyl concentrations, congener profiles, and ratios in the fat tissue, eggs, and plasma of snapping turtles (*Chelydra s. serpentina*) from the Ohio basin of Lake Erie, USA. *Arch Environ Contam Toxicol.* 51:270-286.

de Solla, S.R., Bishop, C.A., Lickers, H., and Jock, K. 2001. Organochlorine pesticide, PCB, dibenzodioxin and furan concentrations in common snapping turtle eggs (*Chelydra serpentina serpentina*) in Akwesasne, Mohawk Territory, Ontario, Canada. *Arch Environ Contam Toxicol* 40:410-417

de Solla, S.R. and Fernie, K.J. 2004. Characterization of contaminants in snapping turtles (*Chelydra serpentina*) from Canadian Lake Erie Areas of Concern: St. Clair, Detroit River, and Wheatley Harbour. *Environ Pollut.* 132:101-112

Struger, J., Elliott, J.E., Bishop, C.A., Obbard, M.E., Norstrom, R.J., Weseloh, D.V., Simon, M., and Ng, P. 1993. Environmental contaminants in eggs of the common Snapping Turtles (*Chelydra serpentina serpentina*) from the Great Lakes-St. Lawrence River Basin of Ontario, Canada (1981, 1984). *J Great Lakes Res.* 19:681-694.

United States and Canada. 1987. *Great Lakes Water Quality Agreement of 1978, as amended by Protocol signed November 18, 1987.* Ottawa and Washington.

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State of the Great Lakes 2007