# Kawartha Lakes Fish Die-offs in 2007

# Summary Report

**Ministry of Natural Resources, Peterborough District**

**April 2008 FINAL Report**

## Executive Summary

The purpose of this report is to provide a summary of the fish-kill events that occurred in the Kawartha Lakes during the spring and summer of 2007. The primary focus of the report is on the large die-off of carp (*Cyprinus carpio*) that was observed on area lakes, including Lake Scugog, Sturgeon, Cameron (including the Burnt River), Balsam, Mitchell, Canal, Pigeon (including Big and Little Bald Lakes), Buckhorn, Chemung and Sandy Lake. The report describes the nature and extent of the events, documents agency responses, discusses the conditions that contributed to the fish kill, and presents the results of analysis conducted by the Ministry of Natural Resources (MNR) and the Ministry of the Environment (MOE).

Estimates based on municipal waste collections and public reports indicate that between 12,000 – 24,000 carp were taken to municipal landfills between early June and early September. The size range of carp affected was varied, with fish as small as 30-35 cm (12-14 inches) and carp exceeding 75 cm (~30 inches) observed on area waterbodies. Reports and observations of other fish species including pumpkinseed and bluegill sunfish, largemouth and smallmouth bass, muskellunge, walleye and brown bullheads were few.

A combination of stressors including changes to water/air temperatures, storm events, spawning stress, and high population abundance have likely combined to increase the stress and susceptibility of carp to a disease outbreak. The bacterium *Flavobacterium columnare* was the first confirmed pathogen found in carp sent to the laboratory for testing. *F. columnare* is commonly present in the environment where it is found naturally in water and mud and the environmental conditions were conducive to growth of the bacteria. The bacteria causes the fish disease called columnaris and this disease was found in carp from Sturgeon and Pigeon Lakes. A second confirmed pathogen, koi herpesvirus (KHV), was found in one carp was collected from Lake Scugog and in one carp from Pigeon Lake. Koi herpesvirus is caused by a virus that affects only carp, koi and goldfish and this is the first detection of the virus in Ontario. When fish are under stress they may not be able to fight off diseases and it is not possible to say with complete certainty to what extent environmental conditions, spawning, columnaris and koi herpesvirus were factors in the mortalities of the carp.

# Introduction

## 1.1 The Kawartha Lakes

The Kawartha Lakes are part of the Trent-Severn Waterway, an interconnected series of lakes, river channels and artificial canal cuts stretching for 386 km from Georgian Bay on Lake Huron to the Bay of Quinte on Lake Ontario (Angus, 1988). The lakes and rivers that make up the waterway are under the jurisdiction of the Trent-Severn Waterway, Parks Canada (TSW). Water in the system comes from two major river watersheds; the Trent and Severn Rivers. Mitchell and Canal Lakes have been raised by flooding to allow navigation through them. This section of the canal is the link between two major watersheds, the Trent, which flows southeast to Lake Ontario, and the Severn, which flows northwest to Georgian Bay. The Kawartha Lakes are part of the main canal in the Trent watershed and flow southeast into Lake Ontario via the Trent River. A map of the lakes including the direction of water flow is shown in Figure 1, with a summary of lake characteristics provided in Table 1.

All of the Kawartha Lakes have similar fish communities because of their comparable physical, chemical and biological characteristics and their direct connectivity via the Trent-Severn system. Historically, the Kawartha Lakes supported muskellunge, smallmouth bass, pumpkinseed sunfish and yellow perch populations. Introductions, via intentional stocking, range extensions, non-native species invasions, and unintentional releases have resulted in increasingly complex aquatic communities. Walleye were introduced and largemouth bass and rock bass have spread throughout the system. Bluegill and black crappie are native to Ontario, but have only recently established naturally reproducing populations in the Trent-Severn system.

The bottom of many of the Kawartha Lakes are soft and covered by dead and decaying vegetation. The breakdown of these materials can deplete oxygen near the bottom, particularly at night or during low-light conditions.

## 1.2 Agency Roles in the Kawartha Lakes

The roles and responsibilities of the various agencies involved in managing the fisheries and aquatic ecosystems within the Trent-Severn Waterway are complex, with each agency filling specific roles and mandates. These mandates are summarized in Table 2.

**MINISTRY OF NATURAL RESOURCES (PROVINCIAL; MNR)**

The MNR Peterborough, Bancroft and Aurora Districts works closely with TSW in matters related to resource management in the watershed. The MNR is responsible for the management of fish populations and other natural resources in the region through inventory and assessment, fishing regulations, enforcement, habitat rehabilitation and working with municipalities to protect areas of provincial significance such as provincially significant wetlands, Areas of Natural and Scientific Interest (ANSI), fish habitat and species at risk. MNR is also responsible for managing areas of provincial crown land including provincial parks.

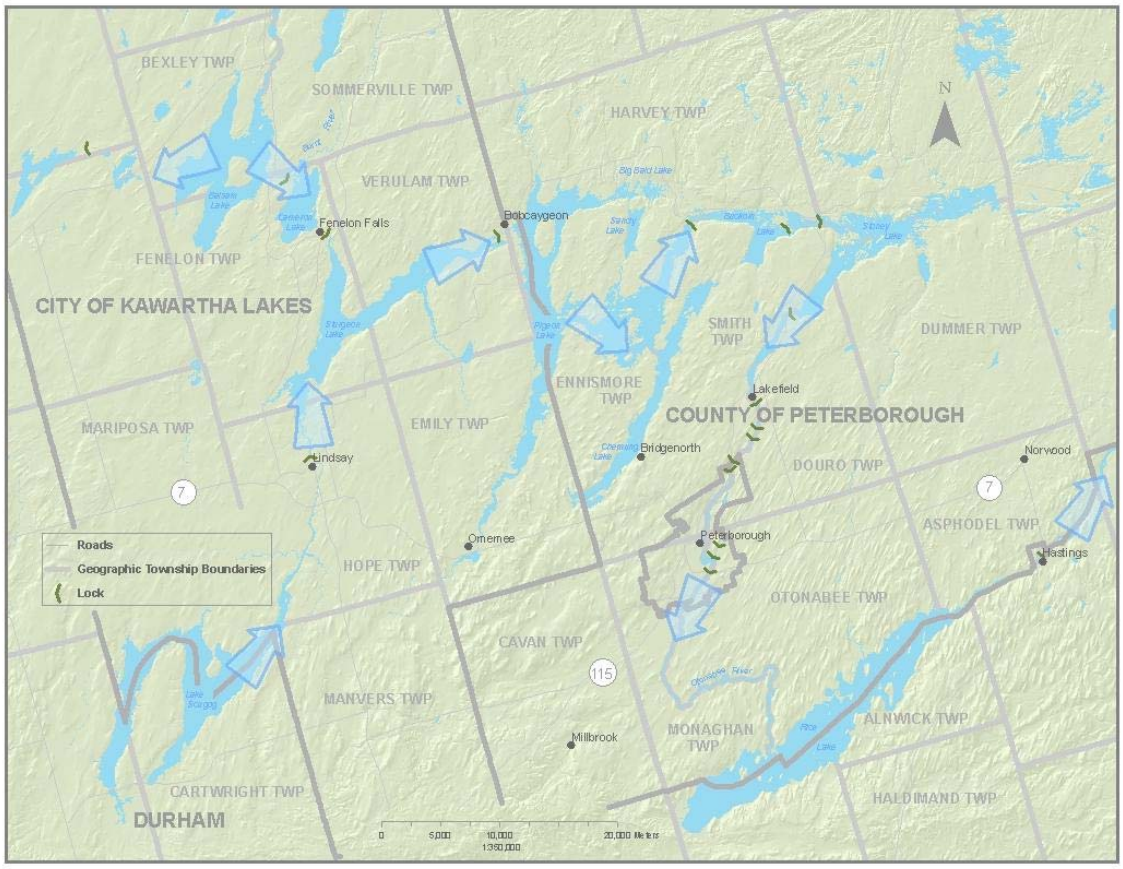


**Figure 1: Map of the Kawartha Lakes. Blue arrows indicate the direction of water flow between lakes.**

## Table 1: Characteristics of the Kawartha Lakes greater than 200 ha in surface area

| Lake Name | Area (ha) | TDS (mg/L) | Mean Depth (m) | Max Depth (m) | Secchi (m) | GDD > 5 °C |
|---|---|---|---|---|---|---|
| Cameron Lake | 1303 | 75 | 6.3 | 18.3 | 4.2 | 1859 |
| Stony Lake | 2825 | 91 | 5.9 | 32.0 | 2.0 | 1880 |
| Balsam Lake | 4665 | 78 | 5.0 | 14.9 | 8.3 | 1867 |
| Clear Lake | 1054 | 105 | 5.6 | 12.2 | 2.6 | 1918 |
| Sturgeon Lake | 4495 | 85 | 2.8 | 12.2 | 0.5 | 1881 |
| Sandy Lake | 370 | 181 | 4.8 | 12.8 | 1.5 | 1866 |
| Pigeon Lake | 5349 | 120 | 3.0 | 17.4 | 2.2 | 1885 |
| Lovesick Lake | 257 | 110 | 2.5 | 25.0 | 2.6 | 1909 |
| Rice Lake | 10018 | 130 | 2.6 | 7.9 | 1.9 | 1959 |
| Big Bald Lake | 201 | 128 | 2.5 | 9.5 | 2.9 | 1863 |
| Buckhorn Lake | 3191 | 121 | 2.1 | 9.4 | 2.3 | 1885 |
| Katchewanooka Lake | 351 | 110 | 1.8 | 10.1 | 2.3 | 1921 |
| Chemung Lake | 2280 | 148 | 2.4 | 6.7 | 2.6 | 1920 |
| Lake Scugog | 6374 | 156 | 1.8 | 7.0 | 0.7 | 1920 |
| Canal Lake | 1084 | 142 | 1.3 | 4.3 | 2.1 | 1890 |
| Mitchell Lake | 851 | 109 | 0.7 | 3.7 | 2.0 | 1880 |

| Table 2: Roles and responsibilities of various agencies in the Kawartha Lakes with respect to fisheries management and fish die-offs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **FEDERAL GOVERNMENT** | | | **PROVINCIAL GOVERNMENT** | | | | |
| **Agency** | **Fisheries and Oceans Canada** | **Parks Canada (Trent – Severn Waterway)** | **Canadian Food Inspection Agency** | **Ministry of Natural Resources** | **Ministry of Environment** | **Municipality** | **Health Unit** | **Conservation Authorities** |
| **Responsibility** | Fish Habitat | Management of water levels, ownership of lake beds | Safeguarding food, animals and plants | Fisheries management | Management of water quality and regulation of waste disposal | Waste disposal, tourism promotion, land use planning, parks and recreation | Promote health, prevent illness and protect against disease | Watershed management agencies that deliver services and programs that protect and manage water and other natural resources |
| **Priorities** | No net loss of the productive capacity of fish habitat | Public safety, navigation, cultural and natural resources | Protection of animal health and marketability of animal products and bi-products | Conserve biodiversity and use natural resources in a sustainable manner | Protect clean and safe air, land and water to ensure healthy communities, ecological protection and sustainable development | Waste disposal, tourism promotion, land use planning, parks and recreation | Mandatory programs determined by Provincial Ministry of Health | Protect, manage and restore rivers, lakes and streams woodlands, wetlands and natural habitat. Provide public recreation opportunities |
| **Actions** | Agreement in place with TSW regarding fish habitat referrals on the Kawartha Lakes | Manage lake levels and issue permits for activities in and around shorelines | Protecting animal health, maintaining list of diseases, ensuring early detection, control and eradication, import and export certifications | Issue fishing licences, set angling regulations, monitor fish populations, fish health | Monitor water quality with respect to environmental health | Provide services to residents (e.g. waste collection) | Monitor water quality from the perspective of public health (beaches) | Monitor water quality, property maintenance |

### MINISTRY OF THE ENVIRONMENT (PROVINCIAL; MOE)

The Ontario Ministry of the Environment (MOE) is responsible for protecting clean and safe air, land and water to ensure healthy communities, ecological protection and sustainable development for present and future generations of Ontarians. MOE's mandated responsibilities include:

- Lead provincial agency for protecting and monitoring water quality in the natural environment,
- Manage the Provincial Water Quality Monitoring Network (PWQMN) – sampling in rivers/streams in watersheds in partnership with Conservation Authorities,
- Manage the Lake Partner Program - monitors lakes for phosphorus and water clarity through local volunteers,
- Manage the provincial sport fish monitoring program – samples sport fish in popular lakes and provides consumption advice in the publication Guide to Eating Ontario Sport Fish,
- Regulation of municipal and industrial dischargers through the Certificate of Approval process and inspection programs (e.g., sewage treatment plants),
- Respond to pollution incident reports, such as spills; ensure clean up and steps taken to prevent re-occurrence,
- Regulation/inspection of Drinking Water Plants,
- Regulate and provide guidance on waste management, and
- Administers the *Environmental Assessment Act* (EAA), which requires a detailed environmental assessment of the impacts from provincial or municipal projects.

### TRENT SEVERN WATERWAY (FEDERAL; TSW)

The beds of the lakes that make up the Trent-Severn Waterway are owned by the Federal Government (Parks Canada). The TSW manages water levels and flows for purposes of public safety, navigation, and protection of natural and cultural resources. The Waterway also issues work permits and licences on federal lands under its jurisdiction, conducts environmental assessments for work on federal property, reviews site-specific planning proposals, and protects species at risk and significant cultural resources. The TSW does not have the mandate for managing the fisheries resources.

### FISHERIES AND OCEANS CANADA (FEDERAL; DFO)

In Ontario, Fisheries and Oceans Canada (DFO) is responsible for administering the fish habitat protection provisions of the *Fisheries Act*. The Act prohibits activities that result in the harmful alteration, disruption or destruction of fish habitat (HADD) unless authorized by the Minister of Fisheries and Oceans Canada. The Act also prohibits the discharge of deleterious substances into waters frequented by fish. The penalties for violating the *Fisheries Act* are severe and an offence can result in fines up to $1,000,000.

Many of DFO's responsibilities for the protection of fish habitat within the Trent-Severn Waterway are delegated to TSW under a partnership agreement with DFO fish habitat management. The responsibilities associated with managing species at risk under the Canada's *Species at Risk Act* are shared by a number of federal and provincial bodies. The Minister of Fisheries and Oceans is the minister responsible for aquatic species other than those that are in or on federal lands administered by Parks Canada. The local DFO

office did not have any responsibilities associated with the carp die-off in the summer of 2007.

### CANADIAN FOOD INSPECTION AGENCY (FEDERAL; CFIA)

The Canadian Food Inspection Agency (CFIA) is dedicated to safeguarding food, animals and plants. The CFIA has the lead for fish disease control in Canada and CFIA works with DFO, which has the lead for fish research including disease diagnostics and testing at a federal level. The CFIA is in the process of establishing the National Aquatic Animal Health Program (NAAHP), a science-based regulatory program for aquatic animal diseases which will include diseases designated reportable or notifiable in Canada because of their potential impact on trade and our economy. Specifically, the activities of CFIA under the NAAHP will include: protecting the health of the fisheries resources, maintaining a list of regulated aquatic animal diseases, implementation of surveillance and monitoring programs geared towards the early detection of fish diseases, control and eradication of aquatic animal diseases as appropriate, establishing requirements for import and export, and sustaining and increasing export market opportunities. In terms of fish health issues in the Kawartha Lakes, the CFIA would be notified if results of testing done at MNR's request indicate the possible presence of an OIE-listed disease or a CFIA reportable disease. At present, the reportable disease list is still in the process of regulatory amendment. Once the required regulatory amendments are complete, anyone suspecting the presence of a listed disease will have to report this to the CFIA.

### MUNICIPALITIES

Municipalities play a role in the protection of water quality, wetlands and fish habitat through the *Planning Act* and the implementation of the Provincial Policy Statement. Municipalities are the front line agency involved in local land use planning and development decisions, and can also protect riparian areas through site alteration and tree cutting by-laws. With respect to the carp die-off, the primary role of the municipalities was to provide waste collection services for residents and associated communications.

### HEALTH UNITS

The local health units work in partnership with residents and agencies to promote health, prevent illness and protect against disease. Health units encourage healthy lifestyles and a safe environment for residents. The health unit also monitors health trends in our communities and keeps track of local disease statistics.

All health units in the province are mandated to provide the services outlined by the Ministry of Health and Long-Term Care in the Mandatory Health Programs and Services Guidelines. The Guidelines set the goals, objectives and standards of program delivery by which health units are legislated to comply.

### CONSERVATION AUTHORITIES (CAS)

The role of a Conservation Authority in the management and protection of fish and aquatic habitat has greatly expanded over the past decade. CAs utilize Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation under Section 28 of the *Conservation Authorities Act* to regulate development and landscape alteration within the areas surrounding lakes, rivers and streams. Outside of the

Trent-Severn Waterway, CAs have been delegated authorities under Section 35(1) of the *Fisheries Act*, and are responsible for applying the some aspects of the Act. Recently, fisheries management plans have been developed by CAs, often in partnership with MNR, as companion documents to watershed management plans. CA's may also undertake local water quality sampling/monitoring and reporting activities, possibly involving local stewardship groups such as the Kawartha Water Watchers.

## 2.0 Timing and Extent of the Event

Beginning the week of April 23rd, MNR received reports of dead fish on area waterbodies including Rice, Sturgeon, and the Otonabee River. These fish kills involved primarily small bodied fishes including pumpkinseed, bluegill and rock bass. The Otonabee River report related to a number of dead walleye (approximately 12). In each of these instances, no visible signs of illness were reported or observed. Winter fish kills are relatively common on the Kawartha Lakes, and may have contributed to these observations. Ice cover prevents oxygen recharge from the atmosphere and from plant photosynthesis. Oxygen can drop to dangerously low levels and fish can suffocate or become susceptible to disease and die, resulting in a winter fish kill.

In late May and early June, MNR received a number of reports of dead fish, primarily small bodied fishes including pumpkinseed and bluegill sunfish, rock bass, yellow perch and small numbers of game fish from Chemung, Pigeon, Rice and Canal Lakes. The reports from Canal Lake included a number of brown bullhead in addition to the small-bodied fishes. In these instances, there were no reports of external symptoms of disease or illness. Early summer fish kills, particularly those involving sunfishes and rock bass are common on the Kawartha Lakes. These fish are actively spawning at this time, and are engaged in nest building and the guarding of eggs and fry, often in very shallow waters. The stress associated with spawning, when combined with dramatic fluctuations in water temperatures in these shallow areas, can lead to mortality, or increased susceptibility to other pathogens.

The Kawartha Lakes Fisheries Assessment Unit (KLFAU) was conducting an End of Spring Trap Netting (ESTN) survey on Lake Scugog between May 23 and June 8, 2007. This survey was part of routine monitoring conducted annually by the KLFAU on a rotational basis on four area lakes (Lake Scugog, Balsam, Rice and Buckhorn Lakes). In addition to the ESTN survey, the KLFAU conducted a scheduled open-water creel survey on Lake Scugog, and were present on the lake approximately three days each week between May 12 (opening of walleye season) and the Labour Day weekend (early September).

On the weekend of June 2, 2007 carp captured in the trap nets displayed obvious signs of poor health including haemorrhaging, 'pop-eye', lethargic behaviour, and deterioration of the fins. Carp collected in the nets prior to this date did not display obvious external signs of illness. Following the initial detection, the majority of carp sampled in the trap netting program displayed similar signs. During the week of June 11th, a large number of dead carp were observed on the surface of the lake. By the weekend of June 16th, reports and observations of freshly dead carp had declined on Lake Scugog, although a significant number of carcasses were still on the lake. Spawning behaviour was observed on the lake in the weeks that followed the onset of the die-off, suggesting that fish were

in pre-spawn condition prior to the die-off and that apparently healthy carp were still present in the lake (G. Cimbura, personal communications).

On June 21, 2007 MNR began to receive reports from residents on Sturgeon Lake reporting dead carp. Initial reports were received from all areas of the lake including Lindsay (inflow from Lake Scugog) to Bobcaygeon (outflow to Pigeon Lake). Live carp were observed to be lethargic, with obvious white markings present on the head and body of the fish. There were few observations of fish showing signs of illness similar to those observed in fish from Lake Scugog (e.g., haemorrhaging). Dead carp were reported on Sturgeon Lake as late as July 6, 2007.

Initial reports of dead carp on Pigeon Lake were received as early as June 29th, with subsequent reports from Buckhorn and Chemung Lakes, which are directly connected. KLFAU were conducting summer gill netting surveys on the lake during the week of July 17th, and reported large numbers of dead carp. Reports of dead carp on Pigeon Lake included the Pigeon River upstream to the dam in Omemee, as well as Big and Little Bald Lakes. By the week of July 30th, observations by MNR staff indicated that dead carp on Pigeon and Buckhorn Lakes were substantially lower in number than previous observations on these waterbodies (G. Cimbura, personal communications).

At the same time as initial reports from Pigeon Lake were being received, the MNR received calls from residents of Cameron Lake (upstream of Sturgeon Lake), including the Burnt River. Reports from Cameron Lake continued until July 9th, and were much lower in volume than on the larger lakes. MNR staff conducted an on the water survey of the Burnt River on July 9th, covering 12-14 km of river and observed roughly 50 dead carp, and no live carp. Staff estimated that the carp had been dead for some time, perhaps as early as late June (D. Flowers, personal communications).

Initial reports of dead and dying carp were received from Sandy Lake (upstream via a small tributary from Upper Buckhorn Lake) beginning on July 23. Observations from residents suggested that the number of dead carp was relatively low; however carp showing external signs of illness including white markings were observed by residents.

Reports of dead carp during the last week of July and throughout the majority of the month of August were relatively few. On August 27th, MNR began to receive reports of dead carp *above* the dam in Omemee on the Pigeon River system. MNR staff were on site August 31st and observed 'hundreds' of dead carp in the pond above the dam. During the same time period, KLFAU staff conducting index netting work on Balsam Lake (upstream of Cameron Lake), as well as staff from Balsam Lake Provincial Park and area residents, began to observe dead and dying carp. Although substantial, the number of dead carp observed on Balsam Lake was reported to be lower than observations from the other large lakes. Calls were also received during this time period reporting dead carp on Mitchell and Canal Lakes. A series of storm events which included heavy rain occurred prior to the initial reports of dead carp in these areas, which may have increased the level of environmental stress.

Additional reports of dead carp were received by MNR throughout the summer months from the Trent and Otonabee Rivers, Lovesick Lake, and Stoney Lake. There were also media reports of dead carp (fewer than 6 fish) in Little Lake and Katchewanooka Lake, although observations of dying fish on these waterbodies were not reported to MNR.

Throughout the summer months, MNR received reports of dead sport fish species including walleye, largemouth bass, smallmouth bass and muskellunge. Typically, these were reports of individuals or very small numbers of dead fish, and were very few in numbers relative to reports of dead carp. Descriptions of some of the dead fish did correspond to signs typically observed in fish with diseases known to be found in fish in these lakes (e.g., Lymphocystis and Lymphosarcoma). Other factors, including angling stress, parasites, and natural causes may have contributed to the mortality of other fish species. MNR staff, including staff from the District Offices, Conservation Officers, and the KLFAU, who collectively spend a significant amount of time on area lakes each year, did not observe any abnormal mortality of sport-fish species.

Final estimates from municipal waste collections indicated that close to 90 tonnes (~200,000 pounds) of carp were disposed of at local landfills. Determining the number of carp this represents is difficult, given the wide range of the size of the fish impacted, but MNR estimates between 13,000-24,000 carp were disposed of at municipal landfills. This estimate does not include the number of carp that were disposed on private land, or those that decomposed in the lakes.

## 3.0 Agency Actions

**MINISTRY OF NATURAL RESOURCES (MNR)**

Prior to the carp die-off, MNR staff investigated a number of fish kill reports on local waterbodies. Where specimens suitable for testing were available, they were sent to the Fish Health Lab at the University of Guelph for analysis.

In addition to sampling associated with these fish kills, MNR District and KLFAU staff collected fish in association with surveillance monitoring for Viral Hemorrhagic Septicemia (VHS), a viral disease of fish first identified in the Great Lakes in 2005. VHS was not detected in fish collected in the spring of 2007 from Rice and Balsam Lakes

Upon discovery of the carp with clear signs of illness, MNR staff immediately sent samples to the Fish Health Lab for analysis. The suite of viral and bacterial tests that were conducted require fish in a moribund (live fish showing signs of illness) state. Fish that had been dead for even a short period of time were not suitable candidates for testing. Throughout the remainder of the summer, MNR staff collected samples for analysis and worked closely with staff from the University of Guelph to ensure the lab had the capacity to quickly process the samples. In total, MNR sent 17 carp to the Fish Health Lab from five area lakes including Lake Scugog, Sturgeon Lake, Pigeon Lake, Buckhorn Lake and Sandy Lake.

The MNR District Office worked closely with local municipalities and other agencies to determine appropriate courses of action. Consistent with advice obtained from the Ministry of the Environment, landowners were directed to bury carcases on their property or to double-bag the carcasses and have them disposed at local landfill sites. MNR provided technical information to our agency partners, as well as regular updates as the summer progressed.

MNR staff at various levels responded to public calls reporting fish kills as well as those looking for information. MNR also responded to local media from Port Perry, Lindsay,

Bobcaygeon, Peterborough as well as major media from Toronto and Barrie. MNR staff provided the best available information to the public and media throughout the summer months. To provide factual information to the public, the MNR hosted a Technical Briefing for the media on July 31st. A technical panel including representatives from MNR, the Ministry of Environment, University of Guelph, local health units, local municipalities were present, with representatives from Fisheries and Oceans Canada and the Canadian Food Inspection Agency participating via teleconference. Three Public Information Sessions were held in late August in the City of Kawartha Lakes to answer questions and provide information to the public. MNR, MOE, the Haliburton-Kawartha-Pine Ridge Health Unit and the City of Kawartha Lakes were represented on the panel. These public sessions were attended by a total of roughly 120-140 residents. MNR staff provided an update to local residents at the Lakeland Conference in Buckhorn on August 11.

MNR staff, including those from the Peterborough District office and Provincial Parks, removed dead carp from areas of Provincial Crown Land including Emily and Balsam Lake Provincial Parks. District staff removed more than 200 carp from the area above and below the MNR-owned dam in Omemee. MNR did not remove carp, or any other dead fish or wildlife from private or non-Provincial Crown Land.

In summary, in response to the carp die-off in the summer of 2007 MNR:

- Worked with agency partners to share available information and determine the best course(s) of action,
- Collected fish for testing at the University of Guelph as required,
- Monitored the status of fish populations via index netting programs and creel surveys,
- Provided up to date information to the public and media, and
- Removed carp carcasses from areas of Provincial Crown land.

**MINISTRY OF THE ENVIRONMENT (MOE)**

With respect to the carp die-off, MOE responded when the die-off was first identified in Lake Scugog area. MOE staff visited Scugog Lake and the Scugog River to check for potential pollution or spill incidents, and reviewed available information. No spills or other water quality pollution issues were identified in the upstream lakes and rivers, or downstream lakes where the die-off also occurred during the later stages.

As a direct response to the carp die-off, MOE undertook a special water quality sampling survey in the Kawartha Lakes in mid-August to check for potential water quality impacts. The survey involved five lakes, with 29 water samples for laboratory analysis. The lakes selected included Sturgeon Lake as a lake that was heavily impacted by the die-off; Balsam, Mitchell and Canal Lakes as lakes where the die-off was occurring close to the time of the sampling; and Rice Lake, a downstream lake that was not impacted by the die-off.

The MOE advised that it would be appropriate for persons finding dead fish on their property to dispose of the material as they would their regular domestic waste (after double-bagging it) or by taking it to the local landfill as soon as possible. MOE worked

closely with local municipalities and landfills to ensure they were prepared to dispose of carp carcasses as effectively as possible.

MOE staff provided information to partner agencies and responded to calls from the public. MOE staff also provided technical expertise at the media Technical Briefing as well as the Public Information Sessions.

In addition to the response specific to the carp die-off, MOE oversees the Provincial Water Quality Monitoring Network (PWQMN) and the Lake Partner Program, both of which may contribute relevant data.

As part of mandated responsibilities, MOE monitored information from municipal drinking water supplies for communities in the affected areas that use surface water as their drinking water source. All municipal drinking water supplies remained safe for the duration of the summer. Municipal water treatment systems are effective in the removal and inactivation of pathogens and bacteria, as they must meet strict regulatory standards for design, operation and testing, and are inspected annually by MOE so as to ensure compliance with the regulatory requirements.

**MUNICIPALITIES**

The upper-tier municipalities with jurisdiction over the areas affected by the carp die-off included the Regional Municipality of Durham, City of Kawartha Lakes, and the County of Peterborough. The Township of Scugog and Smith-Ennismore-Lakefield were also directly involved.

The primary role of the municipalities throughout the carp die-off was to provide waste collection services and facilities to area residents. Most municipalities provided carp collections during regular curb-side collections, and waived tipping fees for carp at area landfills. The Regional Municipality of Durham provided special curb-side collections of carp carcasses on June 16, 18, 23 and 25 at no cost to area waterfront residents. The City of Kawartha Lakes offered special curb-side collections on June 30, July 1, 7, 8, 28 and 29 for area residents. More than 50 tonnes of carp were disposed of at landfills in the township of Smith-Ennismore-Lakefield, between regular and special curb-side collections and drop-off by local residents. Municipal staff were active in maintaining municipally owned properties where carp carcasses were present. Staff from the City of Kawartha Lakes coordinated the Public Information Sessions and participated in the media Technical Briefing.

**LOCAL HEALTH UNITS**

A number of public health units were active in the summer of 2007 conducting scheduled monitoring of public beaches, primarily looking for E-coli bacteria. Beach closures are relatively common in some areas of the Kawartha Lakes, and did occur at various locations throughout the summer of 2007. The local health units have protocols in place to track human health related issues. None of the health units reported any instances of human illness associated with the carp die-off. Health units routinely discourage the use of untreated water for household purposes, and encourage a ‘common sense’ approach regarding the safety of swimming in areas with dead fish and wildlife.

Health units directly involved in the areas impacted by the carp die-off included: Durham Region Health Unit, the Haliburton, Kawartha, Pine Ridge District Health Unit and the

Peterborough County (City) Health Unit. Representatives from one of the health units were present at the media Technical Briefing and the Public Information Sessions.

**CONSERVATION AUTHORITIES**

The role of Conservation Authority staff was largely dictated by their ongoing programs and services. CA staff responded to calls from the public and media regarding the carp die-off, and provided technical expertise where available. Properties owned by CAs were maintained by their staff. Kawartha Conservation provided water quality data associated with the preparation of the Lake Scugog Environmental Management Plan, and other CAs contributed to MOE's existing water quality monitoring programs.

**AREA RESIDENTS**

Local landowners played a critical role in the clean-up of individual properties. In many instances, groups of landowners coordinated efforts to clean up large areas of shoreline and open water areas. Residents provided regular reports to MNR as dead or dying carp were observed in new areas, allowing the various agencies to coordinate their subsequent actions. The efforts of residents acting as stewards of the lake resources were valuable in helping to manage the situation.

# 4.0 Analysis and Results

## 4.1 Water Quality

Analytical results from the special water quality sampling event completed by the MOE were obtained for a suite of general chemistry parameters indicative of lake water quality: heavy metals, nutrients, pH, alkalinity, conductivity, $BOD_5$, suspended solids, and bacteria (except Sturgeon Lake). Also, samples were collected for algae identification at two lakes. The samples collected from affected lakes (Sturgeon Lake, Balsam Lake, Mitchell Lake, and Canal Lake) showed no significant difference in water quality when compared to historic ranges. The samples collected from downstream/unaffected Rice Lake show no significant difference from historic ranges, however, nutrient levels and total suspended solids results were marginally elevated suggesting the possibility of an algae bloom in progress at the time of sampling. Algae identification of samples from Balsam and Mitchell Lakes indicated that blue-green algae were present, as expected, but not at densities necessary to produce toxins at levels that would explain the carp die-off. Field observations and measurements made while sampling did not indicate any apparent water quality impacts either.

PWQMN stream water quality data from June 2006 to June 2007 shows local stream water quality was generally better than water quality guidelines set. Median total phosphorus concentration (18 µg/L) was well below the Provincial Water Quality Objective (30 µg/L). Nitrate concentrations were consistently below the Canadian Water Quality Guideline.

Concentrations of metals, including copper, iron, lead, nickel and zinc, were generally below (i.e., met) the Provincial Water Quality Objectives. Spring 2007 sampling from the Lake Partner Program identified low phosphorus levels in area lakes which is indicative of good water quality.

Water quality data were also collected in association with the Lake Scugog Environmental Management Plan by Kawartha Conservation at three points in the summer: June 7, July 10 and August 7. Based on the physical and chemical water quality characteristics measured, water quality on June 7 was considered satisfactory. Water temperature was approximately 18ºC, with pH between 7.9 and 8.5. Dissolved oxygen levels were high, ranging from 9.0 – 11.4 mg/L. These levels were often above 100% saturation, and are likely attributed to the photosynthetic processes of the abundant aquatic vegetation. Ammonia, nitrate and nitrite levels were below detection levels of 10 ug/L, 8 ug/L and 2 ug/L respectively. TKN concentrations were considered moderate ranging from 0.60-0.66 mg/L. Total phosphorus concentrations ranged from 10-16 ug/L (A. Shulyarenko, personal communications).

On July 10, water temperature varied from 22.8ºC (bottom layer) to 26.1ºC (surface layer), and pH was between 8.3 and 9.1. Dissolved oxygen levels remained in excess of 100 % saturation near the surface (9.48 – 10.43 mg/L) and between 41 % and 123 % (3.58 – 10.13 mg/L) near the substrate. Total Phosphorus concentrations were between 16 and 27 ug/L, TKN was approximately the same as June: 0.65 – 0.69 mg/L. Nitrate and ammonia were once again below detection limits. August results were similar, although lower Total Phosphorus levels were reported, ranging from 12-16 ug/L (A. Shulyarenko, personal communications).

Based on the information collected by MOE and other agencies, there is no evidence to suggest that the 2007 carp die-off was directly associated with a water quality impact or pollution incident.

### 4.2 Climatic and Environmental Conditions

Weather data was downloaded from the Environment Canada website. All air temperature and precipitation data is based on data collected at the Peterborough Airport weather station, the closest station to the areas affected by the carp die-off. Water temperature was measured at a number of locations across the Kawartha Lakes using temperature data loggers that record hourly temperatures. These data provide lake-specific information on water temperature in 2007 relative to previous years. Locations sampled include: Bobcaygeon (Pigeon Lake), Gannons Narrows (Pigeon Lake), Gull River, North Bay (Balsam Lake), Otonabee River, Scotsman's Point (Buckhorn Lake), Southview Cottages (Rice Lake) and West Shore Marina (Lake Scugog).

The winter of 2006-07, December in particular, was reported to be warmer than average. When the winter fishing season opened on Lake Scugog, some anglers were able to fish from boats rather than by drilling holes through the ice. Air temperatures in December were higher than normal, with 26 days where the maximum daily temperature exceeded 0ºC, compared to long-term Climate Normals of 15.6 days. Only 3 days had minimum temperatures reported as low as -10ºC, compared to a Climate Normal of nearly 14 days with minimum temperatures equal to -10ºC. As a result ice formed later than usual on area lakes. A longer ice-free period can increase the growing season for aquatic vegetation and increase winter survival of aquatic plants. This may explain observations from residents and resource users of increased aquatic plant growth and densities on area lakes in 2007.

Throughout most of May 2007, the average daily air temperature was comparable to 2005 and 2006 data. Between May 23rd and 25th, air temperatures were more than 5ºC higher than 2005 or 2006 values. Temperatures were also elevated between June 1st and 3rd. Air temperatures in 2007 were lower than 2005 or 2006 on June 5-7, and were generally within the range of temperature values for 2005 and 2006 for the remainder of June. Air temperatures through July were comparable to 2005 and 2006 records.

When compared to historical (1971-2000) data, June 2007 had more days where the maximum temperature exceeded 20ºC and 30ºC than Climate Normals (Table 3). More warm days were also reported in August and September. May and July were both comparable to Climate Normals. Minimum air temperatures were lower in May, 2007 than Climate Normals. In other months, minimum air temperatures matched Climate Normals.

Water temperature typically shows less day-to-day variability than air temperature. In late May, Lake Scugog and Balsam Lake water temperatures were rising quickly, and were higher than values recorded in 2003 and 2004 (but comparable to 2006 – see Figure 2). Following a decline in early June, water temperatures were again higher than those recorded in previous years by mid-June on Lake Scugog, but consistent with recent data on Balsam Lake. For the remainder of the summer, 2007 water temperatures were consistent with those measured in previous years on both waterbodies.

**Table 3: Comparison of 2007 air temperature data (Peterborough Airport Weather Station) to climatic normals (1971-2000)**

| | May | | June | | July | | August | | September | |
|---|---|---|---|---|---|---|---|---|---|---|
| Max Temperatures | 2007 | Average | 2007 | Average | 2007 | Average | 2007 | Average | 2007* | Average |
| <= 0 °C | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| > 0 °C | 31 | 31.0 | 30 | 30.0 | 31 | 31.0 | 31 | 31.0 | 29 | 30.0 |
| > 10 °C | 31 | 29.5 | 30 | 30.0 | 31 | 31.0 | 31 | 31.0 | 29 | 29.7 |
| > 20 °C | 14 | 12.5 | 27 | 23.9 | 28 | 29.7 | 30 | 28.4 | 24 | 14.5 |
| > 30 °C | 1 | 0.4 | 4 | 1.3 | 3 | 3.3 | 6 | 1.9 | 3 | 0.4 |
| > 35 °C | 0 | 0.0 | 0 | 0.0 | 0 | 0.1 | 0 | 0.1 | 0 | 0.0 |

| | May | | June | | July | | August | | September | |
|---|---|---|---|---|---|---|---|---|---|---|
| Min Temperatures | 2007 | Average | 2007 | Average | 2007 | Average | 2007 | Average | 2007* | Average |
| > 0 °C | 23 | 28.2 | 30 | 29.8 | 31 | 31.0 | 31 | 31.0 | 26 | 27.2 |
| <= 2 °C | 15 | 7.1 | 0 | 0.8 | 0 | 0.0 | 0 | 0.2 | 5 | 5.8 |
| <= 0 °C | 8 | 2.8 | 0 | 0.2 | 0 | 0.0 | 0 | 0.0 | 2 | 2.8 |
| < -2 °C | 2 | 0.4 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.9 |
| < -10 °C | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| < -20 °C | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| < - 30 °C | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |

* value missing for September 27, 2007

Figure 3 shows environmental and water temperature data in the weeks preceding the initial detection of sick carp in Lake Scugog (June 3). Water temperature data is based on temperatures taken at West Shore Marina on Lake Scugog. Air temperature data is from the weather station at the Peterborough Airport. Just over 1 week prior to the initial

fish kill, a dramatic change in air temperature occurred. Just prior to the observations of sick carp, the maximum daily air temperature was gradually decreasing from 30ºC to 27ºC, with a moderate increase in water temperature to approximately 19-20ºC. Precipitation events occurred on May 27th (8.5 mm), May 31 (5.5 mm) and June 1 (1.5 mm). Water temperatures increased during the week prior to the detection of dead carp from approximately 18ºCto 23ºC.

Figure 4 shows environmental and water temperature data in the weeks preceding the initial detection of sick carp in Sturgeon Lake (June 21). In the ten days prior to the detection, a moderate increase in water temperature from 22ºC to just over 24ºC occurred. Maximum air temperature was generally declining from approximately 27-28ºC to 20-22ºC. The largest precipitation event occurred on June 19 (15.5 mm). Water temperature was stable or slightly declining (from 24 to 22ºC) prior to the initial detection of dead carp on Sturgeon Lake.

Figure 5 shows climate and water temperature data in the weeks proceeding the initial detection of sick carp in Pigeon and Cameron Lakes (July 3), with water temperature data from a data logger located near Bobcaygeon (Pigeon Lake). Following an increase in maximum daily air temperature to greater than 30ºC in late June, maximum daily temperature decreased to less than 25ºC in the days immediately prior to the die-off. Water temperature increased to a maximum of nearly 25ºC on June 27th, and declined to 22ºC at the time of first detection. Very little precipitation occurred during this time period.

Figure 6 shows climate and water temperature data in the weeks preceding the initial detection of sick carp in Balsam Lake (July 17). Between July 9th and 14th, daily maximum air temperatures declined from greater than 30ºC to less than 20ºC, while water temperatures remained relatively stable between 22 and 23ºC. In the three days prior to the detection of dead carp, air temperatures increased to 26ºC. There was very little precipitation prior to the die-off.

The timing of the initial detection of dead or dying carp on area waterbodies does not appear to correspond with a consistent weather pattern for the area (Table 4). Initial detections were often associated with changes in air and water temperatures, although the degree and direction of change may have differed. Both increases and decreases in temperature can act as a stressor to fish, and may have contributed to the susceptibility of carp populations. From the end of May through the remainder of the summer water temperatures exceeded 18ºC, providing a suitable environment for the growth of microbes.

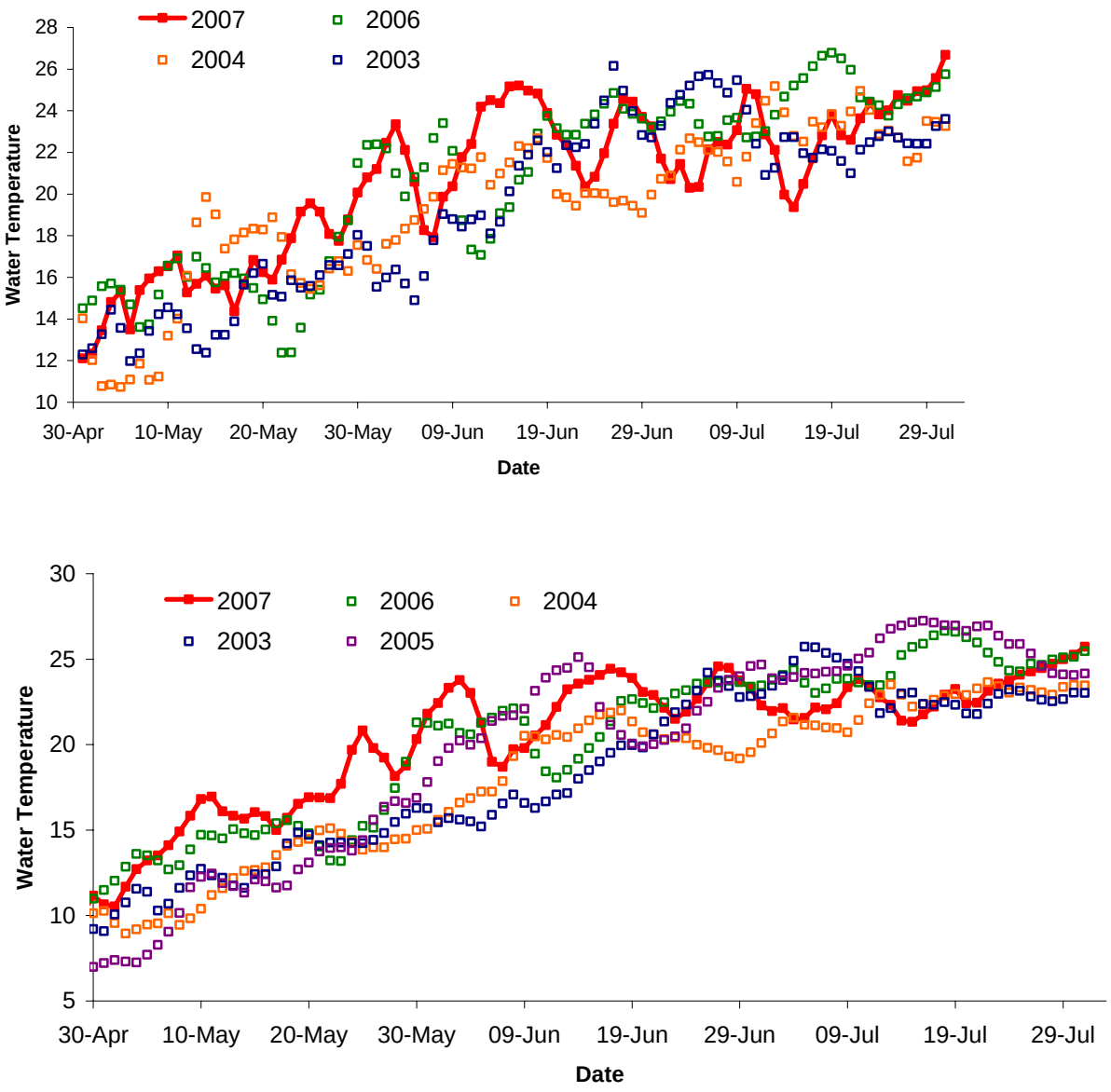


**Figure 2: Average daily water temperature (degrees Celsius) data for the months of May, June and July from the Lake Scugog (upper graph) and Balsam Lake (lower graph) for 2003-2007. Data points represent the daily average of temperature taken at hourly intervals.**

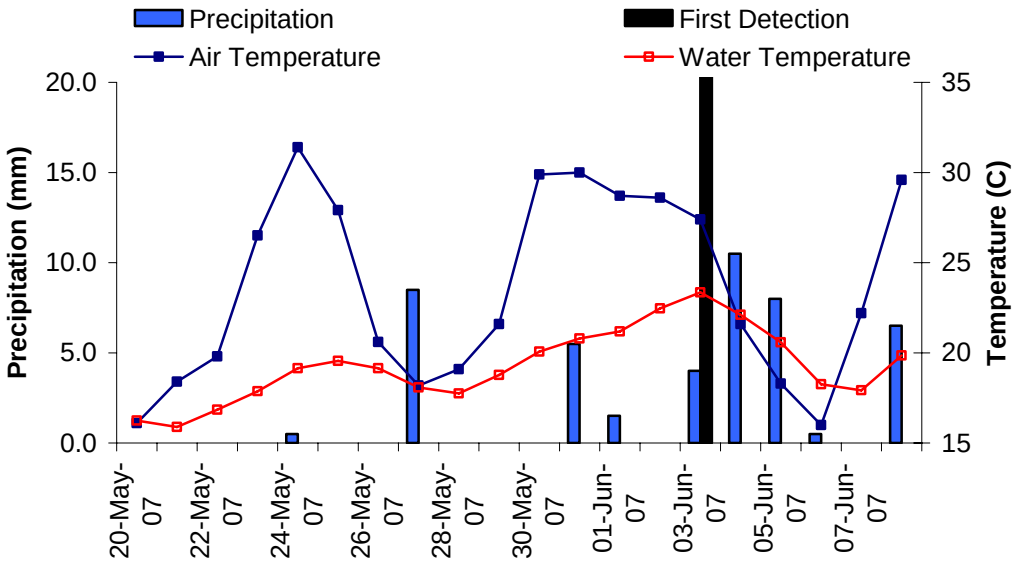


**Figure 3: Environmental conditions in advance of the initial detection of dead carp in Lake Scugog. Water temperature is the daily average (degrees Celsius) of hourly recordings taken from West Shore Marina. Air temperatures and precipitation are based on the data from the weather station at the Peterborough Airport. The black bar indicates the date that dead carp were first observed (June 3rd, 2007).**

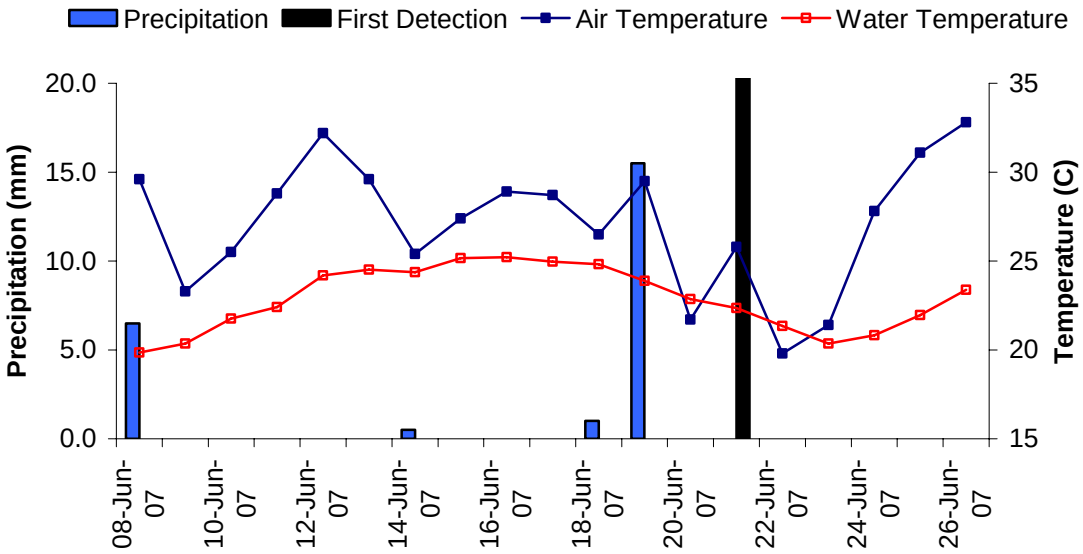


**Figure 4: Environmental conditions in advance of the initial detection of dead carp in Sturgeon Lake. Water temperature is the daily average (degrees Celsius) of hourly recordings taken from West Shore Marina (Lake Scugog). Air temperatures and precipitation are based on the data from the weather station at the Peterborough Airport. The black bar indicates the date that dead carp were first observed (June 21st, 2007).**

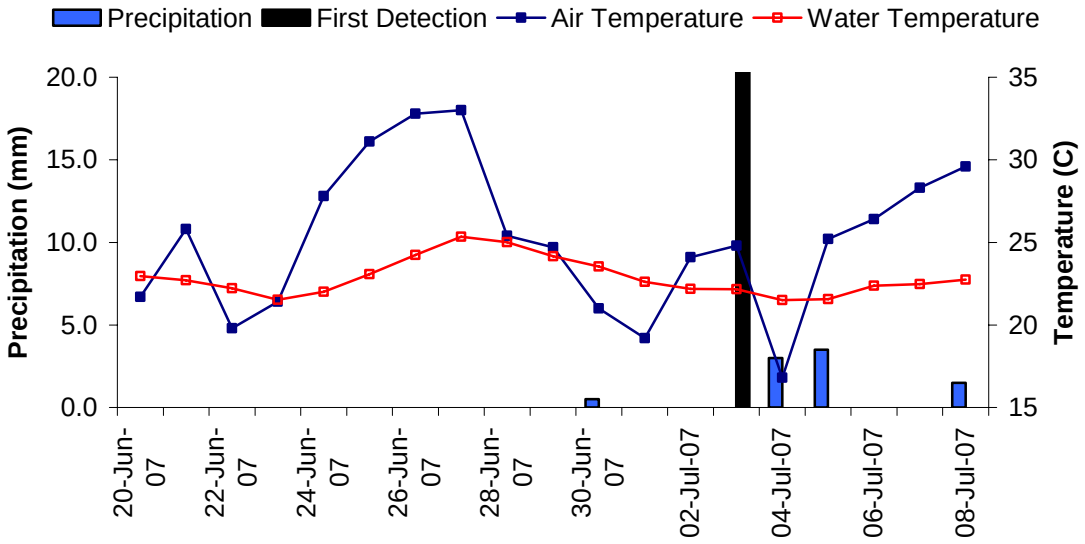


**Figure 5: Environmental conditions in advance of the initial detection of dead carp in Pigeon and Cameron Lakes. Water temperature is the daily average (degrees Celsius) of hourly recordings taken from Bobcaygeon (Pigeon Lake). Air temperatures and precipitation are based on the data from the weather station at the Peterborough Airport. The black bar indicates the date that dead carp were first observed (July 3rd, 2007).**

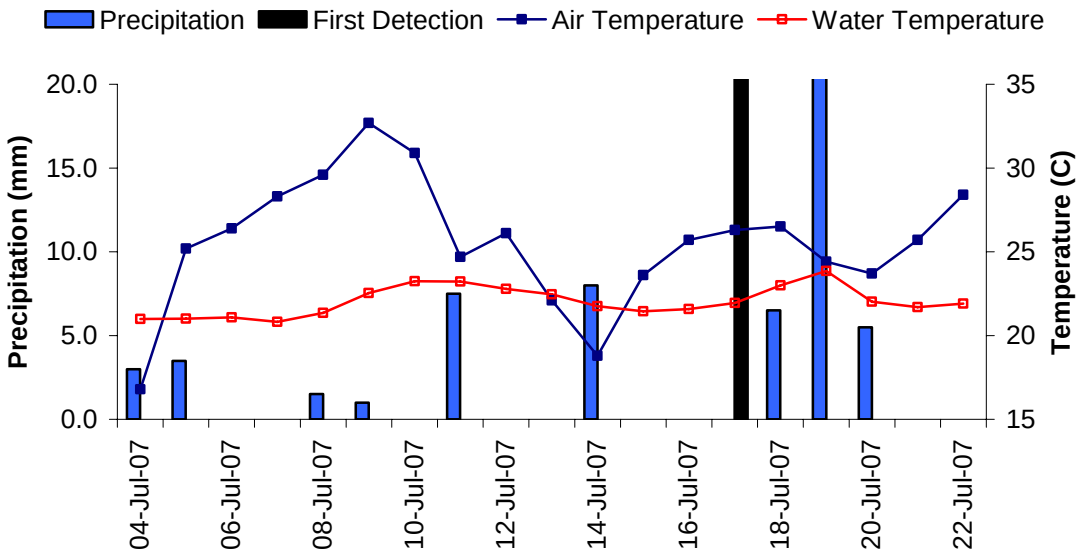


**Figure 6: Environmental conditions in advance of the initial detection of dead carp in Balsam Lake. Water temperature is the daily average of hourly recordings taken from North Bay of Balsam Lake. Air temperatures and precipitation are based on the data from the weather station at the Peterborough Airport. The black bar indicates the date that dead carp were first observed (July 3rd, 2007).**

**Table 4 - Summary of weather characteristics associated with outbreaks on various waterbodies**

| Lake | Date of Detection of Sick Carp | Air Temperature in days prior | Water Temperature in days prior | Precipitation |
|---|---|---|---|---|
| Scugog | June 3 | Decreasing from 30-27ºC | Increasing trend, to 23ºC | Moderate in weeks prior (events of 5-10 mm) |
| Sturgeon | June 21 | Decrease from 27-28 to 20-22ºC | Moderate decline to 24ºC | 1 major event prior (15.5 mm) |
| Pigeon and Cameron | July 3 | Decrease from 30 to 25ºC | Decreasing trend to 20ºC | No rain events |
| Balsam | July 17 | Increasing to 25-26ºC after a dramatic decrease | Stable between 22 and 23ºC | Moderate in weeks prior (events of 5-10 mm) |

### 4.3 Fish Health Testing Procedures and Results

Determining the cause of a fish die-off is often extremely difficult. Fish are resistant to many diseases, however, when fish are under stress (from spawning, rapidly changing water conditions, crowding, etc.) fish may not be able to fight off an illness.

There are several challenges faced when trying to determine what pathogen (a pathogen could be a bacterium, parasite or virus) has killed a fish and these include:

- Fish sick with a variety of different diseases often show the same, or similar, signs of illness,
- By the time people see a sick fish, that particular fish is very sick and may actually be sick with more than one pathogen because opportunistic pathogens will invade weakened fish,
- Since a fish cannot tell us what symptoms they have or what diseases they have been exposed to, we must rely on the process of elimination in the laboratory to determine what might have caused the fish to get sick and/or die, and
- When a fish dies, opportunistic pathogens invade fish almost immediately, and can mask the initial cause of the illness.

When fish are collected, and ideally collections are made of sick and dying fish rather than dead fish, fish are immediately placed fresh on ice and sent to the lab for immediate examination and testing. Once at the lab, each fish is externally examined (skin, fins, gills, etc) before being cut open. The fish is examined for parasites, both with the naked eye and using a microscope, and a variety of fish tissues such as the kidney, heart, liver, spleen, or gill are sampled.

Attempts are made by qualified laboratory staff to isolate potential pathogens using standardized test methods and highly specialized equipment. If a lot of one particular

pathogen is present in the fish, and grows in the lab, then it was highly likely to have contributed to making the fish sick.

Growing pathogens in the lab takes time. Some bacteria grow very rapidly within a few days however viruses take longer and often require two growing periods, each taking 21 days. Viruses are more difficult to work with in the laboratory because they grow inside of cells and are prone to mutating making identification challenging. For viruses never before observed in Ontario, a further period of time (usually several weeks) is required to send the virus sample to a federal government laboratory for confirmation.

In addition, 20 healthy bluegill were collected on Chemung Lake, at the same time as a mortality event was occurring in June 2007, and sent to the lab for testing. There were no unexpected high concentrations of pathogens found in these fish.

A total of 17 sick or dead carp were collected and sent for testing at the University of Guelph, however not all of these fish were in a condition that was good enough for laboratory testing to proceed. Some fish had been dead for more than 24 hours and several fish had been frozen. The fish were collected from Lake Scugog, Scugog River, Sturgeon Lake, Pigeon Lake, Buckhorn Lake and Sandy Lake. Testing was not done on fish in advanced states of decay where the expectations of successful recovery of pathogens were very low.

The bacterium *Flavobacterium columnare* was the first confirmed pathogen found in carp sent to the laboratory for testing. High levels of *F. columnare* bacteria were found in carp from Sturgeon and Pigeon Lakes. This bacterium is commonly present in the environment where it is found naturally in water and mud and causes a disease in fish called columnaris. Environmental conditions during the summer of 2007 were conducive to growth of *F. columnare.*

A virus was suspected by the Fish Health Laboratory and initially found by the Fish Pathology Laboratory at the University of Guelph. The Canadian Food Inspection Agency's Aquatic Animal Health Division was notified and following confirmatory testing by Fisheries and Oceans Canada laboratories, two of the carp submitted were found to have Koi Herpesvirus (KHV). One fish was collected from Lake Scugog and the other was from Pigeon Lake.

This is the first detection of the virus in Ontario and as such required additional testing and confirmation with a federal laboratory.

To what extent environmental conditions, spawning, columnaris and KHV were factors in the mortalities of the carp cannot be ascertained. As stated above, when fish are under stress, they may not be able to fight off diseases. The test results were not sufficient or definitive enough to determine whether the virus or the bacteria was the cause of all the carp mortalities in 2007. Therefore, further testing will be conducted in 2008 as needed, particularly if there are carp mortalities in the Kawartha Lakes.

### 4.3.1 Columnaris

Columnaris is a fish disease caused by *F. columnare*. This bacterium is naturally occurring and commonly found in freshwater lakes and rivers. Columnaris infections are commonly associated with exposure to biological or environmental stressors such as water temperature greater than 20ºC, high fish densities and poor water quality (Tripathi

et al. 2003). The transmission of *F. columnare* to gill tissue is accelerated by high nitrite concentrations (greater than 5mg/L), high organic content (greater than 2mg/L), high water temperatures (greater than 28ºC), and rapid changes in water temperature of 5ºC or greater. Heavily infected fish may die within 24 hours; however fish with infections of *F. columnare* on the skin may take longer to show signs of disease (two to seven days) (Tripathi et al. 2003). Fish with columnaris disease usually display signs on their gills and body surface.

Common external signs of columnaris include sores on the gills and body that are white to brown, greyish-white or orange-yellow in colour. These sores may occur on the fins, head and body that eventually increase in size and may expose the underlying muscle. Signs consistent with those listed above were observed on a number of carp (dead and alive) in the Kawartha Lakes in 2007. Once established, the infection can spread quickly and cause high mortality rates.

Columnaris has been associated with large scale fish die-offs in the past. In 2006, between 2000 and 4000 channel catfish died over a two week period in a 160km section of the Ottawa River. This event was linked to high temperatures, torrential rains and extreme runoff events in late July and early August of 2006. These factors combined to create an environment that was particularly stressful for juvenile channel catfish and allowed the columnaris bacteria to spread quickly (Punt and Castro, 2006).

A large-scale die-off of carp occurred in 2001 on the St. Lawrence River. Investigations determined that the ultimate causes of the die-off were opportunistic bacterial infections with *Aeromonas hydrophila* and *Flavobacterium* sp. in fish with suppressed immune systems that resulted from a combination of biological (i.e., spawning) and environmental (i.e., high temperatures and low water levels) stressors, and possibly enhanced by an infection causing lymphocytic encephalitis observed in 50% of the 18 fish examined. (Monette et al., 2006)

### 4.3.2 Koi Herpesvirus

Koi Herpesvirus (KHV) is a fish disease caused by a virus. This disease only affects carp, goldfish and koi. KHV is not known to be a human health risk. Fish become infected with the virus as it is passed from fish to fish when they are in close physical contact. This virus does live in fish and can live in water for short periods of time, possibly for at least four hours, but probably for less than a day. The virus is thought to survive in the mud bottoms of lakes and rivers however it does require a fish host for it to survive for an extended period of time. Fish that have become infected with KHV may survive a disease outbreak and become carriers of the virus, passing the virus to other fish.

Common external signs of KHV may include patches of discolouration on skin; swollen, pale or rotting gills, appetite loss and erratic swimming just before death, excess mucus during the early stages of disease or loss of mucus in the latter stages of an outbreak of disease. Fish may also have sunken eyes and a notch on the nose. Many of these signs of disease are common to other fish disease and therefore, KHV can only be diagnosed in a laboratory.

The patches of discolouration on the skin are signs common to both KHV and columnaris and were seen on carp collected in the Kawartha Lakes. The carp collected were not observed to have either sunken eyes or a notch on the nose typical of KHV.

Disease outbreaks associated with KHV typically occur when water temperatures are between 18 to 28°C. Although temperature is often a key factor in a disease outbreak another contributing factor is spawning stress. Outbreaks of KHV in the wild are almost impossible to prevent or treat.

KHV was identified for the first time in 1998 and is believed to be moved throughout the world via the ornamental fish industry. The virus was first found in the United States in 1999 and has been associated with large scale fish die-offs in New York State. This virus has not previously been found in Ontario. It is not known how or when KHV arrived in Ontario waters.

# 5.0 Biology and Ecology of Fish

## 5.1 Bass and Sunfishes

Bass and sunfish species, collectively known as Centrarchids, are all species in which the adult males provide a significant amount of parental care through the construction of a nest, guarding eggs and fry. Some species, such as bluegill, pumpkinseed, crappies, rock bass, and largemouth bass build these nests in shallow water, often less than 1m deep. Often, these nests are located in shallow, heavily vegetated bays. Providing this level of parental care often takes a significant physiological toll on the male, as foraging opportunities are limited for a number of weeks. Hinch and Collins (1991) estimated that the metabolic rate of nest guarding smallmouth bass was 60% higher than non-nesting bass. The nesting locations also expose the fish to environmental stressors including changing water temperatures and potential decreases in dissolved oxygen due to the decomposition of aquatic vegetation or other organic materials at the bottom of the lake. These stressors may increase the susceptibility of these species to a number of pathogens. The combination of these or other stressors is believed to account for the majority of early summer fish kills involving Centrarchids.

## 5.2 Carp

Carp are a species that is not native to North America, but were introduced in the 1800s as a desired food fish. The introduction into Ontario waters is believed to be the result of an accidental introduction in the 1890s when a dam dear Newmarket Ontario burst.

MNR has not developed an index netting program to determine population abundance for carp. The species is not vulnerable to some of the netting gears due to their large size, and behaviourally carp are not often caught in trap nets in the late summer or fall. Spring catches are too variable to derive any reasonable abundance estimates. Incidental catches of carp in trap netting programs may provide a measure of relative abundance, but would not provide a reliable estimate of population size.

Carp are a prolific and fast growing species. Females mature as early as 4-5 years, males mature earlier, typically by age 3-4. Females produce a large number of eggs; a 10kg female may hold more than 2,000,000 eggs. Spawning occurs in late May or early June,

but spawning may continue throughout the summer in some years if environmental conditions permit. Young are fast growing and may reach up to 8 inches in length by the end of their first year. Carp are generally able to tolerate poor environmental conditions including low oxygen and high temperatures. They are omnivorous, feeding on plant material as well as aquatic insects, crustaceans, annelids, and molluscs (Scott and Crossman, 1998).

Many of these features may make carp susceptible to a columnaris outbreak. Columnaris is believed to reside in the substrate, and the feeding behaviour of carp may increase the likelihood of exposure. The direct contact of fish during spawning may also facilitate the spread of an infection, as the bacteria are likely present on the body of infected fishes.

Although a large number of carp were killed during the summer of 2007, healthy carp were still present in the area lakes, and the prolific nature of the species should allow for a quick recovery of the population. Area lakes still provide optimal habitats for carp. Fall Near Shore Community Index Netting (NSCIN) surveys on Lake Scugog actually had a higher catch per unit effort for carp in 2007 (0.53 carp per trap net) than either 2006 (0.28 carp per trap net) or 2003 (0.42 carp per trap net) surveys. Carp are neither a critical forage nor predator species, thus impacts to the ecosystem are expected to be minor. The most probable competitors with carp include native cyprinids, suckers, and brown bullheads. These species may benefit from an increase in available niche space.

## 6.0 Next Steps

The MNR has developed a Fish Die-off Response Protocol with the support of our agency partners to establish the roles and responsibilities of each agency should a fish die-off occur in the future.

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## Personal Communications

G. Cimbura is a Senior Fisheries Technician with the MNR Kawartha Lakes Fisheries Assessment Unit. The KLFAU completed numerous index netting surveys on area lakes in 2007, as well as a creel census on Lake Scugog.

D. Flowers is a Fisheries Extension Biologist with the MNR Bancroft District office and completed a field inspection on the Burnt River in response to public concerns about dead carp on the river.

A. Shulyarenko is a Water Quality Specialist with Kawartha Conservation, and has overseen water quality monitoring on Lake Scugog in 2006 and 2007 as a component of the development of the Lake Scugog Environmental Management Plan.