Environment Canada Environnement Canada

GREAT LAKES FACT SHEET

Stormwater detention ponds of Southern Ontario: *Are they a risk to wildlife?*

Wildlife are likely to be attracted to stormwater detention ponds. Due to concerns that wildlife using these ponds may be exposed to contamination, 15 ponds in Southern Ontario were studied in 1997 and 1998. This fact sheet describes the results of the study which a) assessed the degree to which wildlife used the ponds, b) measured the contaminant levels in sediment, water and wildlife and c) evaluated the toxicity of sediments to invertebrates and fish and the toxicity of water and sediments to frogs. The study did not examine all of the benefits and risks of urban stormwater ponds. Ongoing monitoring at stormwater detention ponds is recommended.

What is the purpose of stormwater detention ponds?

Urban stormwater, whether from rain or melting snow, flushes debris and contaminants from roads, parking lots, sidewalks, rooftops, lawns, and other surfaces. Stormwater can contain suspended solids, nutrients, bacteria, oil and grease, trace metals, and organic contaminants such as pesticides, polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs).

Stormwater detention ponds are designed and constructed to reduce downstream flooding and erosion by controlling the peak flow, frequency of peak flow and velocity of stormwater. These ponds are also designed to trap and settle much of the solid material carried by the stormwater as sediment, which improves water quality and helps reduce contaminant loads into rivers or lakes. Structural devices, such as oil and grit separators, may be incorporated upstream of the pond system to capture oil and larger particles. Aquatic vegetation can serve as a biological filter to retain fine sediment and the contaminants bound to this sediment.

Stormwater can contain contaminants that are toxic. While some contaminants biodegrade within the stormwater pond, others are more persistent and accumulate in the sediment.

Lesley Dunn

A typical stormwater pond

Wetlands can develop in stormwater ponds as a result of natural seeding and succession. "Constructed wetlands" are wetlands that have been built to improve downstream water quality. Combined pond and constructed wetland systems generally provide increased water storage time, allowing a greater number of the lighter particles, such as clays, to settle out of stormwater. Plants growing in the wetland further improve downstream water quality by assimilating phosphorus and nitrogen from the stormwater.

Why are there wildlife concerns about urban stormwater detention ponds?

Although stormwater ponds are designed to protect downstream areas by containing material that could create undesirable conditions for aquatic life, the accumulation of contaminants within the ponds could pose a threat to local wildlife using these facilities as habitat unless ponds are properly managed. Because stormwater detention ponds are exposed water bodies, and may be located in or near natural green spaces, wildlife is likely to be attracted and use them as habitat. Some stormwater contaminants can remain in the water column of the pond and may be toxic to wildlife living in the water. Other contaminants such as trace metals and organic compounds bind with solids that settle to the bottom of the pond as sediment. As sediment accumulates, the concentration of metal and organic contaminants could exceed levels that have toxic effects on the organisms that live or feed in the sediment. The contaminants may also accumulate in the tissues of animals living in the water or sediment and predators that consume these animals. It is therefore necessary to clean out the ponds periodically and dispose of the sediment properly. With out some form of control, contaminants from stormwater run-off would be flushed into streams and lakes and subsequently very difficult and costly to clean up.

Environment Canada

Mallard

What have previous studies found?

In 1996, Environment Canada conducted a review of the available information on contaminants in water, sediment or biota and the number and species of wildlife that frequent stormwater ponds and associated wetlands. The review revealed that there was little information on persistent and non-persistent contaminants (e.g., mercury, lead, chromium and other trace metals and organochlorine chemicals such as PCBs) in wetlands associated with stormwater ponds (Wren et al., 1997). However, the review found studies documenting that urban stormwater run-off from roads contained persistent contaminants and that accumulation of these compounds occurred in the sediment of stormwater-receiving areas (Wren et al., 1997).

There was no information on the use of stormwater ponds by wildlife in Ontario; however, studies of three wetlands constructed for wastewater treatment in the United States found that over one hundred species of birds had utilized some of the sites, invertebrate populations had developed and plants had self-seeded the wetlands (Wren et al., 1997). Contaminant analyses of those wetlands were not performed. In a study on wetlands used to treat stormwater in California, accumulation of metals in biota did occur, however surveys to evaluate the extent of wildlife use of the wetlands were not performed (see Wren et al., 1997). Reports published since the Environment Canada review also indicated that stormwater detention ponds accumulate persistent contaminants in sediment, but wildlife surveys of these ponds are lacking (Liscko and Struger, 1995; Mayer et al., 1996; Helfield and Diamond, 1997).

Table 1. *Monitoring Protocol for Stormwater Detention Ponds*

Baseline Data

- *Wetland size (surface area)*
- *Water depth*
- *Inflow volume*
- *Expected retention time*
- *Inflow / outflow water quality: 3-4 times per year*
- *Sediment contamination: once per year*
- *Toxicity testing using bioassays: at minimum every five years*

Level 1 Monitoring

- *Continued* ***Baseline Data*** *collection*
- *Vegetation/habitat evaluation*
- *Wildlife surveys to determine biota potentially exposed to contaminants*
- *If warranted, contaminant analysis of biota*

Level 2 Monitoring

- *Intensive exposure monitoring of abiotic media (i.e., water and sediment)*
- *If warranted, intensive monitoring of wildlife use*
- *Examination of health effects on wildlife*

Adapted from (Wren et al., 1997)

A monitoring protocol for stormwater detention ponds

The lack of information on stormwater pond contamination and the wildlife that use such ponds led to the development of a three-tiered monitoring protocol (Table 1). The protocol is described in a Canadian Wildlife Service Technical Report (Wren et al., 1997). The purpose of the protocol is to evaluate the level of contaminants captured in stormwater ponds, determine wildlife use of the ponds, evaluate the level of contaminants in wildlife, and determine the effects of contaminants in the pond on wildlife health. *Baseline Data* are necessary to assess if the stormwater pond is functioning properly and to determine the level of contaminants at the site. *Level 1 Monitoring* is valuable for determining if wildlife use the pond and whether they are bioaccumulating contaminants. *Level 2 Monitoring* is indicated if concentrations in sediments or water exceed sediment and water quality guidelines and wildlife health problems are suspected.

The field study

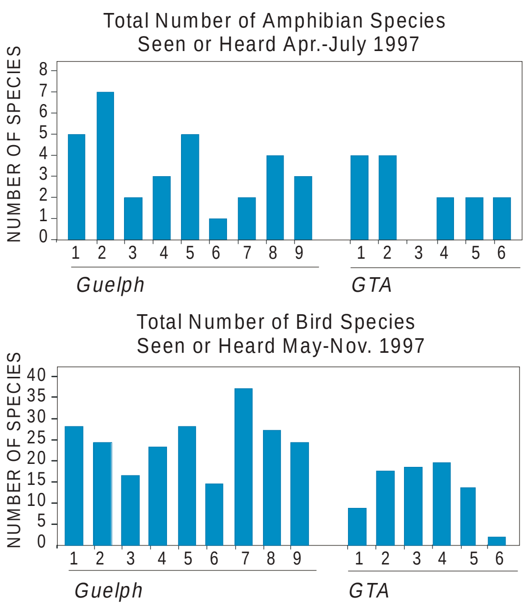
In 1997 and 1998, stormwater detention ponds at six sites in the Greater Toronto Area (GTA) and nine sites in Guelph were studied using components of the monitoring protocol described by Wren et al. (1997). Some of the ponds contained small wetlands that had developed (self-seeded) but none had received any specific habitat enhancements. The ponds ranged in age from three to 22 years, in depth from 1.0 to 1.5 metres and approximately 0.5 to 2.0 hectares in surface area. Tweleve ponds were located in residential areas. GTA #1 was located in a commercial area, GTA #3 in a commercial/light industrial area and GTA #6 in a residential/commercial area. Nine of 15 sites were single ponds whereas one site in the GTA and five sites in Guelph were two-pond systems.

For each pond, a wildlife survey (birds, amphibians, fish, reptiles and mammals), sampling and analysis of water and sediment, and toxicity tests using fish and benthic organisms were conducted. Contaminant levels in the eggs of nesting red-winged blackbirds were measured from two ponds in the GTA. At four ponds in Guelph, *in-situ* bioassays of frog egg and tadpole development were also performed. This fact sheet presents a summary of the findings of the study regarding the use of these ponds by wildlife, the levels and effects on wildlife of contaminants captured in the ponds and recommendations on the need for ongoing monitoring at these sites. Further analysis and discussion are in preparation for publication in a scientific journal.

What is the wildlife use of stormwater detention ponds compared to other ponds and wetlands?

Wildlife used all of the 15 sites, even though there had not been deliberate habitat enhancement at the stormwater detention ponds surveyed.

Figure 1: *Wildlife Using Stormwater Ponds in Guelph and the GTA*



Birds

From May to November, 1997, bird surveys were conducted in the morning (when birds are most active) for 10 to 15 minutes once or twice each week. The highest number of bird species seen feeding or nesting at a pond was 38, while less than 10 species were seen at two ponds (Fig. 1). In total, 71 species of birds were seen nesting or feeding at the stormwater ponds during the six months of surveys.

For some stormwater ponds, the number of bird species seen was comparable to other small ponds in the GTA. For example, breeding bird surveys conducted in 1998 at Chester Springs pond, a 0.25 hectare wetland in Toronto, found 28 species of birds using the site (Toronto and Region Conservation Authority, unpublished data). At another wetland where water levels are maintained to create a 3.0 hectare pond at the Kortright Centre near Toronto, 22 species are regularly found during the breeding season (D. Stuckey, pers. comm.). Seven stormwater ponds in Guelph, but none in the GTA, had more than 20 species of birds using them. Clearly, stormwater ponds can attract similar numbers of bird species as other small wetlands.

In order to further understand the results shown in Figure 1, the Marsh Monitoring Program (MMP) protocol was used in June, 1997. This protocol, which has been applied to hundreds of ponds and wetlands in the Great Lakes basin, consisted of two ten minute surveys at each site (for methodological details see Weeber et al.,1997). During the MMP surveys, the average number of species seen was 5.7 in Guelph ponds and 1.0 in GTA ponds.

The maximum number of bird species at any one stormwater pond during the MMP surveys was eight. In contrast, MMP surveys at Chester Springs pond revealed 15 species of birds. According to MMP analysis, which rates species richness of one to seven as 'low', eight to 14 as 'medium' and 15 to 22 as 'high' (Weeber et al., 1997), all the stormwater ponds were rated low in species richness.

The apparent difference between the intensive surveys and the MMP can be attributed in part to the lower frequency and time of day of the surveys. In looking at both the intensive field surveys and the MMP results, overall bird species richness was rated low to moderate.

Mike Hopiak / Cornell Lab of Ornithology

Nesting red-winged blackbird

American toad: a common species found in stormwater ponds

Amphibians

Once or twice each week from April to July, 1997, amphibians were surveyed at night during three to five minute surveys per pond. Among all sites, seven of the nine species of amphibians that could be expected in these southern Ontario locations were found (Fig. 1). The species found were wood frog (*Rana sylvatica*), American toad (*Bufo americanus*), northern leopard frog (*Rana pipiens*), green frog (*Rana clamitans*), gray tree frog (*Hyla versicolor*), spring peeper (*Pseudacris crucifer*), and western chorus frog (*Pseudacris triseriata triseriata*). The range in species found per pond was one to seven in Guelph and zero to four in the GTA.

Although the amphibians were surveyed with higher frequency than is required for the Marsh Monitoring Program, the number of amphibians found per stormwater pond is still rated as low to moderate when compared to other MMP sites in the Great Lakes basin. Seven stormwater ponds had two or less amphibian species while eight ponds had three to seven species. The MMP rates wetlands with one to three amphibian species as 'low' in terms of species richness and those with five to eight species as 'medium' (Weeber et al., 1997). Nonetheless, some of the stormwater ponds had a diversity of species similar to other ponds in and around Toronto. At the Kortright Centre pond, nine species of amphibians have been found (D. Stuckey, pers. comm.). In Toronto, a one hectare pond at Colonel Sam Smith Park had only two species of amphibians while the Brickworks pond (5.0 hectare) had four (Toronto and Region Conservation Authority, unpublished data).

Fish, Reptiles and Mammals

Fish were sampled with minnow traps in July, 1997. Observations of reptiles and mammals were noted during the course of the bird and amphibian surveys. Among all ponds in the study, four species of reptiles including eastern garter snake (*Thamnophis sirtalis*) and three species of turtles were found. One species of turtle was an introduced species, the red-eared slider (*Trachemys scripta*), which is commonly kept as a pet and often released into local ponds. Eight species of fish, mainly minnows, as well as white sucker (*Catostomus commersoni*), pumpkinseed (*Lepomis gibbosus*) and a non-native goldfish were seen or trapped among all ponds. Eight species of native mammals were observed including meadow vole (*Microtus pennsylvanicus*), raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), eastern cottontail rabbit (*Sylvilagus floridanus*), groundhog (*Marmota monax),* muskrat (*Ondatra zibethicus*), white-tailed deer *(Odocoileus virginianus*), and red fox (*Vulpes vulpes*).

Overall, for all species surveyed, stormwater ponds vary in their attraction of wildlife species, and can generally be rated as low to moderate in terms of species richness.

> As pointed out in the Ontario Ministry of the Environment's manual *Stormwater Management Practices* (OMOE, 1994), stormwater ponds should be considered treatment facilities and not a replacement for natural wetlands.

What levels of contaminants are found in stormwater ponds?

As expected, since stormwater ponds are designed to trap sediments, contaminants were found in all of the sites. These were generally at low levels; however, concentrations of some persistent contaminants in sediment and water from 14 of 15 ponds exceeded the Ontario and Canadian guidelines for sediment and water quality.

Sediment

In 1997, four or more surficial sediment samples were collected along a transect through an area of deep sediment in each pond. The samples were pooled together from each pond for a composite sediment sample of approximately 15 liters. GTA ponds were sampled in July and Guelph ponds were sampled in September. Each sample was thoroughly mixed and 0.5 liters was sub-sampled and analysed for trace metals, PCBs, PAHs, organochlorine pesticides, total organic carbon, nutrients, and oil and grease. The remainder of each sediment sample was used in short-term bioassays with fish and benthic invertebrates.

Sediments from 14 of 15 ponds contained concentrations of at least one contaminant that exceeded the 'Lowest Effects Level' (LEL) of the *Guidelines for the Protection and Management of Aquatic Sediment in Ontario* (Persaud et al., 1992) (Fig. 2). Sediments from some ponds showed multiple cases of concentrations that exceeded provincial guidelines (Fig. 2). Total PCBs in sediments ranged from non-detectable (below 500 ng/g) to 789 ng/g (parts per billion) (Figs. 2 and 3). The concentrations of organochlorine pesticides in sediment were relatively lower ranging from non-detectable to 5.75 ng/g.

Most pond sediments showed contaminant concentrations exceeding provincial sediment quality guidelines at the LEL for chromium, zinc and copper (Fig. 2). For PAHs and lead, concentrations in sediments exceeded the provincial LEL in six and seven ponds respectively (Fig. 2). The LEL is the sediment concentration which can be tolerated by most benthic species but sensitive species will not thrive. However, while cadmium, copper, lead and zinc were twice the LEL at some Guelph sites, only copper and zinc occurred at concentrations above those typically found in Great Lakes sediments (Persaud et al., 1992). Sediments at one site (GTA #3) exceeded the provincial guideline at the 'Severe Effect Level' (SEL) for chromium (Fig. 2). Exceeding the SEL likely affects the health of and has the potential to be acutely toxic to most benthic organisms.

Canadian Water Quality Guidelines for the Protection of Aquatic Life

The goal of these guidelines is the protection and maintenance of all forms of aquatic life and all aquatic life stages in the freshwater environment.
These guidelines can be found on the World Wide Web at: *http://www.ec.gc.ca/ceqg-rcqe/water.htm.*
Information on ordering the guidelines is available at: *http://www.ccme.ca/ccme/pdfs/cat-eng.pdf.*

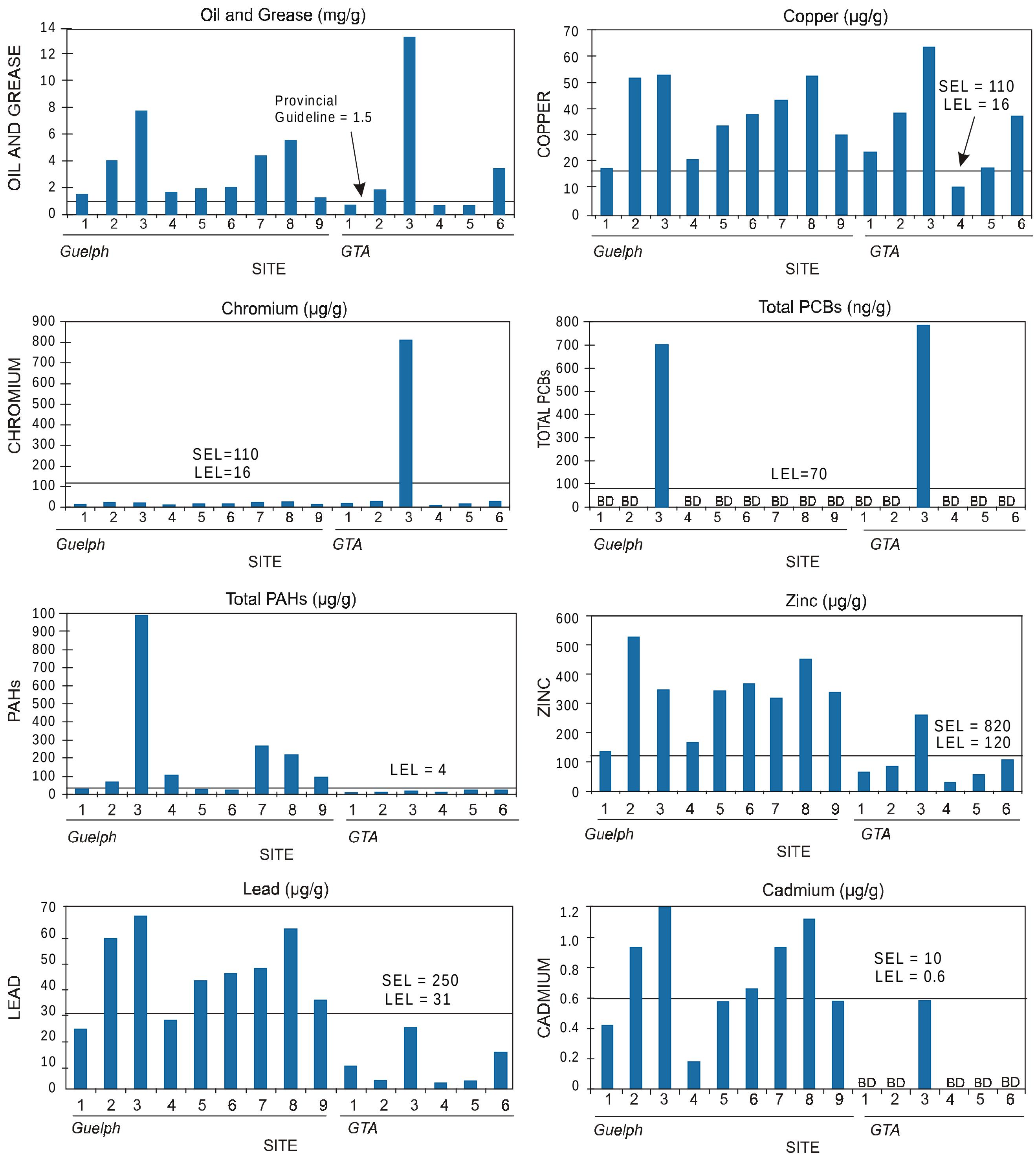
Provincial Water Quality Objectives

For certain substances, the Provincial Water Quality Objectives are more stringent than the Canadian Water Quality Guidelines.
These guidelines can be found on the World Wide Web at: *http://www.ene.gov.on.ca/envision/gp/index.htm#PartWater.*

Guidelines for the Protection and Management of Aquatic Sediment in Ontario

The Lowest Effect Level (LEL) indicates clean to marginally polluted sediment quality, which can be tolerated by most benthic species. Exceedences of the LEL may require further testing (including laboratory bioassays to confirm the effect) and a management plan. The Severe Effect Level (SEL) indicates heavily polluted sediment that is likely to affect the health of most benthic animals and may be acutely toxic.
These guidelines can be found on the World Wide Web at: *http://www.ene.gov.on.ca/envision/gp/index.htm#PartWater.*

Figure 2: *Contaminant Concentrations in Sediments from Stormwater Ponds in Guelph and the GTA (1997)*



Provincial Sediment Quality Guidelines:
LEL = Lowest Effect Level
SEL = Severe Effect Level
BD = Below Method Detection Limit:
Total PCBs = 500 ng/g, Cadmium = 0.111 µg/g

All sites contained concentrations of oil and grease which were in the part per thousand range. The provincial guideline is 1.5 mg/g (parts per thousand) for oil and grease in sediment. The concentrations found in the sediments of most stormwater ponds in this study are considered to be high. For example, among three stormwater detention ponds sampled in the GTA in the 1990s, concentrations of oil and grease ranged from 3.5 µg/g (parts per million) to 3.9 mg/g (Greenland Engineering Group, 1998). Nine of 15 ponds sampled in this study contained oil and grease concentrations in sediment between 1.0 and 2.5 mg/g and the remaining six sites contained concentrations of 4.0 to 13.0 mg/g (Fig. 2).

Water

Water samples were collected using a hand-held sub-surface grab sampler. Water samples were analysed for trace metals, chloride, and nitrogen and phosphorus compounds. Samples were collected bi-weekly from May to August, 1997 and monthly until December, 1997. The average concentration of some compounds in water exceeded the *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (CCME, 1999) (Fig. 4). Most notably, at five of 15 sites, copper levels in water exceeded the guideline (Fig. 4). Guidelines were also exceeded by average water concentrations for lead and zinc at three sites and possibly for chromium at two sites (Fig. 4). Levels of chlorides increased in the ponds during the winter, probably due to road-salting. Concentrations of phosphorus and nitrates increased in the ponds in the spring and autumn months, likely due to fertilizer use in residential areas surrounding the ponds.

Overall, a number of water quality parameters exceeded guidelines for the protection of aquatic life in the freshwater environment. The concentrations found in this study were fairly typical of urban stormwater quality (Makepeace et al., 1995).

Red-winged blackbird eggs

Red-winged blackbirds (*Agelaius phoeniceus*) nested at two of the GTA ponds. Two to three eggs per nest were collected at these sites for measurement of organochlorine contaminants. In figure 3, these results are compared to levels in eggs previously sampled elsewhere (Bishop et al., 1995). Concentrations from the stormwater pond sites were 260 and 1130 ng/g pp'DDE, a breakdown product of DDT. Concentrations of total PCBs were 300 and 670 ng/g. Some variation among sites can be seen, although statistical conclusions cannot be made due to the small number of nests sampled. Eggs from the GTA ponds were more contaminated than those from Wye Marsh, Georgian Bay which receives no industrial and little agricultural contamination. In addition, eggs from GTA #3 were more contaminated with pp'DDE and PCBs than eggs from a large urban wetland, Coote's Paradise, in Hamilton Harbour, an Area of Concern identified under the Great Lakes Water Quality Agreement. Eggs from GTA #2 were slightly more contaminated with PCBs than eggs from Coote's Paradise whereas pp'DDE concentrations were lower than those from Coote's Paradise. The concentrations found in this study were of an order of magnitude lower than those known to cause health problems in songbirds (Jefferies, 1971; Elliott et al., 1994; Custer, et al., 1998; Bishop et al., 1999).

Other studies have shown that contaminants in chicks and eggs of migratory insect-eating songbirds, such as red-winged blackbirds and tree swallows (*Tachycineta bicolor*), are generally derived from sediments close to their nests (Shaw, 1984; Elliott et al., 1994; Bishop et al., 1995, 1999; Custer et al., 1998). After arrival at their nest site, birds feed intensively in a very small area in order to build up sufficient fat for egg production. In urban areas stormwater ponds may provide a major food source for these birds. Compounds such as pp'DDE and PCBs in the eggs come from the diet of emergent aquatic insects (Orians, 1980) which have most likely emerged from the stormwater pond sediments. Even when sediment contaminant levels are extremely low, pp'DDE and PCBs can accumulate in songbird eggs to detectable concentrations (Bishop et al., 1995).

Figure 3: *pp'DDE and PCBs in Sediment and Eggs of Red-winged Blackbirds (1997)*

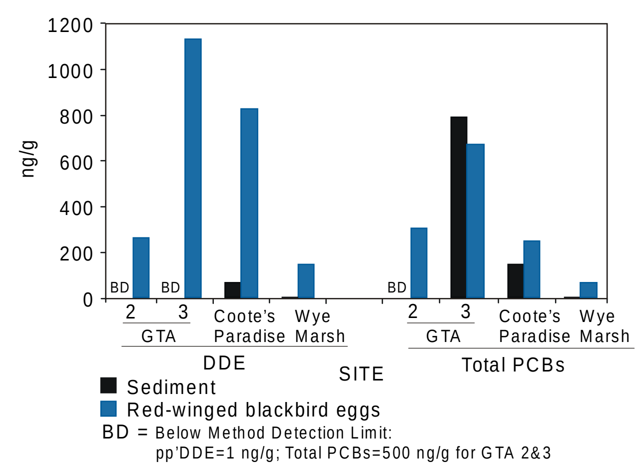
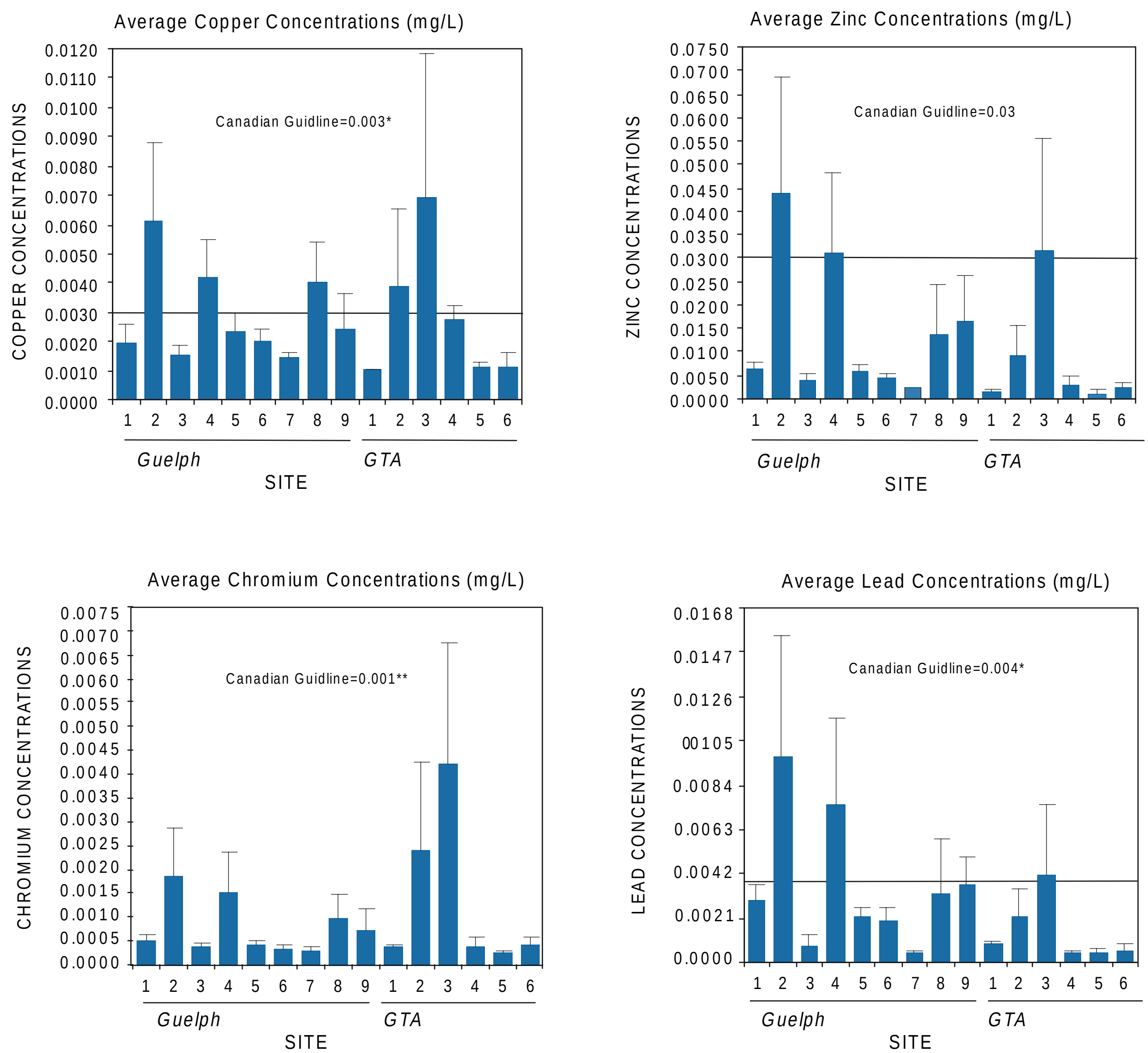


Figure 4: *Mean Contaminant Concentrations in Water Samples from Stormwater Ponds in Guelph and the GTA (1997)*



*Assuming water hardness of 120-180 mg/L $CaCO_3$
**Guideline based on hexavalent chromium which constitutes 10-60 % of unfiltered samples

Sediment bioassays with fish and invertebrates

For each sediment sample, toxicity to three aquatic animals was determined. The test species, fathead minnow (*Pimephales promelas*), mayfly (*Hexagenia limbata*) and midge (*Chironomus tentans*) were used in short-term bioassays. Fathead minnows and mayfly larvae were exposed to sediments for 21 days and midge larvae were exposed for 10 days. Biological effects measured in the organisms were survival and growth after exposure, following standard test methods (Bedard et al., 1992). Sediment from Honey Harbour in Georgian Bay, Lake Huron, which is known to be relatively clean from previous tests, was used as a control.

There were no statistically significant differences in survival of mayflies, midges or minnows between the Guelph sediments and sediments from Honey Harbour (Fig. 5). There was a range in mayfly and midge growth (growth in minnows was not evaluated) among sites in Guelph (Fig. 6). Growth of mayflies and midges in pond sediments was similar to or above that of Honey Harbour results. This may be influenced by the

Figure 5: *Mortality of Midges and Mayflies in Bioassays from Guelph and the GTA*

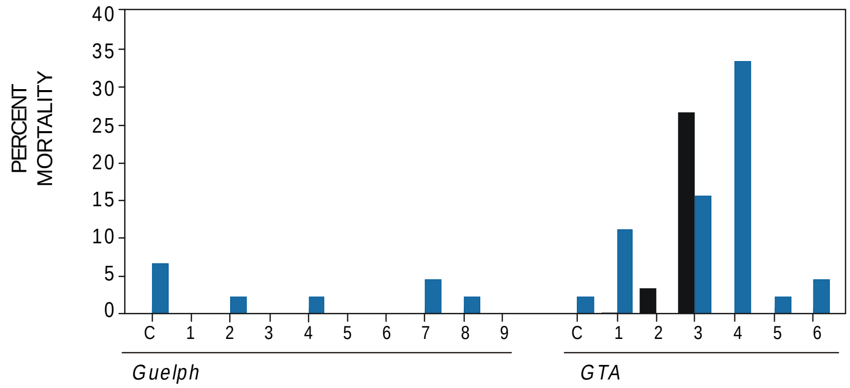
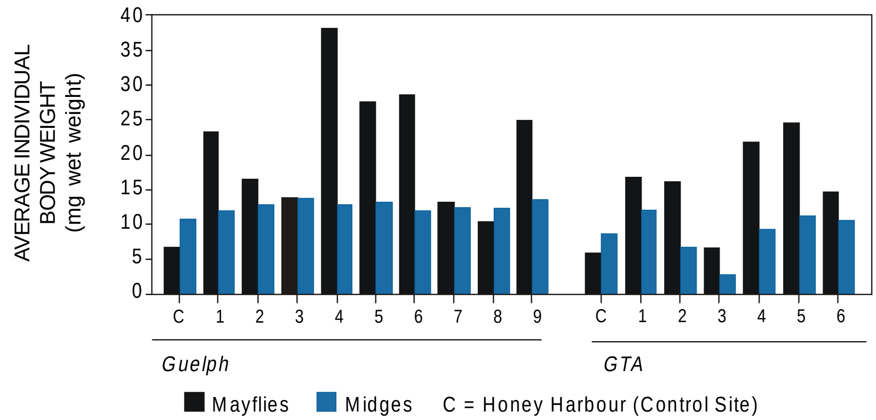


Figure 6: *Average Wet Weight of Midges and Mayflies in Bioassays from Guelph and the GTA*



greater availability of nutrients in the stormwater ponds and the longer storage period of the Honey Harbour sediment. Even though mayfly growth was generally greater in Guelph sediments than the control, there was a significant correlation between increasing oil and grease concentrations and reduced mayfly growth (Bedard, in prep.).

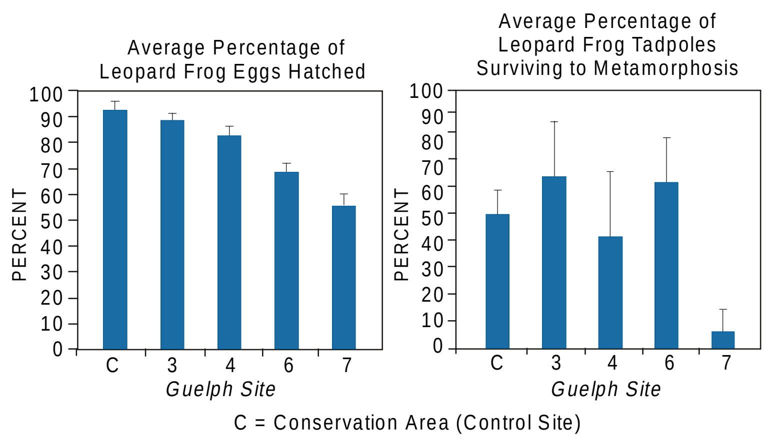
Among the GTA ponds, survivorship of minnows showed no differences in stormwater ponds compared to the Honey Harbour control sediments. Mortality of midges was elevated at GTA #4 but was not statistically higher than that in Honey Harbour (Fig. 5). There was significantly elevated mortality of mayflies at GTA #3, a pond located in a commercial/light industrial area (Fig. 5). Also, the mortality of mayflies in GTA sites was correlated with oil and grease as well as total PAH concentrations in the sediment (Bedard, in prep.).

In general, growth of mayflies and midges in GTA sediments was equal to or higher than the Honey Harbour sediments (Fig. 6). This may have been influenced by the greater availability of nutrients in the stormwater ponds and the longer storage period of the Honey Harbour sediments. However, GTA #3 showed mayfly and midge growth to be significantly lower than other GTA sites and Honey Harbour (Fig. 6). GTA #3 is the site where concentrations of chromium and oil and grease in sediment were highest among all sites (Fig. 2). While chromium concentrations in sediment were highest at GTA #3 and above the SEL, they were still below levels known to be toxic to benthic animals in other studies (USEPA, 1991; Bedard and Petro, 1997). Nonetheless, there was a significant negative trend between mayfly growth in the GTA sediments and chromium, total organic carbon and oil and grease concentrations in those sediments (Bedard, in prep.).

Bioassay of northern leopard frog eggs and tadpoles

In 1998, three northern leopard frog (*Rana pipiens*) egg masses were collected from a natural wetland in a conservation area in Guelph. Ten eggs from each egg mass were placed in each of six nylon cages per study pond. The study sites were four stormwater ponds in Guelph (sites #3, 4, 6, 7) and the natural wetland where the eggs for the experiment were collected. The hatching success and survival of tadpoles were determined for each cage. When the eggs hatched the number of tadpoles was counted. The tadpoles were fed and raised to metamorphosis in cages in each pond over a two and a half month period. Frog development at three stormwater ponds showed no statistical differences from the natural wetland (Fig. 7). The percentages of eggs and tadpoles that survived were statistically lower at one site, Guelph #7, than at all the others (Fig. 7). The percentage of eggs that hatched decreased with increasing alkalinity (pH 7.4-8.6), chlorine and sodium, and decreasing mercury in the water. The percentage of frogs surviving to metamorphosis was positively correlated with the amount of phosphorus in water, and total organic carbon in sediment.

Figure 7: *Survival of Leopard Frog Eggs and Tadpoles (1998)*



Findings

- Wildlife used all of the 15 stormwater detention ponds. Species richness was low to moderate.
- As expected, all stormwater ponds contained contaminants, generally at low levels. Levels of some persistent contaminants in sediment and water from the 15 stormwater detention ponds exceeded Ontario and Canadian guidelines for water and sediment quality in the freshwater environment .
- Bioaccumulation of persistent contaminants (i.e., pp'DDE and PCBs) into red-winged blackbird eggs was found at the two sites where they nested.
- Sediment from one of 15 sites, situated in a commercial / light industrial area, was toxic to invertebrates in a short-term bioassay. No sites contained sediments that were toxic to fish in short-term bioassays. Conditions were toxic to frog development at one of four residential sites.
- Stormwater ponds do not provide good quality habitat for fish and wildlife due to the potential for contamination.

Recommendations

- Pollution prevention (i.e., controlling contaminants at their source) is an effective way of reducing contaminant loads to stormwater ponds and to mitigate downstream water quality. Monitoring conditions within the stormwater pond itself may identify the need to investigate and eliminate pollutant sources.
- Stormwater pond management is recommended, including water and sediment quality monitoring. It is recommended that guideline exceedences be used to trigger decisions on follow-up action, including wildlife surveys. Quantifying wildlife use will assist in determining the need for further risk assessments or remedial actions.
- Enhancement for wildlife habitat is more ecologically viable in natural wetlands than in stormwater ponds.
- Natural wetlands should not be used to treat stormwater because they provide many ecological and economic values which can easily be degraded or lost.

References

Bedard, D., A. Hayton, and D. Persaud. 1992. Ontario Ministry of Environment laboratory sediment biological testing protocol. Ontario Ministry of Environment, Water Resources Branch, Toronto, Ontario. 23 pp.

Bedard, D., and S. Petro. 1997. Laboratory sediment bioassay report on St. Marys River sediments 1992 and 1995. Ontario Ministry of Environment, Standards Development Branch, ISBN 0-7778-6674-9, Toronto, Ontario. 59 pp.

Bedard, D. in prep. Laboratory sediment bioassay report on stormwater pond sediments in Guelph and Toronto, Ontario, 1997. Draft Report in peer review. Ontario Ministry of Environment, Standards Development Branch, Toronto, Ontario. 40 pp.

Bishop, C.A., A.A. Chek, M.D. Koster, D. Hussell, and K. Jock. 1995. Chlorinated hydrocarbons and total mercury in sediments, red-winged blackbirds and tree swallows from wetlands in the Great Lakes-St. Lawrence River basin. Environ. Toxicol. Chem. 14 (3):491-502.

Bishop, C.A., N.A. Mahony, S. Trudeau, and K.E. Pettit. 1999. Reproductive and physiological responses to chlorinated hydrocarbons in tree swallows (*Tachycineta bicolor*) in Areas of Concern in the Great Lakes-St. Lawrence River basin. Environ. Toxicol. Chem. 18(2): 263-271.

Canadian Council of Ministers of the Environment (CCME). 1999. Canadian water quality guidelines for the protection of aquatic life. In: Canadian environmental quality guidelines, 1999. CCME, Winnipeg.

Custer, C.M., T.W. Custer, P.D. Allen, K.L. Stromborg, and M.J. Melancon. 1998. Reproduction and environmental contamination in tree swallows nesting the Fox River drainage and Green Bay, Wisconsin, USA. Environ. Contam. Toxicol. 17 (9): 1786-1789.

Elliott, J.E., P.A. Martin, T.W. Arnold, and P.H. Sinclair. 1994. Organochlorines and reproductive success of birds in orchard and non-orchard areas of central British Columbia, Canada, 1990-1991. Arch Environ Contam Toxicol 26:435-443.

Greenland Engineering Group. 1998. Storm water sediment management study. Appendix B1. Toronto, Ontario. pp. 1-4.

Helfield, J.M., and M.L. Diamond. 1997. Use of constructed wetlands for urban stream restoration: a critical analysis. Environ. Management 21 (3); 329-341.

Jefferies D.J. 1971. Some sublethal effects of pp'DDT and its metabolite pp'DDE on breeding passerine birds. Overdruk uit: Mededelingen fakulteit Landbouw-Wetenschappen Gent. 36 (1): 34-42.

Liscko, Z.J., and J. Struger. 1995. Trace metals contamination of urban streams and stormwater detention ponds. Chapter 17 In: Advances in Modeling the Management of Stormwater Impacts. Ed. W. James. Ann Arbor Press. Chelsea, MI. pp. 269-277.

Makepeace, D.K., D.W. Smith and S.J. Stanley. 1995. Urban stormwater quality: Summary of contaminant data. Critical Reviews in Environmental Science and Technology: 25(2):93-139.

Mayer, T., J. Marsalek, and E. Delos Reyes. 1996. Nutrients and metal contaminants status of urban stormwater ponds. Lake and Reserv. Manage. 12(3); 348-363.

Ontario Ministry of the Environment. 1994. Stormwater management practices. Queen's Printer for Ontario, Toronto, Ontario. 177 pp.

Orians, G.H. 1980. Some adaptations of marsh-nesting blackbirds. Princeton University Press, Princeton, NJ. 295 pp.

Persaud, D., R. Jaagumagi, and A. Hayton. 1992. Guidelines for the protection and management of aquatic sediment in Ontario. Water Resources Branch, Ontario Ministry of Environment. Queen's Printer for Ontario, Toronto, Ontario, Canada. 23 pp.

Shaw GG. 1984. Organochlorine pesticide and PCB residues in eggs and nestlings of tree swallows, *Tachycineta bicolor*, in Central Alberta. Can Field-Nat 98:258-260.

United States Environmental Protection Agency (USEPA). 1991. Remedial investigations report for the Cannelton Industries superfund site, RI report. Washington, DC. 22 pp.

Weeber, R.C., A.A. Chabot, J.D. McCracken, C.D., Francis, and K.E. Jones. 1997. Marsh monitoring program Vol. 1: 1995-1996 technical report. Long Point Bird Observatory, Port Rowan, Ontario. 133 pp.

Wren, C.D., C.A. Bishop, D.L. Stewart, and G.C. Barrett. 1997. Wildlife and contaminants in constructed wetlands and stormwater ponds: current state of knowledge and protocols for monitoring contaminant levels and effects in wildlife. Canadian Wildlife Service Technical Report No. 269. Toronto, Ontario. 106 pp. *Available from: Canadian Wildlife Service, 867 Lakeshore Road, P.O. Box 5050, Burlington, Ontario, L7R 4A6; email: glenn.barrett@ec.gc.ca; fax: (905) 336-6434.*

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This fact sheet will be available on-line in 1999 at the Canadian Wildlife Service site on the Green Lane at: http://www.cciw.ca/green-lane/wildlife/intro.html.

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