Regional Watershed Monitoring Program
Progress Report 2011

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Watershed Monitoring and Reporting Section
Ecology Division

TORONTO AND REGION Conservation for The Living City

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Report prepared by: Watershed Monitoring and Reporting Section
Reviewed by: Scott Jarvie, Manager, Watershed Monitoring and Reporting Section

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1 Introduction

Healthy Rivers and Shorelines and *Regional Biodiversity* are key elements of the Toronto and Region Conservation Authority's strategic business plan. The ability to track and report on changes to these elements is vital to the success of an organization that is responsible for watershed planning, management and reporting in the greater Toronto region.

The Regional Watershed Monitoring Program (RWMP) is a science based, long-term monitoring initiative developed by the Toronto and Region Conservation Authority (TRCA). Its purpose is to collect aquatic and terrestrial ecosystem data at the watershed and sub-watershed scale, and across the region as a whole. The program provides the data and information that informs the key planning and reporting mechanisms of the TRCA. Since its inception in 2001, the program has enhanced the planning and coordination of monitoring activities, helped standardize protocols, and has filled several key data gaps that have been identified. It also facilitates the communication of data availability and data sharing both internally and with external agencies.

The scope of the RWMP focuses on key components of the terrestrial and aquatic ecosystems, including:

- ***Stream Water Quality*** - assesses a variety of basic and enhanced water chemistry;
- ***Stream Water Quantity*** - stream gauges and in-stream measurements monitor changes in the water levels of the region's watercourses;
- ***Aquatic Habitat and Species*** - including aquatic insects, fish populations, algae, stream temperature and the physical shape of the stream;
- ***Terrestrial Habitat and Species*** - staff and trained volunteers monitor flora and fauna species and communities through biological inventories and fixed plots;
- ***Meteorology*** - assesses the contribution of rain and snow to the hydrology of the region; and,
- ***Groundwater Quantity and Quality*** - assessed at a series of wells throughout the region.

The data collected are shared with partner municipalities and other agencies, and are used for planning, implementation and reporting purposes. Partnerships with academic institutions facilitate achievement of common research objectives as well as data sharing in support of academic study. All elements of the program are designed to provide data sets that allow for interpretation at the watershed and regional scales. In certain circumstances data can be assessed at the site scale and can be used as a "flag" to identify potential issues or direct additional assessment. Where restoration and recovery plans are implemented, future monitoring will track the progress of such enhancement initiatives.

All program elements are strongly focused on the collection of scientific data. When possible, community outreach and education are incorporated. This is accomplished through the involvement of trained volunteers (e.g. Terrestrial Volunteer Monitoring Program), through partnerships with community groups and other non-governmental organizations, and through special events that demonstrate to or involve the community.

In addition to regional monitoring, numerous special projects are undertaken annually by TRCA in order to address research questions related to restoration and mitigation techniques and to provide valuable baseline information on watershed condition. Where possible the monitoring for these special projects follows the same sampling methodology and protocols as the RWMP. This consistency in methodology increases efficiency and provides continuity in the data, allowing the data to be easily compared to RWMP monitoring sites.

This report is designed to provide an overview of each component of the monitoring program, identify the types of data available, and to provide highlights from both the 2011 season. This information will be used to promote and facilitate additional opportunities for data sharing and collaboration based on this body of work. Due to differences in the timelines and types of analysis, data interpretation and reporting is at varied stages of availability. A detailed list of the various reports and other products that have been developed through this program is provided in section 14 of this report. Since the program is multifaceted, a staff directory with contact information for the various staff involved is also provided to facilitate additional follow-up if necessary.

2 Terrestrial Habitat and Species

Staff Lead: Sue Hayes

Support Staff: Gavin Miller, Paul Prior, Kelly Purves, Natasha Gonsalves, Michael King, Allison Scovil, Derek Tune, Priscilla Lai, Rivka Shachak and Natalie Racette

Funding: City of Toronto, Peel Region, Durham Region, York Region and Toronto Remedial Action Plan

2.1 Background

The Terrestrial Natural Heritage component of the RWMP was established in 2000 and builds on data collected over the preceding 15 years under the Environmentally Significant Areas (ESA) work. The core focus of this component to date has been systematic inventories of habitats and species throughout the region. This data informs watershed planning and reporting, land management planning, remedial action planning (RAP), and provides information to partner municipalities and other agencies. Terrestrial data has been key to the development and testing of terrestrial ecosystem modelling and the development of the Terrestrial Natural Heritage System Strategy (TRCA 2007a). Annual data analysis provides for maintenance of the regional species and vegetation communities of conservation concern ranking to inform conservation, recovery and site restoration planning activities. In 2008, Toronto and Region Conservation Authority (TRCA) implemented terrestrial monitoring at a number of fixed plots throughout the Toronto region. This new component of the program will identify species and vegetation community trends that are occurring across the jurisdiction over time.

2.2 Methods

The terrestrial areas surveyed in 2011 are identified in **Figure 4.** Seventeen biological inventory sites that covered approximately 1300 hectares were inventoried for vegetation community, flora and fauna species. In addition, breeding bird surveys were updated at three inventory sites and two Natural Channel Design (NCD) sites covering approximately 300 hectares of land. Road kill amphibian surveys were also conducted along several sections of road in Peel Region. As part of the regional fixed monitoring plots, data was collected at 24 forest vegetation, 29 forest bird, 24 red-back salamander, 20 wetland vegetation, 22 wetland bird, 20 amphibian and 16 meadow bird plots distributed across the TRCA jurisdiction. Long-term fixed monitoring plots for project sites such as Caledon East, Ontario Power Generation and Duffin Heights were also monitored.

Terrestrial Inventories

A biological inventory of each of the 17 sites was conducted at the levels of vegetation community and species (flora and fauna) according to the TRCA data collection methodology (TRCA 2007b).

Vegetation community designations were based on the Ecological Land Classification (ELC) and determined to the level of vegetation type (Lee *et al.* 1998). Community boundaries were outlined onto printouts of 2007/2008 digital ortho-rectified photographs (ortho-photos) to a scale of 1:2000 and then digitized in ArcView. Flora and fauna species of concern were mapped as point data with approximate number of individuals seen. The methodology for identifying confirmed and possible breeding birds follows Cadman *et al.* (1987).

Sites for inventories are prioritized based on an identified need, such as imminent or recent local development or land management planning requests. Data are processed and stored in the main TRCA master ArcMap files.

Natural Channel Design (NCD)

The Natural Channel Design study is intended to measure the effectiveness of different stream construction techniques. The NCD sites are inventoried for all fauna (breeding birds and amphibians) and flora species found throughout the site along with vegetation community mapping based on the ELC. In addition, invasive non-native flora species are mapped. Two NCD sites were re-surveyed for breeding fauna (breeding birds and amphibians) in 2011. Please refer to the Natural Channel Design Terrestrial Monitoring Methodology for more information (TRCA 2009).

Fixed-plot Monitoring

Fixed-plots were set-up in forest, wetland and meadow habitats. Forest plots were set-up to document changes in tree health, ground vegetation, tree regeneration and shrubs, breeding birds and red-backed salamanders. The vegetation and red-backed salamander monitoring follows protocols outlined by the Ecological Monitoring and Assessment Network (EMAN)(Roberts-Pichette and Gillespie 1999; Zorn *et al*. 2004) and breeding birds follow the Forest Bird Monitoring Protocol (FBMP) (Cadman *et al.* 1998). Wetland plots and stations are designed to capture changes in aquatic vegetation, breeding birds, frogs and toads. Wetland bird, frog and toad monitoring protocols follow the Marsh Monitoring Program (MMP)(Bird Studies Canada 2008). Meadow plots were set-up to monitor meadow bird communities.

2.3 Data

Data are processed and stored in TRCA ArcMap digital layers. Digitized ELC data are stored as polygons while the flora and fauna data are stored as points along with the associated attributes. The data are available to internal and external clients as shape files or hardcopy maps. Full inventory data collection under the current protocol began in 2001; however, data exists in digital format from 1996 onwards.

At the regional scale, terrestrial data continues to inform initiatives such as species and vegetation community recovery planning and implementation of the Terrestrial Natural Heritage System Strategy. At the site scale, the data is often used for TRCA projects such as management plans and trail planning for TRCA property.

Externally, data is shared with other organizations to support initiatives such as wetland and Area of Natural & Scientific Interest (ANSI) evaluations, the update of the ELC system by the Ministry of Natural Resources, and input into land use planning. Collaboration on inventory and monitoring is occurring with neighbouring Conservation Authorities, especially Credit Valley Conservation (CVC).

2.4 2011 Highlights

The 2011 field season was split between collecting plot data at the long-term fixed monitoring sites and conducting issue based site inventories.

Following are some of the highlights from the issue based site inventories and fixed plot monitoring:

- Hundreds of active bank swallow (*Riparia riparia*) cavities were observed along the Scarborough Bluffs (**Figure 1**) during breeding bird surveys. This constitutes a fairly significant proportion of the regional population of this rapidly declining species. This species belongs to the aerial insectivore group of birds and collectively are facing declines in southern Ontario to the point that some species have now been listed as Species at Risk.

Figure 1: Bank swallow (RIparia riparia) colony along Scarborough Shoreline.

- Small populations of wild crab apple (*Malus coronaria*) were found at one of the biological inventory sites located at Hwy #7 and Islington Avenue. This species has only been found in one other area in the TRCA jurisdiction and is considered to be a species of regional conservation concern with an L-rank of L2. The Hwy #7 and Islington Avenue site supported several other flora species of conservation concern such as bottle gentian (*Gentiana andrewsii*) and moonseed (*Menispermum canadense*). In addition, this site also still supports wood frog (*Lithobates sylvaticus*) which is a species that is sensitive to development and is generally not found in urban areas.

- A territorial American bittern (*Botaurus lentiginosus)* was documented on one of the fixed plot monitoring stations in Peel Region during the breeding bird season. This represents only the third breeding record for this species in close to 15 years of conducting breeding bird surveys in the TRCA jurisdiction. Its nesting habitat opportunities are limited throughout many parts of Ontario as it requires large wetlands to fulfill its breeding habitat requirements.

- Three regional flora species of conservation concern (ranked L1) were found on the Brock Lands. All three species are regionally rare and are associated with fen habitats: Alpine cotton-grass (*Trichophorum alpinum* (**Figure 2**)*,* white beak-rush (*Rhynchospora alba*), and twig-rush (*Cladium mariscoides*). The Alpine cotton-grass, which has a more northern affinity, was the first documented record for the TRCA jurisdiction.

Figure 2: Alpine cotton-grass (*Trichophorum alpinum*).

- The impact of roads on many fauna species is a serious threat to their populations (and therefore to biodiversity in general) in the TRCA jurisdiction. Unfortunately, the sight of road-kill is a common event. This past year one of the three resident river otters (*Lutra canadensis*) that have been seen in a wetland North of Finch Avenue and west of the Pickering Townline, was found dead on the Pickering Townline. In addition, one block away on Altona Road a fisher (*Martes pennanti*) was found dead. This was only the 2nd record for this species in the TRCA jurisdiction in recent years.

- Two new native flora species for the TRCA jurisdiction were identified at Seneca College King Campus during the terrestrial natural heritage inventories – Sartwell's sedge (*Carex sartwellii*) and southern naiad (*Najas guadalupensis* var. *olivacea*)*.* The Sartwell's sedge is a species of high-quality marshes with its range mostly to the west of the TRCA jurisdiction. The southern naiad is a submersed aquatic plant with more southern affinities.

- The analysis on the three years of data collected for the long-term monitoring plots has revealed some interesting baseline conditions from which future monitoring will be compared against. The number of snag (standing dead) trees present in our forests is well below the threshold of what is typically found in healthy forests (**Figure 3**). This will have impacts on the ecological processes within the forests as well as various wildlife species that depend on these trees for various life stage requirements.

Figure 3: Standing (partially) dead tree.

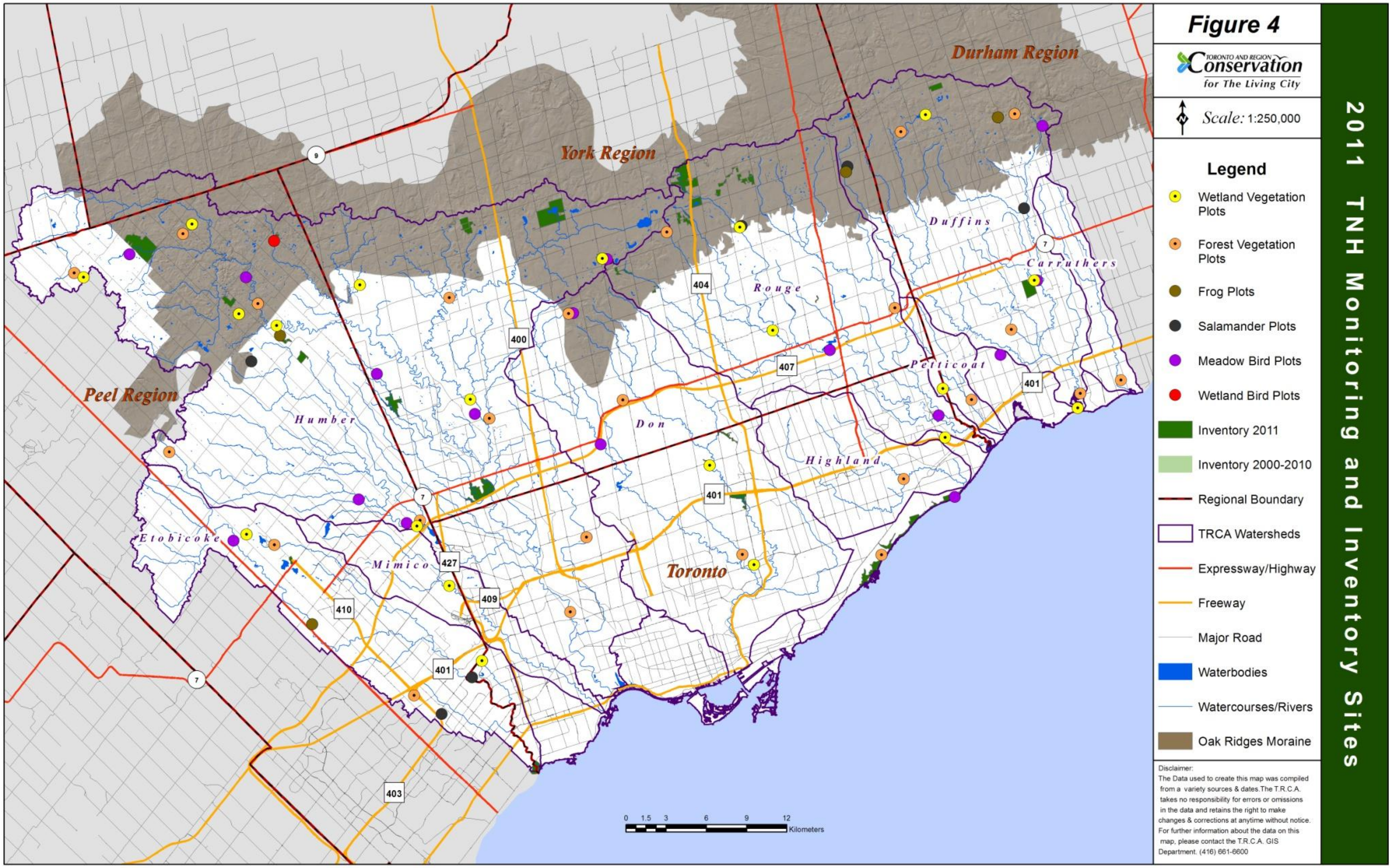

Figure 4: Terrestrial natural heritage monitoring and inventory sites.

3 Terrestrial Volunteer Monitoring Program

Staff Lead: Theresa McKenzie

Support Staff: Team of volunteers (156 participants during 2011)

Funding: City of Toronto, Peel Region, Durham Region and York Region

3.1 Background

The Terrestrial Volunteer Monitoring Program (TVMP), in operation since 2002, uses trained volunteers to survey 10 hectare fixed sites distributed throughout the region (**Figure 6**). Volunteers collect data on the presence of a set of 50 native amphibian, mammal, bird, vascular plant and lichen indicator species. Beginning in 2009, they also conduct two surveys each year to determine the extent of invasion of each site by eight invasive exotic plants. Data are analyzed by TRCA to report on the condition of the terrestrial ecosystem and major habitats of the region, document differences between urbanization zones and to monitor change over time.

3.2 Methods

Volunteers, working in pairs, survey their assigned 10 hectare fixed site 10 times each year, with visits distributed throughout all four seasons. Each of the visits is conducted within a specific date range and time of day, as established in the monitoring protocol. Visual and/or aural observations of indicator species (**Figure 5**) are recorded on a standardized data sheet, along with date, times and environmental data. Confirmation of species identification requires individual verification of two to three observation characteristics. Training is required for all participants, and a manual, field guide, and visual/audio aids are provided. Volunteers are asked to commit to the program for a minimum of three years.

Figure 5: Green Heron (*Butorides virescens*), one of 50 native indicator species.

3.3 Data

Data are recorded on paper data sheets in the field, then entered into an online MS Access database through a data entry website. They are managed, quality assured, analyzed and reported on by TRCA staff. For each fixed site, data records include the native indicator species found by visit date, the number of occurrences and size of the largest occurrence for the invasive indicator plants, and the presence or absence of categorized cultural impacts such as tree harvesting, trails, litter, and dog-walking. Data are analyzed in multiple ways in order to report on ecosystem condition in the region and to support land and watershed management decision making by TRCA, municipalities and other land owners or land managers. As an example, TVMP data have recently been used to investigate relationships between landscape characteristics from other TRCA data sets and the observed indicator species richness, species richness of selected taxa and of selected habitat guild groups (TRCA 2008). Available data include the native indicator species found at sites across the region 2003 - 2011, native indicator species richness by site and urbanization zone by reporting period (TRCA 2008), as well as the severity of invasion by individual invasive indicator species and the overall invasive species complement by site.

3.4 2011 Highlights

- 432 survey visits were completed across 55 sites. Site coverage was good, although 20 sites turned over to new volunteer pairs this year.

- monitoring results relative to forests in the region were presented at the Ontario Forest Association conference in February 2011.

- the value of incorporating TRCA's local rank of conservation concern for indicator species (L rank) into metrics for native species richness, and a method for doing so, were presented to the Southern Ontario Conservation Authorities Terrestrial Monitoring Network at their April meeting.

- 2011 completes the third year of data collection for invasive plant indicator species at TVM sites; this dataset will be analyzed during 2012 to investigate regional patterns in severity of invasion by individual species, the degree of overall invasion at TVM sites, explore differences by urbanization zone, and with relationships with native indicator species.

- an extensive literature review conducted during 2011 was unable to discover any other long-term monitoring programs that have published results from the systematic monitoring of invasive plants; TRCA's program appears to be a leader in invasive plant monitoring.

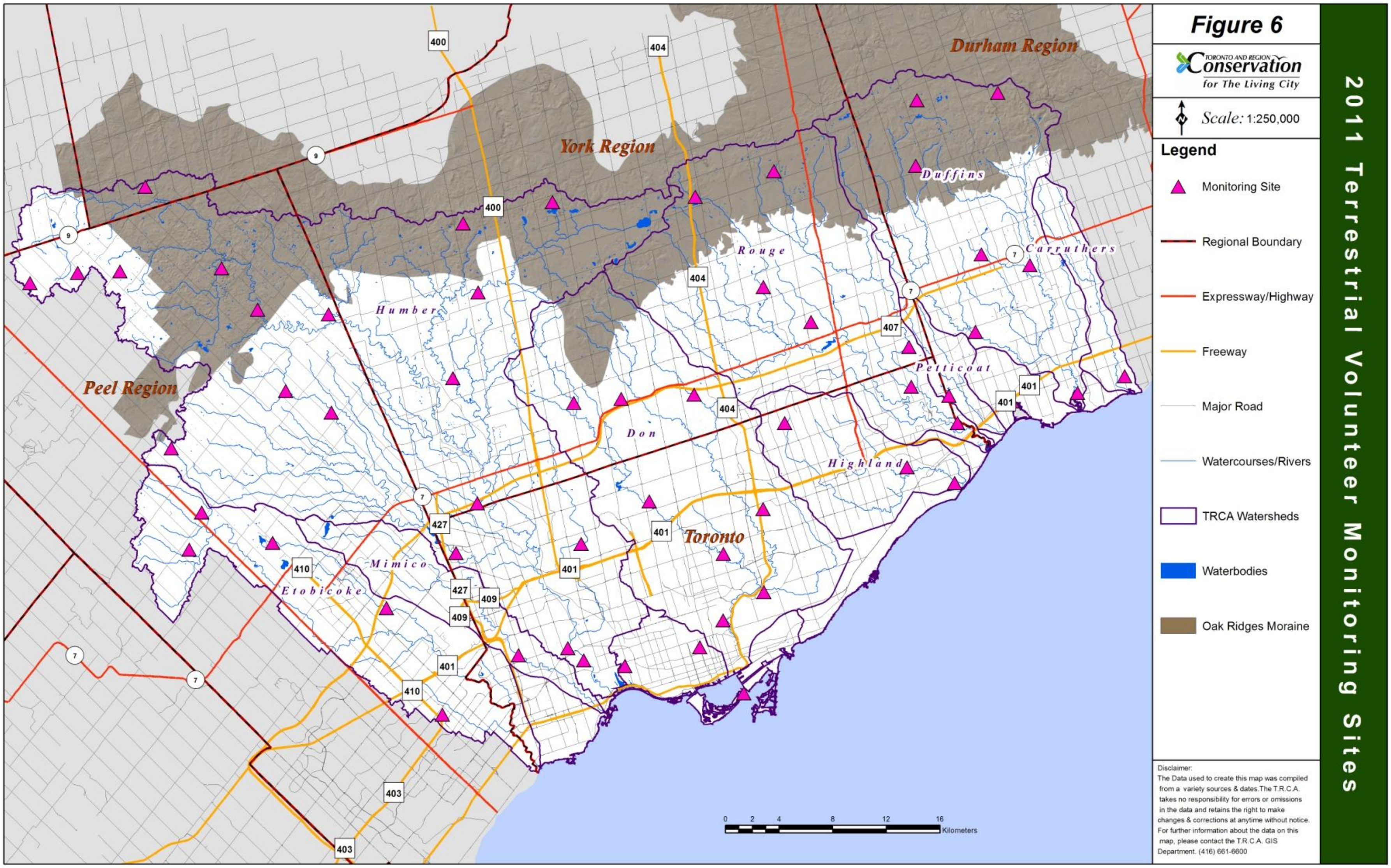

Figure 6: Terrestrial volunteer monitoring sites.

4 Fish Community and Habitat Surveys

Staff Lead: Jeff Vandenberg, Melanie Croft-White, Jan Moryk,

Support Staff: Nelson Amaral, Mike Brestansky, Ellen Fanning, Mark Szonda, Bruna Peloso, Danielle Gustaw, Matt Wilson, Tyson Reid, Claire Crowley, Andrew Nelson, Sarah Irvine

Funding: City of Toronto, Peel Region, Durham Region, York Region and Toronto Remedial Action Plan

4.1 Background

The aquatic habitat and species component of the RWMP includes fish community and habitat sampling at approximately 150 sites throughout the region. About one-third of these sites are monitored annually, on a three year rotation. Standardized sampling methods are used to allow for the comparison of the fish community with the physical conditions of streams, both spatially and temporally across the jurisdiction

In addition to the RWMP sites, a number of other project sites are also assessed annually on a special request basis. In 2011 these projects included: the Palgrave Fishway, Mill Pond Splash, and Natural Channel design.

4.2 Methods

Monitoring surveys follow the methods outlined in the Ontario Stream Assessment Protocol (OSAP) (Stanfield 2005). Fish community and habitat sampling includes data collection for: fish community composition, in-stream habitat (e.g. sediment type, vegetation), and bank stability. Fish communities are sampled by backpack electrofishing using a single pass approach. Electrofishing is a non-lethal sampling technique using electric currents and electric fields to immobilize fish, allowing capture. Captured fish are identified to species, weighed and measured and then released back into the water. Quality Assurance/Quality Control (QA/QC) of identified samples is carried out by certified TRCA staff and where the identification of a specimen is uncertain it is sent out for verification by a qualified fish taxonomist.

Figure 7: TRCA staff electrofishing.

Habitat surveys involve both in-stream and bank assessments and are completed subsequent to the fish community surveys. The in-stream portion assesses the suitability of the habitat to support a diverse aquatic community whereas; the bank assessment quantifies the riparian condition and the stability of the land bordering the stream.

A total of 52 sites were sampled in 2011(**Figure 9**), including 43 RWMP sites in the Mimico Creek, Don River, Highland Creek, and Frenchman's Bay watersheds. There are now four completed data sets available for the RWMP sites in the Mimico Creek, Don River, Highland Creek, and Frenchman's Bay watersheds (2002, 2005, 2008 and 2011). Natural Channel Design (NCD) accounted for 9 of the 52 sites sampled in 2011. Due to several NCD sites (NCD18-5, NCD18-1C, NCD18-2C, and NCD18-6C) being located within the range of Redside Dace habitat, fish community surveys had to be performed through the use of a seine net instead of back-pack electrofisher (**Figure 7**). The Palgrave fishway surveys occurred in the upper reaches of the Humber watershed and were sampled in partnership with Trout unlimited.

4.3 Data

In previous years, 2001-2010, data were entered into a Microsoft Access database (HabProgs) and the original datasheets were maintained at the Boyd Field Centre as well as being stored in Laserfishce. The year 2011 marked the first year of recording the data on scannable data forms developed together in cojunction with the Ministry of Natural Resources. As this is the first year that the scannable forms have been used there have been unforeseen delays in aquiring the content off the scannable forms. This has resulted in the unavailability of the 2011 fish habitat data and parts of the fish community data which allow for the calculation of the index of biotic integrity, CPUE and BPUE prior to the completion of this report. None the less a positive outlook exists that after this 2011 transition period the scannable forms will allow for more efficient QA/QC of the data and decrease the time it takes to transfer the date from a hard copy to a workable soft copy that can be stored, manipulated, and analyzed.

Aquatic habitat and fish community data are used to report on watershed health in documents such as Watershed Report Cards and Watershed/Sub-Watershed Plans, and most recently the Living City Report Card. The data has been used for the Fisheries Management planning process and by the Southern Ontario Stream Monitoring and Research Team (SOSMART) for the development of tools and models to predict the effect of landscape level disturbance on aquatic habitats and communities.

4.4 2011 Highlights

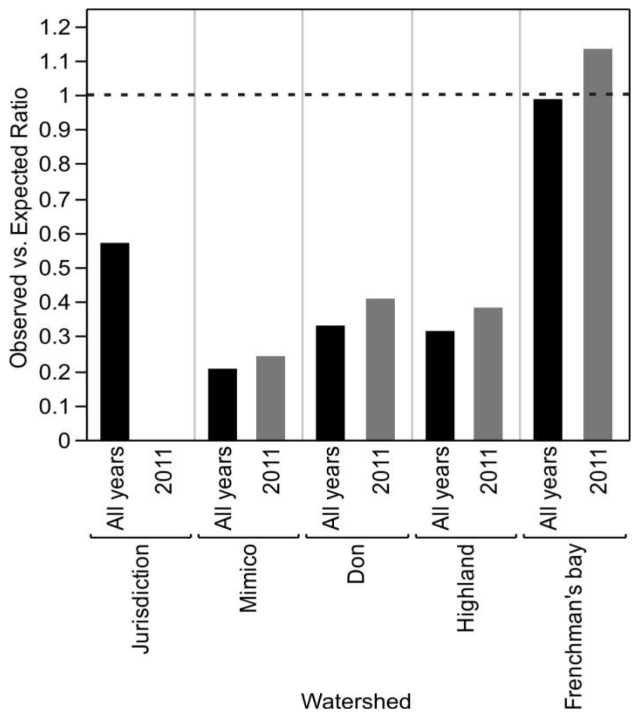

Figure 8: Mean observed vs. expected native fish species richness ratio. Jurisdiction represents a mean across the RWMP sites for all watersheds. All years represents a mean for the 2002, 2005, and 2008 data combined. Latest year of sampling is represented by 2011. The dashed line at a ratio of one represents the desired condition if all habitat and water quality conditions were ideal.

- Changes in fish biodiversity reflect changes in the ecosystems function and health. The number of native fish species collected at each RWMP station is compared to the number of fish species we would expect to find in a healthy lotic system. A higher ratio generally indicates a higher quality in lotic habitat and ecosystem function. Analysis of the observed:expected native fish species richness ratio revealed an increase in the 2011 ratio in contrast to the mean 2002, 2005, and 2008 ratio (**Figure 8**). The Frenchman's Bay showed largest ratio values beyond what would be expected in ideal conditions. This was due to the influence of lake based fish species being captured at the RWMP sites. The Frenchman's Bay large observed vs. expected ratio is a testament to the connectivity between the streams that flow into Frenchman's bay and the Lake Ontario ecosystem. Fish swimming between the Lake and streams artificially increase the ratio beyond what would be expected if ideal conditions were present. The removal of these species from the ratio calculation brings the mean ratio down to 0.63.

- 2011 marked the completion of analysis of 2001-2009 fish habitat data report titled "Draft Regional Watershed Monitoring Program: Fish Habitat Summary 2001-2009. December 2011. Amongst other results, certain relationships with urbanization, estimated through road density, were observed among several variables.

- The Round Goby (*Neogobius melanostomus*) is an invasive exotic species that was introduced into the Great Lakes basin in 1990 via ship ballast water (Corkum et al. 2004). This species was first found in 2007 at RWMP monitoring sites in Etobicoke Creek (EC001WM) and the Humber River (HU003WM). Round Goby were also found at the mouth of Duffins Creek (2008) and Mimico Creek (2008). The 2010 survey found Round Goby in the same sites in Etobicoke Creek and Humber River as the 2007 survey. The 2011 survey continued to find Gobies present at the mouth of Mimico Creek and at the mouth of the Don River where gobies were previously not captured through the RWMP program. A partnership with McMaster University was initiated in 2011 with the purpose of filling knowledge gaps regarding the Round Goby, its population, range expansion, behaviour, and genetics.

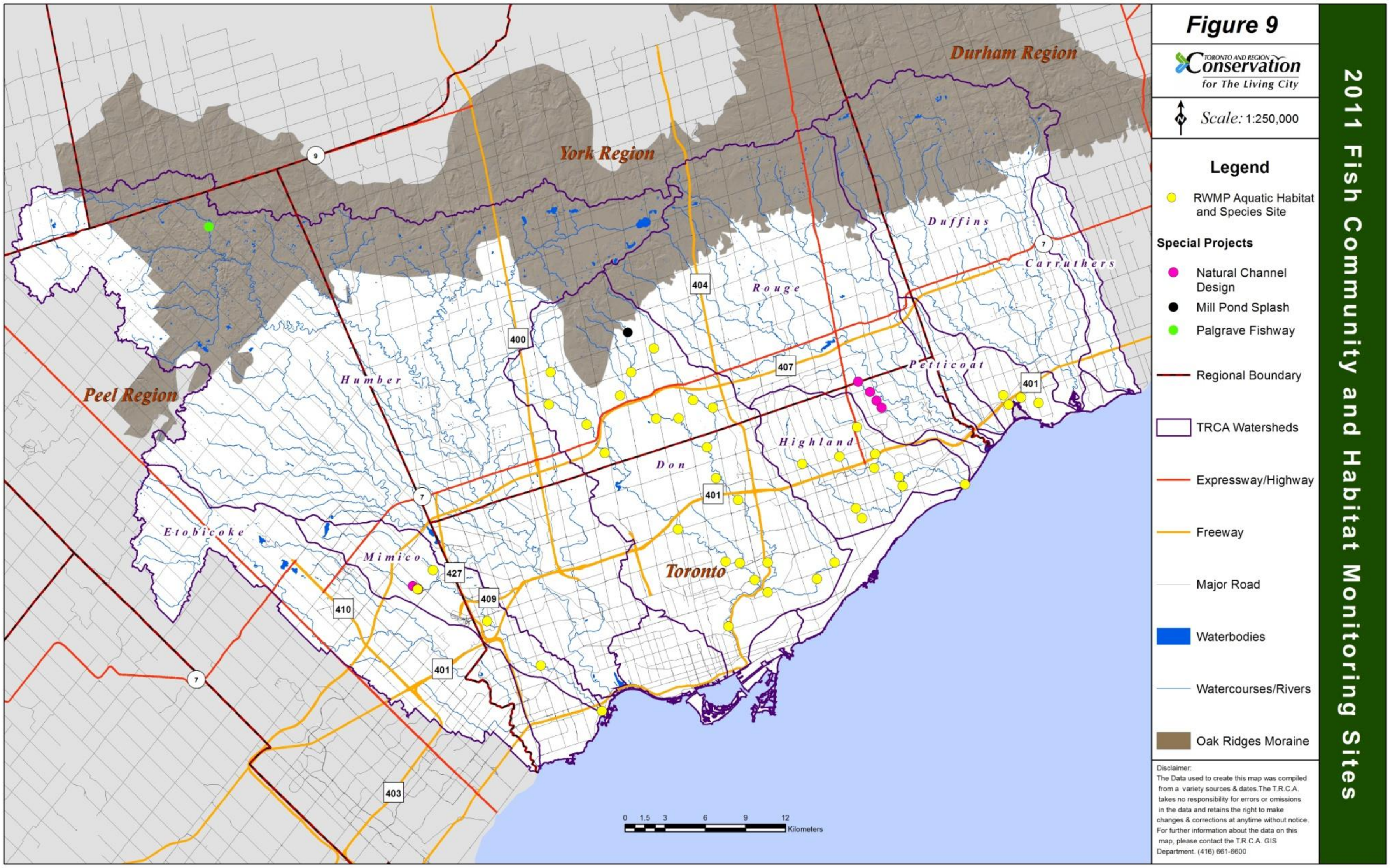

Figure 9: Fish community and habitat monitoring sites.

5 Algae Biomonitoring

Staff Lead: Cheryl Goncalves

Support Staff: Angela Wallace, Nelson Amaral

Funding: Ministry of the Environment

5.1 Background

In 2008, TRCA and the Ministry of the Environment partnered to introduce and promote an Algae Bioassessment Protocol (ABP) (Zugic-Drakulic 2006) under the RWMP. Until recently, the importance of plants (and particularly algae and diatoms) has been undervalued in watershed monitoring. Algae (**Figure 10**), including diatoms, are among the first group of organisms to be impacted by shifts in chemical conditions in a water body, as they are very sensitive to changes in basic water chemistry. As primary producers, benthic algae are an important foundation of food webs in rivers and littoral zones of lakes, and are essential food sources for both fish and benthic invertebrates. Because plants (including algae and diatoms) are more sensitive to changes in water quality, any changes in the community structure would be seen earlier and at lower concentrations than with other communities currently monitored, such as benthic invertebrates. The ability to monitor the algae community provides the advantage of having an early warning system of change in a watershed.

Figure 10: Images of *Fallacia pygmaea* type of algae species.

The repeatability of the Algae Bioassessment Protocol (ABP) was assessed during its first two years through the collection of samples from 20 RWMP monitoring sites in 2008 and 20 sites outside of the TRCA jurisdiction in 2009. In its second year algae sampling was conducted with the help of six other

Conservation Authorities: Ausable Bayfield, Cataraqui River, Credit Valley, Nottawasaga Valley, Saugeen Valley, and Upper Thames.

5.2 Methods

During the 2011 field season 26 Provincial Water Quality Monitoring Network (PWQMN) sites in TRCA's water courses were sampled concurrently with the July 2011 water quality sample. At each of the sites in-situ water quality data was collected using a water quality probe. Five replicated diatom samples were collected at each site from riffle areas, and pooled together for a composite sample (**Figure 11**).

Figure 11: TRCA staff collecting algae samples off a rock.

To identify the diatoms to species level the samples were processed and permanent slides were prepared. A minimum of 400 diatoms will be identified and counted for each sample.

5.3 Data

Currently algae and diatom data is stored in a Microsoft Excel database. This database includes the information collected on the field sheets, as well as the record of diatoms identified at each site. Algae and diatom data is available from TRCA for 2008 and 2009. Once identification of the 2010 and 2011 samples is complete this data will also be made available.

5.4 2011 Highlights

- In the spring of 2011 TRCA's Algal Biologist gave a presentation at the 46th Central Canadian Symposium on Water Quality Research entitled Monitoring Water Quality using an Algae Bioassessment Protocol.

- Diatom community and water quality samples collected in 2008 and 2009 were used to investigate the relationship between the diatom community and water quality. Total kjeldahl nitrogen, total phosphorus, chloride alkalinity and water temperature were strongly correlated to influencing the diatom community.

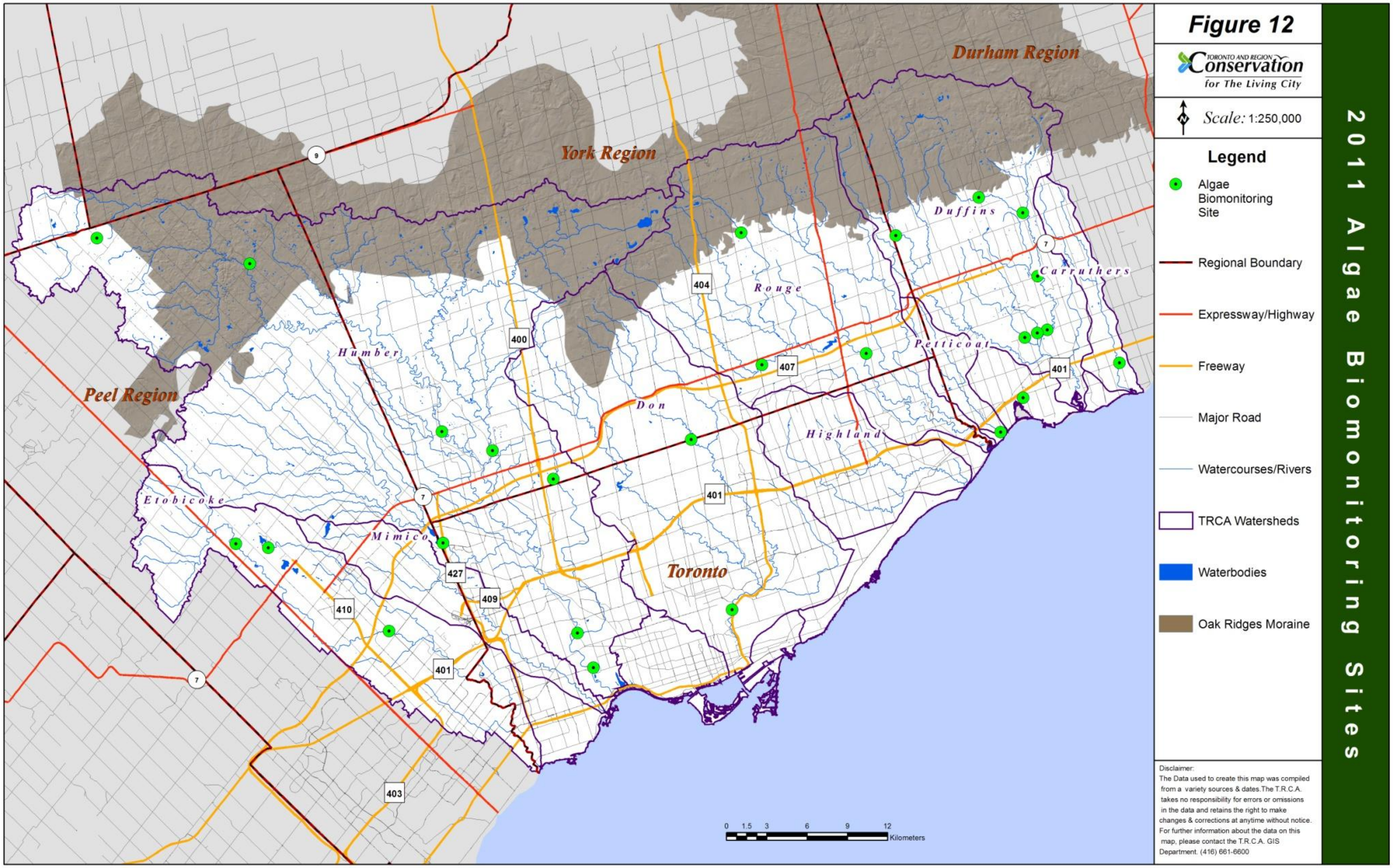

Figure 12. Algae biomonitoring sites.

6 Surface Water Quality

Staff Lead: Angela Wallace, Nelson Amaral

Support Staff: Ming Guo, Roger Hua, Derek Smith (Wet Weather Flow)

Funding: City of Toronto, Peel Region, Durham Region, York Region and Toronto Remedial Action Plan

6.1 Background

Since 2002, TRCA has partnered with the Ontario Ministry of the Environment (OMOE) to monitor surface water quality throughout the TRCA's jurisdiction (**Figure 13**). Surface water quality samples were collected monthly at 38 RWMP sites plus 6 additional sites in 2011 (**Table 1**). The 44 sites were comprised of 13 OMOE Provincial Water Quality Monitoring Network (PWQMN) sites, 25 TRCA sites, 3 Seaton/Duffins Heights sites and 3 new temporary sites within TRCA conservation parks. The three Seaton/Duffins Heights sites were established in September 2010 to help characterize the water quality around a new residential development in the Duffins Creek watershed. The three new sites, established in Heart Lake (Etobicoke Creek), Glen Haffy (Humber River) and Bruce's Mill (Rouge River), were established to help characterize the water quality within TRCA parks. Other TRCA parks (e.g. Petticoat Creek) already had sites within their confines.

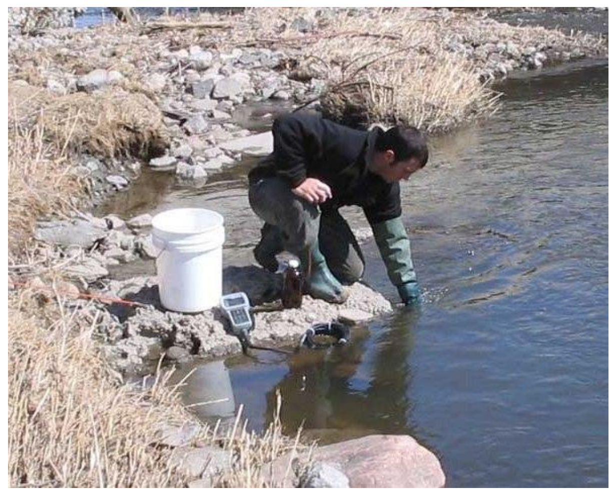

Figure 13: TRCA staff collecting water quality samples.

Table 1. Number of surface water quality sampling sites by watershed

Watershed	# PWQMN Sites	# TRCA Sites	#TRCA Special Projects
Etobicoke Creek	1	2	1
Mimico Creek	1	1	
Humber River	6	5	1
Don River	1	4	
Highland Creek		1	
Rouge River	2	5	1
Petticoat Creek		1	
Frenchman's Bay (Pine Creek)		1	
Duffins Creek	2	4	3
Carruthers Creek		1	
Total	***13***	***25***	***6***

6.2 Methods

Water sampling followed the OMOE PWQMN protocols (OMOE 2003) and included field water chemistry measurements (e.g. water temperature, conductivity, and dissolved oxygen). Sampling occurred year round and was independent of precipitation. Samples were submitted either to the OMOE Rexdale Laboratory or York-Durham Environmental Laboratory, for analysis of the parameters listed in **Table 2**. In addition, samples were collected at stations 85014 (mouth of Don River) and 83019 (mouth of Humber River) from June to November for pesticide sampling on behalf of the OMOE.

Table 2. Select water quality parameters analyzed as part of the RWMP

General Chemistry	Water Temperature	Total Suspended Solids*	Total Dissolved Solids	Dissolved Oxygen	Turbidity
	Conductivity	Hardness	Magnesium	pH	Potassium
	Alkalinity	Sodium	Calcium	Chloride	
Nutrients	Nitrogen, Total Kjeldahl	Total Phosphorus*	Phosphate	Ammonia	Nitrate/Nitrite*
Microbiological	*Escherichia coli*				
Metals	Aluminum	Barium	Beryllium	Cadmium	Chromium
	Cobalt	Copper*	Iron	Lead8	Manganese
	Molybdenum	Nickel	Strontium	Vanadium	Zinc

Note: Additional parameters may be analyzed depending on laboratory (e.g. DOC, sulphates)
*PWQMN indicator parameters

6.3 Data

Water quality data is stored in the TRCA's corporate database which houses monitoring data, includeing laboratory results and metadata (e.g. laboratory analysis methods, sampling equipment).

6.4 2011 Highlights

- A summary of the water quality in the TRCA jurisdiction was completed in a report entitled "*Regional Watershed Monitoring Program: Surface Water Quality Summary 2006-2010*".
- Water quality results for the TRCA jurisdiction were presented at the A.D. Latornell Conservation Symposium (Alliston, Ontario) in November 2011.
- Chloride concentrations and the relationship with road density, diatoms, macroinvertebrates and fish were presented an international conference about road salts in Waterloo, Ontario (**Figure 14**).
- Water quality for Highland Creek and Petticoat Creek were summarized for their individual watershed updates.
- Three additional temporary sites were added to the monitoring network to help characterize the water quality within TRCA conservation parks.
- RWMP staff continued to collect surface water quality samples at Bathurst Glen Golf Course as part of the Audubon Cooperative Sanctuary Program (ACSP) certification. The ACSP is a certification

program that helps golf courses protect and preserve the natural environment. Various TRCA parks will also attempt to receive certification under the ACSP program in the coming years.

- TRCA staff contributed to a Conservation Ontario working group regarding the use of water quality in watershed report cards.

- 2010 Surface Water Quality Summary was completed in December 2011.

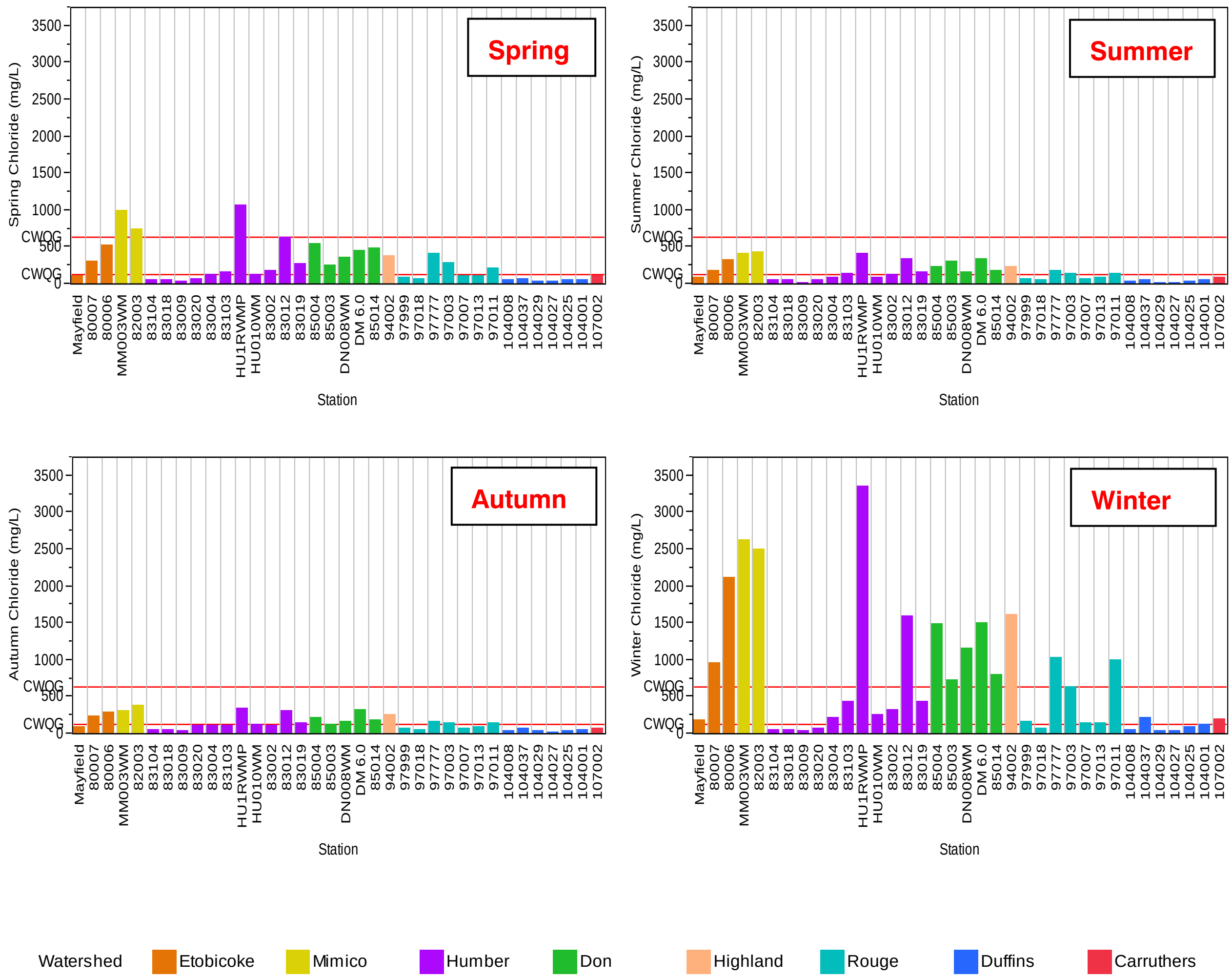

Figure 14: Seasonal average (2006-2010) chloride concentrations across the TRCA jurisdiction.

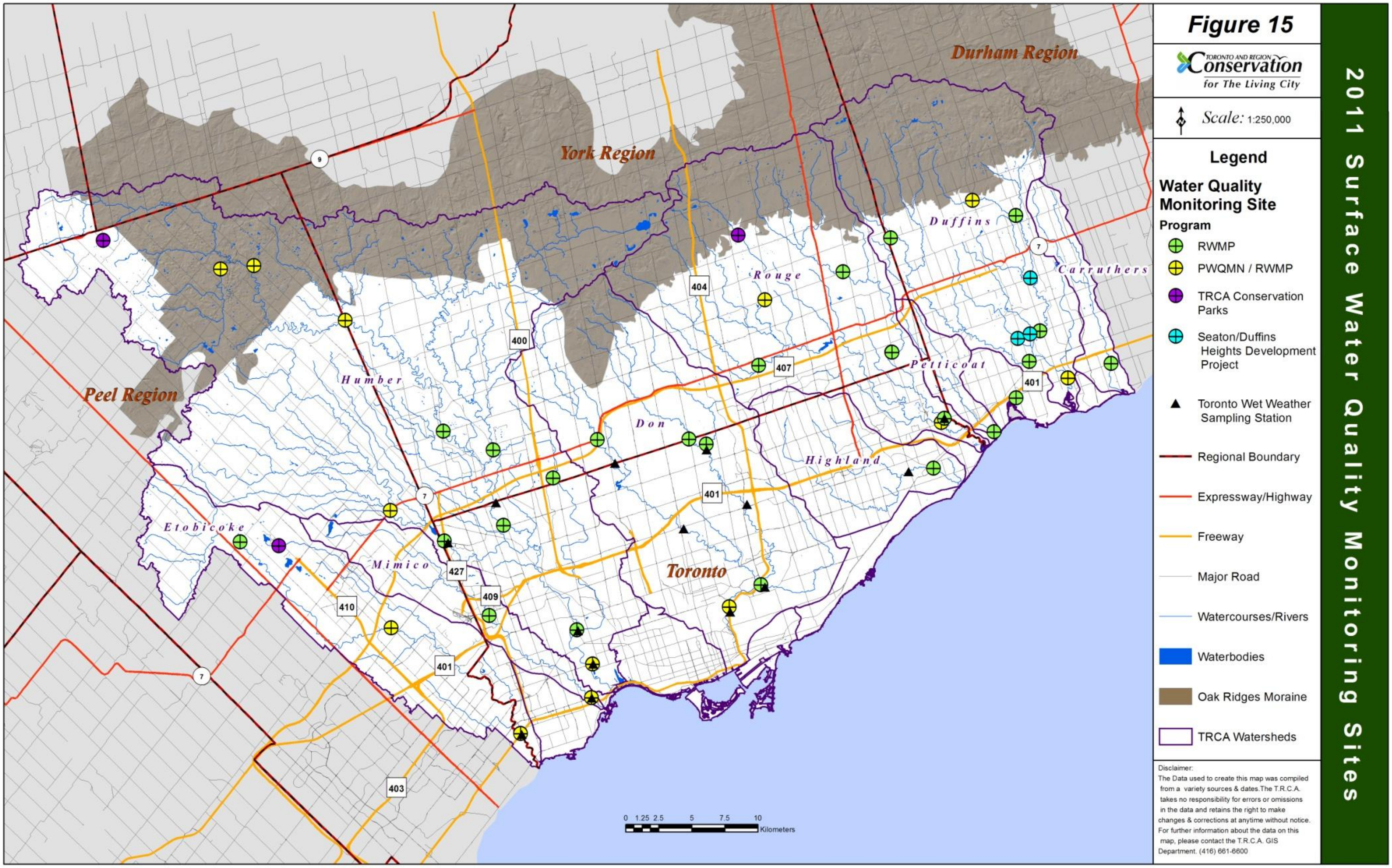

Figure 15: Surface water quality monitoring sites.

7 Water Temperature Monitoring

Staff Lead: Melanie Croft-White, Jan Moryk

Support Staff: Mike Brestansky, Mike Szonda

Funding: City of Toronto, Peel Region, Durham Region, York Region and Toronto Remedial Action Plan

7.1 Background

Water temperature data is collected as part of the aquatic monitoring component of the RWMP. Since aquatic organisms are highly dependent on the temperature of the water they inhabit, much of the diversity within a reach can be associated with temperature. Tracking water temperature can also help indicate the influence of groundwater on the watercourse. Coldwater streams are of particular importance since certain fish species such as Brook Trout (*Salvelinus fontinalis*) rely on groundwater up-wellings for spawning. In addition, the data collected by the RWMP may be able to show long-term changes in water temperature over time caused by anthropogenic factors or climate change.

7.2 Methods

Water temperature data is collected on a three year rotation with approximately one third of the 151 aquatic survey sites sampled each year. Temperature data is collected at the same sites where fish collections occur. Additional sites are monitored on a project specific basis.

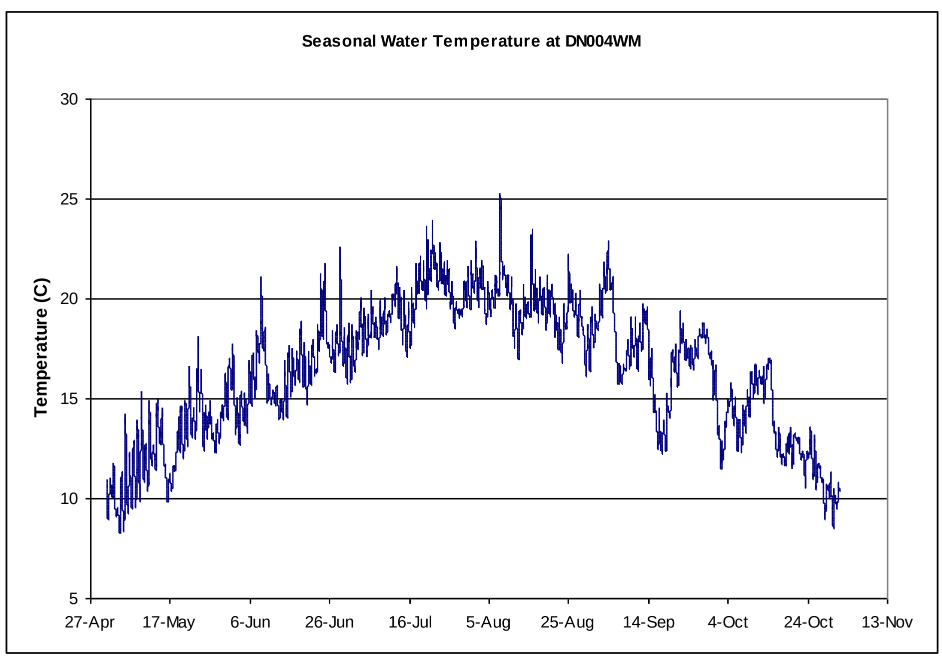

Figure 16: Example of temperature data collected for a site in Don River (DN004WM).

Data is collected using digital temperature loggers installed in the stream in the spring and removed in the fall. All loggers are programmed to sample at 15 minute intervals. The data are assessed using the nomogram developed by Stoneman and Jones (1996) in order to classify stream sites along the continuum from highly stable to unstable in relation to ambient air temperature. Thermally unstable streams are generally unsuitable for coldwater fish species, since their water temperature reaches excessive levels (>25°C) on hot summer days. **Figure 16** illustrates patterns of the typical heating and cooling cycles of a stream from the spring and early summer. **Figure 17** is a sample box and whisker plot that shows both the temperature ranges as well as the predominant seasonal temperatures for a site.

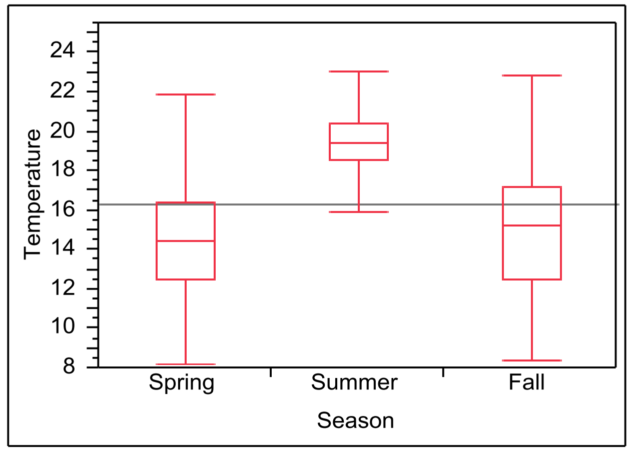

Figure 17: Example of a box and whisker plot displaying water temperature data (DN004WM).

The temperature data is downloaded mid-summer and at the end of the fall and this compensates for data losses by ensuring that data is collected from at least half the season. In the event that the temperature data is not sufficient for thermal stability calculation, another attempt to capture stability information will be made in the following season.

7.3 Data

Logged temperature data is stored electronically in a Microsoft Excel spreadsheet. Thermal stability ratings are developed using the HabProgs MS Access database.

Thermal stability information is primarily used for the development of fish management plans, watershed plans and for restoration purposes. Data is also used to characterize daily and seasonal temperature variation resulting from the influences of air temperature, warmwater run-off, cold thermal contributions from groundwater sources, and anthropogenic influences such as roads.

7.4 2011 Highlights

- In 2011, loggers were deployed at 48 aquatic sites; 5 in Mimico Creek, 1 in the Humber River, 23 in the Don River, 11 in Highland Creek, 4 in Petticoat Creek, and 4 in the creeks flowing into Frenchman's Bay (**Figure 18**).

- There are now four sets of data available for sites in the Mimco Creek, Don River, Highland Creek (2002, 2005, 2008, 2001), and Frenchman's Bay watersheds (2003, 2006, 2008 and 2011). The Petticoat Creek watershed consists of 4 sites which were sampled in (2002 (sites PT001WM and PT002WM), 2003 (site PT003WM only), 2005 (sites PT001WM and PT002WM), 2006, (site PT003WM only), 2008 (all sites), and 2011 (all sites).

- In a normal sampling year a small number of temperature loggers are lost due to storm events and erosion. In 2011 no loggers were lost.

- **Figure 18** shows the percentage of sites that fall in the three stability categories (stable, moderately stable, and unstable) for the Mimico Creek, Don River, Highland Creek, Petticoat Creek, and the Frenchman's Bay tribitaires. In 2011 the majority of sites in all watersheds were moderately stable. The second largest percentage of sites were categorized as thermally unstable. Few sites in all watersheds were thermally stable. Petticoat Creek had one site (PT004WM) that was thermally stable in 2011. The one site (HL006WM) in Highland Creek that was stable in 2008 was found unstable during 2011 sampling. Thermal stability is a reflection of how stream temperature changes with ambient air temperature. Stable streams often have significant groundwater inputs and are well shaded, whereas unstable streams have minimal groundwater inputs and experience more extreme temperature fluctuations throughout the day. Changes in run-off, soil permeability and amount of natural cover as a result of urbanization can negatively impact thermal stability.

- Analysis of 2001-2009 temperature logger data was completed January 2011. The Mimico watershed had a significantly greater July – August mean water temperature (21.90°C) compared to all other watersheds and the jurisdictional average (19.50°C). Lowest July – August mean water temperatures were attributed to the Duffins Creek (18.76°C) and Humber River (18.62°C) watersheds. In general, greatest mean daily temperature changes occurred at sites within watersheds that have the greatest amount of urbanization, these include Etobicoke Creek (4.46°C), Mimico Creek (4.41°C), Highland Creek (4.79°C) and Petticoat Creek (4.23°C). Certain relationships with urbanization, estimated through road density, were observed; mean, minimum, and maximum water temperatures all showed a significantly positive relationship with road density.

- The 2010 and 2011 temperature logger data continues to be amalgamated with the 2001-2009 data and analysis of this long term data set is continuing as new questions regarding climate change and the affect that a changing temperature regime has on our aquatic community arise.

- This year marks the beginning of a year round temperature logging program which purpose is to fill in data gaps regarding spring, fall, and winter stream temperature conditions. In the fall of 2011 ten new temperature loggers were installed as part of a pilot project to test the deployment and functionality of the new loggers throughout the fall and winter season.

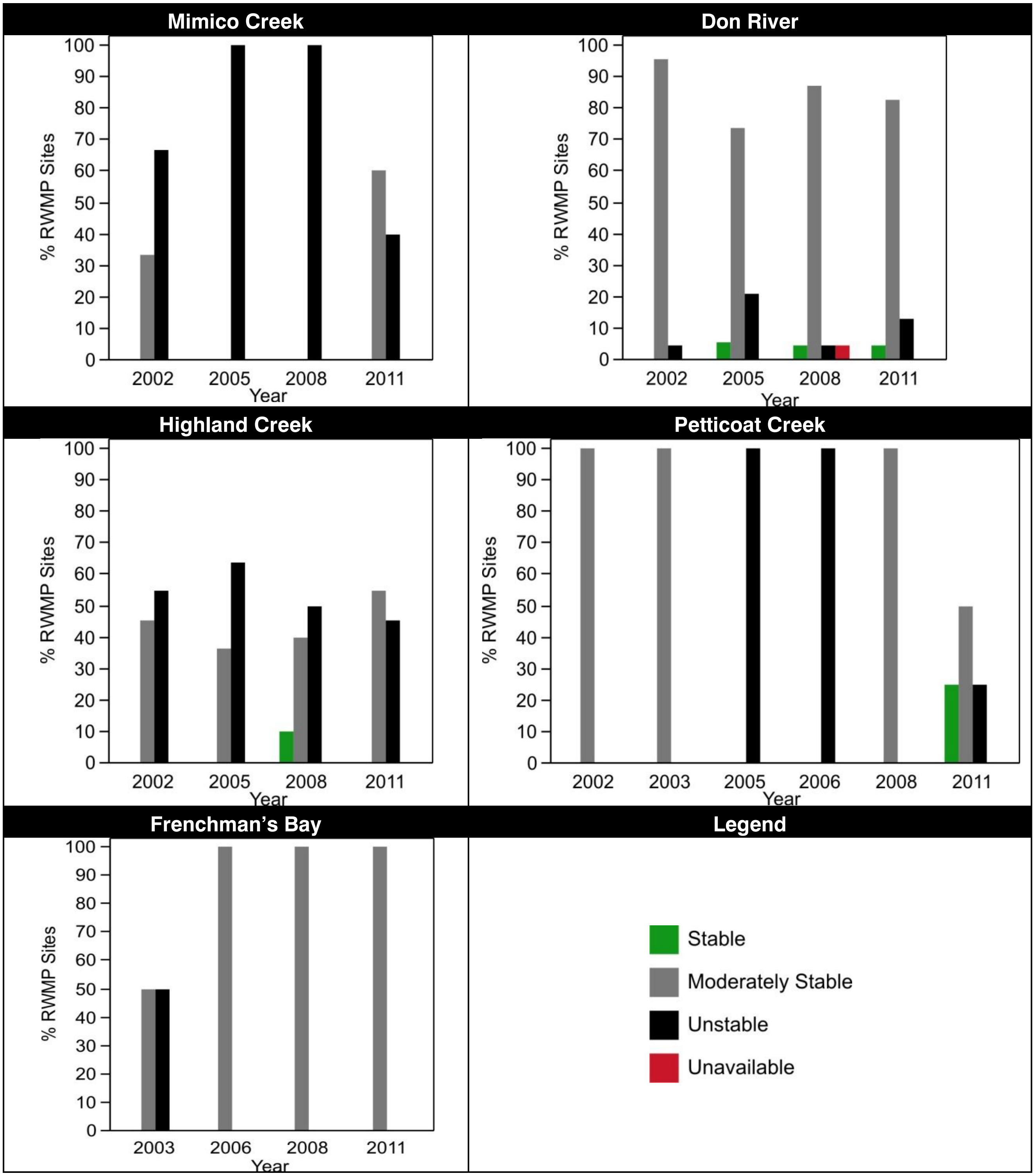

Figure 18: Thermal stability classification for Mimico Creek, Don River, Highland Creek, Petticoat Creek, and Frenchman's Bay tributaries.

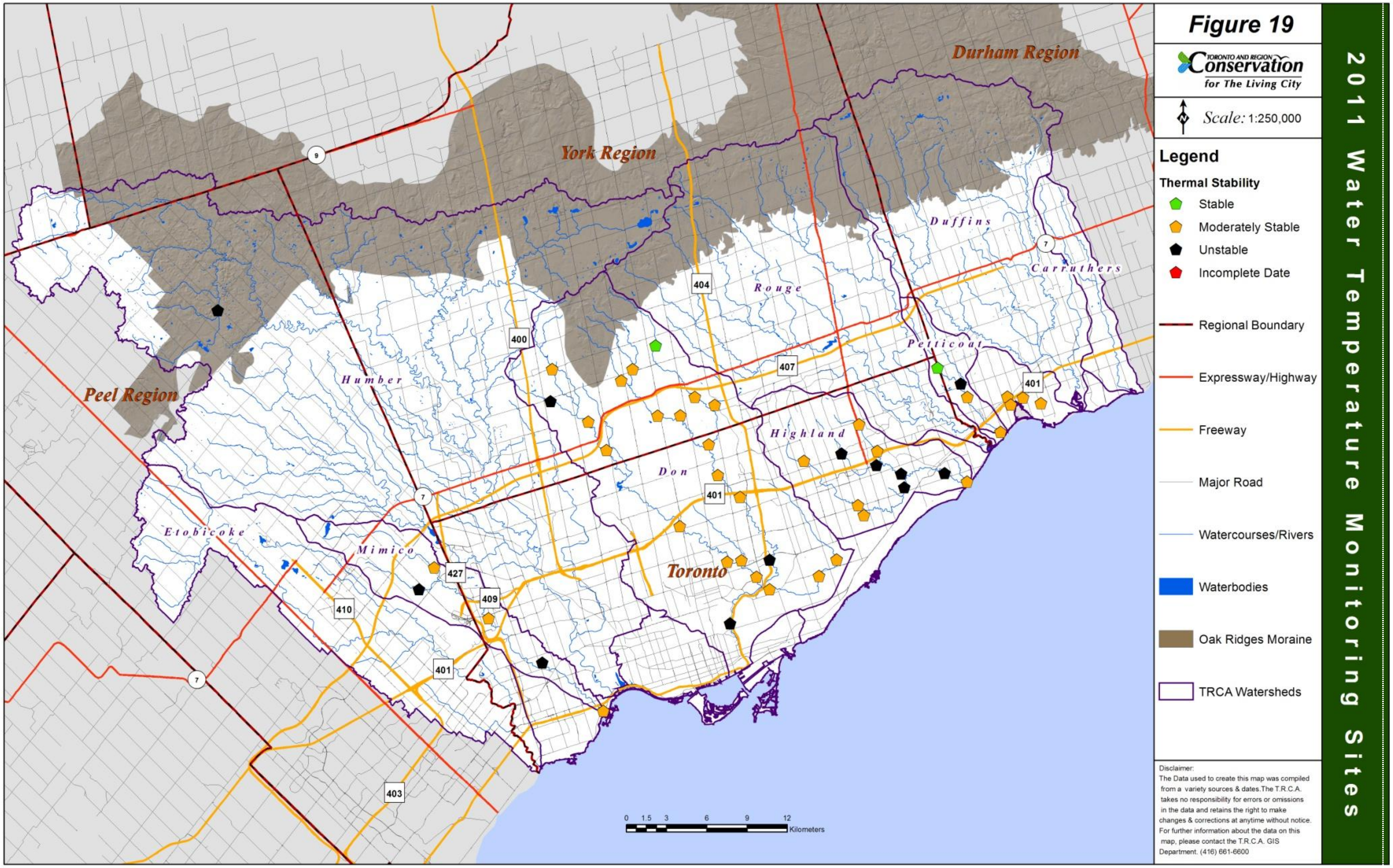

Figure 19: Water temperature monitoring sites.

8 Benthic Invertebrates

Staff Lead: Angela Wallace, Jessica Fang

Support Staff: Ellen Fanning, Danielle Gustaw, Bruna Pelos, Sarah Scharfenberg

Funding: City of Toronto, Peel Region, Durham Region, York Region and Toronto Remedial Action Plan

8.1 Background

Benthic macroinvertebrates (BMI) are organisms which inhabit the bottom of watercourses for at least portion of their lives. These organisms are sensitive to disturbances in their environment, and are useful indicators of change. The different ecological requirements as well as the sensitivity of various benthic organisms to pollution make them ideal candidates for biomonitoring purposes. The BMI biomonitoring program started in 2001 and has been used to track changes in aquatic biota and water quality across the TRCA jurisdiction for the past 10 years. BMI monitoring is conducted yearly at approximately 150 stations across the TRCA jurisdiction as well as at a number of additional stations for special projects.

Figure 20: Image of various macroinvertebrates.

8.2 Methods

BMI are sampled according to the Ontario Stream Assessment Protocol (OSAP) (Stanfield 2005) during the summer months. BMI are collected using the "traveling kick-and-sweep" method whereby stream sediments are disturbed by kicking the stream bottom. BMI are dislodged and swept downstream by the current into a net. Sampling at each station is carried out along a number of transects (dependant on stream width) established across the stream. Each transect sample is collected using a 500 μm mesh D-net, with all transect samples combined into a single composite sample per station. Samples are preserved and brought back to the Boyd Field Center for sub-sampling and identification. A minimum of 100 macroinvertebrate individuals are counted and identified. The samples are initially identified to the coarse 27-group OSAP standard and then further identified to the lowest practical level (LPL) (usually genus/species) depending on availability of

Figure 21: TRCA staff sampling for benthic macroinvertebrates using the kick and sweep method.

resources.

8.3 Data

BMI have been identified to the coarse OBBN 27-group level for all sites up to 2011. Coarse identification data are entered into the Ministry of Natural Resources Habprogs database. Lower level taxonomic data are currently stored in standardized Excel spreadsheets and data are available up to year 2008. It is anticipated that the BMI data stored in Excel spreadsheets will be transferred to the corporate *Envirobase* database. The use of the database will allow for easier data extraction and manipulation.

8.4 2011 Highlights

- This year marks the beginning of a year round temperature logging program which purpose is to fill in data gaps regarding spring, fall, and winter stream temperature conditions. In the fall of 2011 ten new temperature loggers were installed as part of a pilot project to test the deployment and functionality of the new loggers throughout the fall and winter season.

- A total of 140 RWMP stations and 25 special project sites were sampled in 2011 including the TRCA's natural channel design project.

- Staff participated in the collection of BMI for the South-central Ontario Biocriteria Project being conducted by the OMOE. This study is attempting to define reference sampling sites for the Province of Ontario.

- Identification of the 2009 BMI samples to the LPL has been started with an expected completion date of March 2012.

- TRCA's taxonomist was certified by the Society of Freshwater Science for family level BMI identification.

- BMI data from 2001 to 2008 was summarized in the report "*Regional Watershed Monitoring Program: Benthic Invertebrate Summary 2001-2008.*" Analysis revealed a negative relationship between chloride and the number of benthic families (**Figure 22**).

- BMI data and its relationship with chloride were presented at the Second International Conference on Urban Drainage and Road Salt Management in Cold Climates.

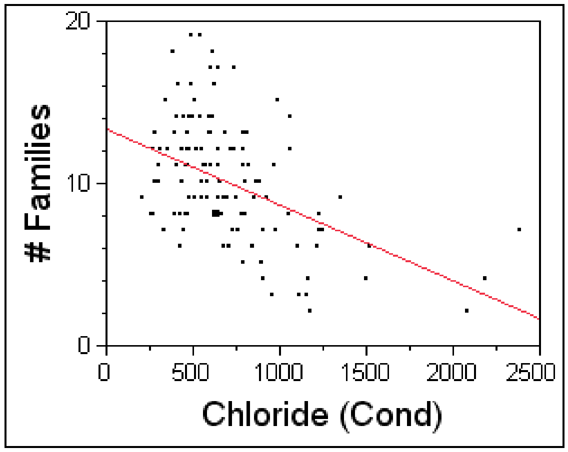

Figure 22: Negative relationship between the number of BMI families and chloride concentrations (measured as conductivity) (R^2=0.219, p<0.001).

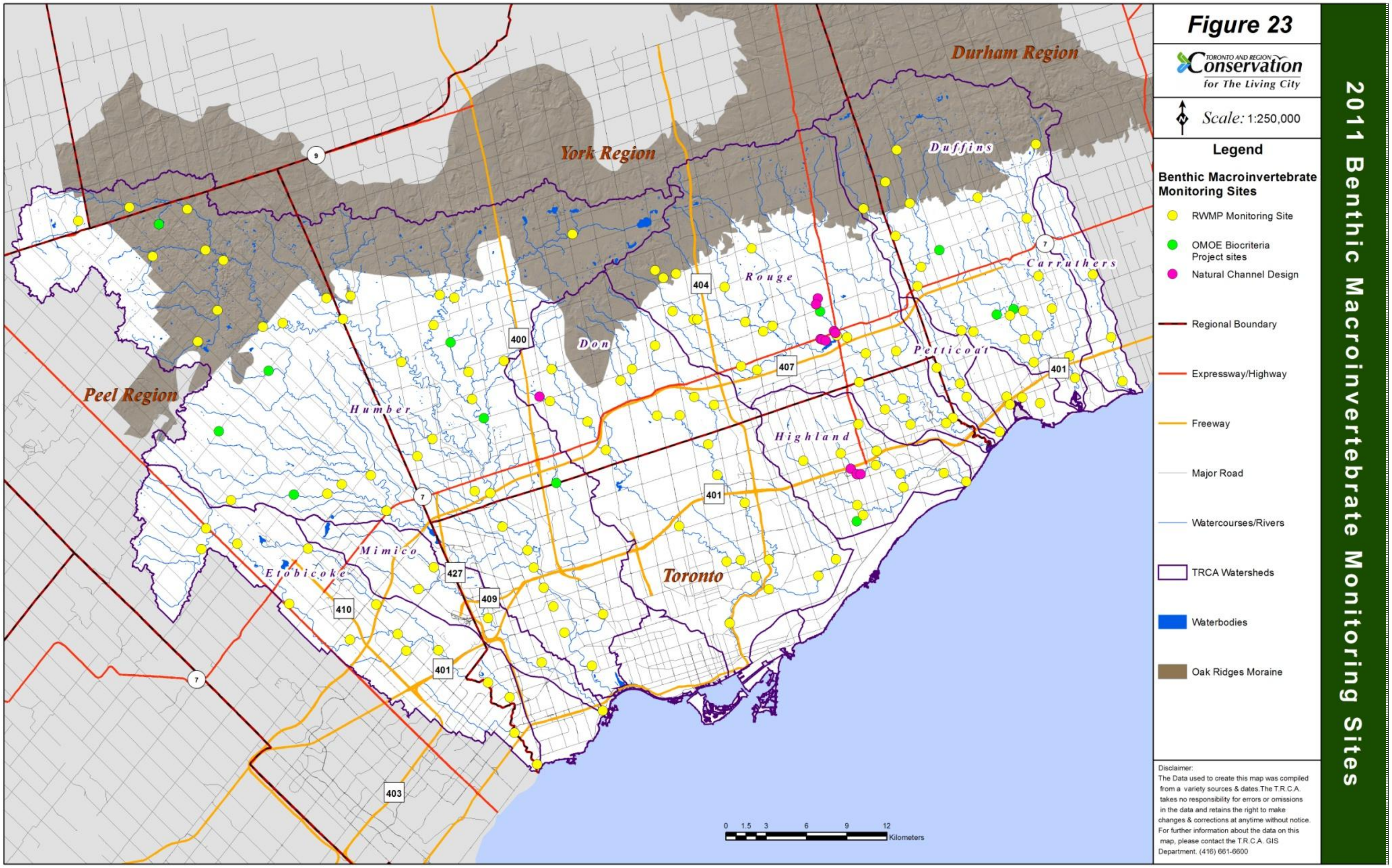

Figure 23. Benthic macroinvertebrate monitoring sites.

9 Fluvial Geomorphology

Staff Lead: Nelson Amaral

Support Staff: Mike Brestansky, Mark Szonda, Ellen Fanning

Funding: City of Toronto, Peel Region, Durham Region, York Region and Toronto Remedial Action Plan

9.1 Background

Fluvial geomorphology measures the physical characteristics of the stream channels and strives to understand how the natural setting and human land use in a watershed determine the shape of watercourses. It also attempts to predict the physical changes that will occur to a stream channel in response to alterations in watershed conditions, and in turn, how these changes will impact human infrastructure and aquatic habitat. The adjustment of watercourses to changes in the environment may take thousands of years (e.g. response to deglaciation) or channel modifications may occur in less than a decade, as is frequently the case with direct human activity in a watershed. Understanding how these processes, both natural and anthropogenic, operating at different time scales, alter the width, depth, and planform of a channel is critical for identifying potential problem areas in a river system.

As the population of the Toronto Region continues to increase, more pressure is being placed on rural and natural areas through urban sprawl and changes in land use. Watercourse alteration, sedimentation, construction activities, changes in hydrology, and increases in the frequency of extreme weather events, are increasing the geomorphic stresses on watercourses. Ongoing monitoring identifies the amounts, trends and rates of change at the site, sub-watershed, and watershed scale caused by channel form adjustment in response to these changes in hydrology and the physical landscape.

A total of 150 fluvial geomorphology sites (**Figure 26**) were established throughout the nine watersheds in the TRCA jurisdiction between 2001 and 2003 as part of the RWMP. Detailed geomorphic data was collected at each site in order to quantify and characterize the channel dimensions along with various bed and bank properties. Data collected includes: longitudinal profile, cross-sectional profile, bankfull width and depth, particle size distribution, substrate characteristics and bank stability. Erosion pins and bed chains were installed in order to monitor changes in bank and stream bed erosion. In addition, historical assessments were conducted using aerial photography to calculate channel widths and migration rates.

9.2 Methods

TRCA staff conduct follow-up monitoring at approximately 50 sites each year on a 3-year cycle. Monitoring efforts include: re-evaluating channel stability through stability indexes, re-measuring channel dimensions along an established “control” cross-section (**Figure 24**) reassessing particle size distribution, and re-measuring bed chains and erosion pins in streambeds and banks.

Figure 24: TRCA staff measuring “control” cross-section.

“Control” cross-sections, usually located in a representative riffle, and erosion pins were installed at the beginning of the program to serve as the starting point for future monitoring efforts.

Geomorphic stability indices such as the Rapid Geomorphic Index (RGA) are also calculated at each site. The RGA is a visual inspection at the site level of four main categories of geomorphic adjustment: evidence of aggradation, evidence of degradation, evidence of widening, and evidence of planimetric form adjustment. The average of the combined score of each of these categories determines the stability index classification of each site.

9.3 Data

RWMP fluvial geomorphological data is available from 2001 to 2011. Data from 2001-2003 is stored in an Access database and data from 2004-2011 is stored in excel files. Database updates are currently underway and all data should be consolidated in a single database in the near future. This data will be used to compare geomorphic changes temporally at the site, subwatershed, and watershed scale that may be attributed to changes in hydrology or watershed land-use. Regional, municipal and academic partners use the data to assess stream channel adjustment and assist with design and construction of erosion controls and other capital infrastructure projects.

Sites are compared to the control/reference data. This type of data is used to calculate geomorphologic measures such as cross-sectional area, width/depth ratio, and the amount of erosion or deposition. Particle size distribution and bed chains are assessed at the monitoring cross-sections to identify any changes in streambed composition and movement. Longitudinal profile graphs can be created to depict changes in elevation in the streambed and bankfull levels.

As previously noted, a change in land-use or a watercourse may take several decades for a measurable change to be noted in fluvial geomorphology. Baseline measurements for the TRCA jurisdiction were completed from 2001-2003, therefore, this component of the RWMP has not been running long enough to show any large-scale changes in the stream channels on the watershed scale.

9.4 2011 Highlights

- A total of 49 RWMP sites were surveyed in 3 watersheds (Don River, Rouge River and Highland Creek) in 2011.
- **Figure 26** displays the 50 RWMP stations that were scheduled to be surveyed in 2011. Station GR-12 was not sampled in 2011 because of a large beaver dam which restricted access to the site. An attempt will be made to sample GR-12 in the spring of 2012.
- In 2011, two new Natural Channel Design (NCD) geomorphic stations located in Mimico Creek and the Rouge River watersheds were setup and sampled. Both new stations, as well as an existing NCD station, were surveyed using a total station.
- **Figure 25** displays the geomorphic data collected at station GH-10 located south of Lawrence Ave. in the lower Highland Creek approximately 1.3 km from Lake Ontario. The data collected in 2011 will be compared to 2008, 2005 and 2002 to identify the active processes acting on upon this station and watershed. Cross-sectional area, width/depth ratio and erosion/deposition will also be calculated and compared over time to help characterize each station, subwatershed, watershed and various land-use areas. The cross-sectional profile of GH-10 identifies a shift in thalweg orientation from one bank to another as well as deposition in the area previously occupied by the thalweg. Watercourses are dynamic systems and this trend may be reversed quite quickly in the future through changes in hydrology.

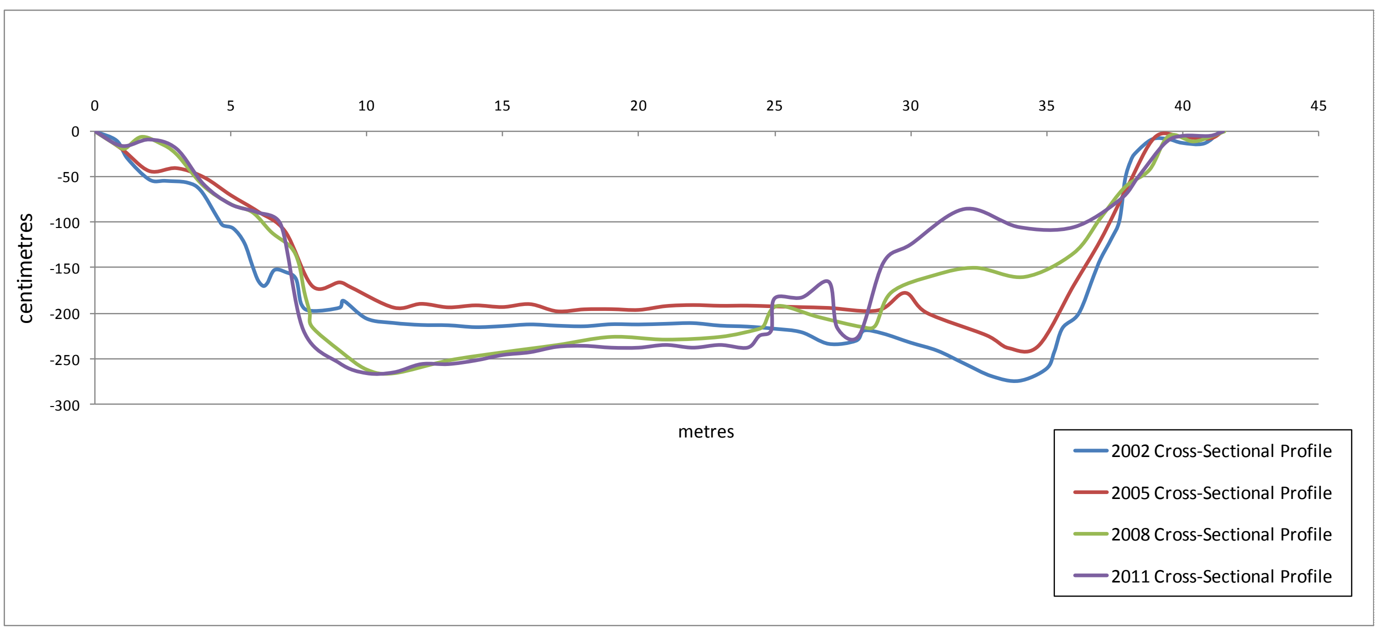

Figure 25: Cross-sectional profile of site GH-10.

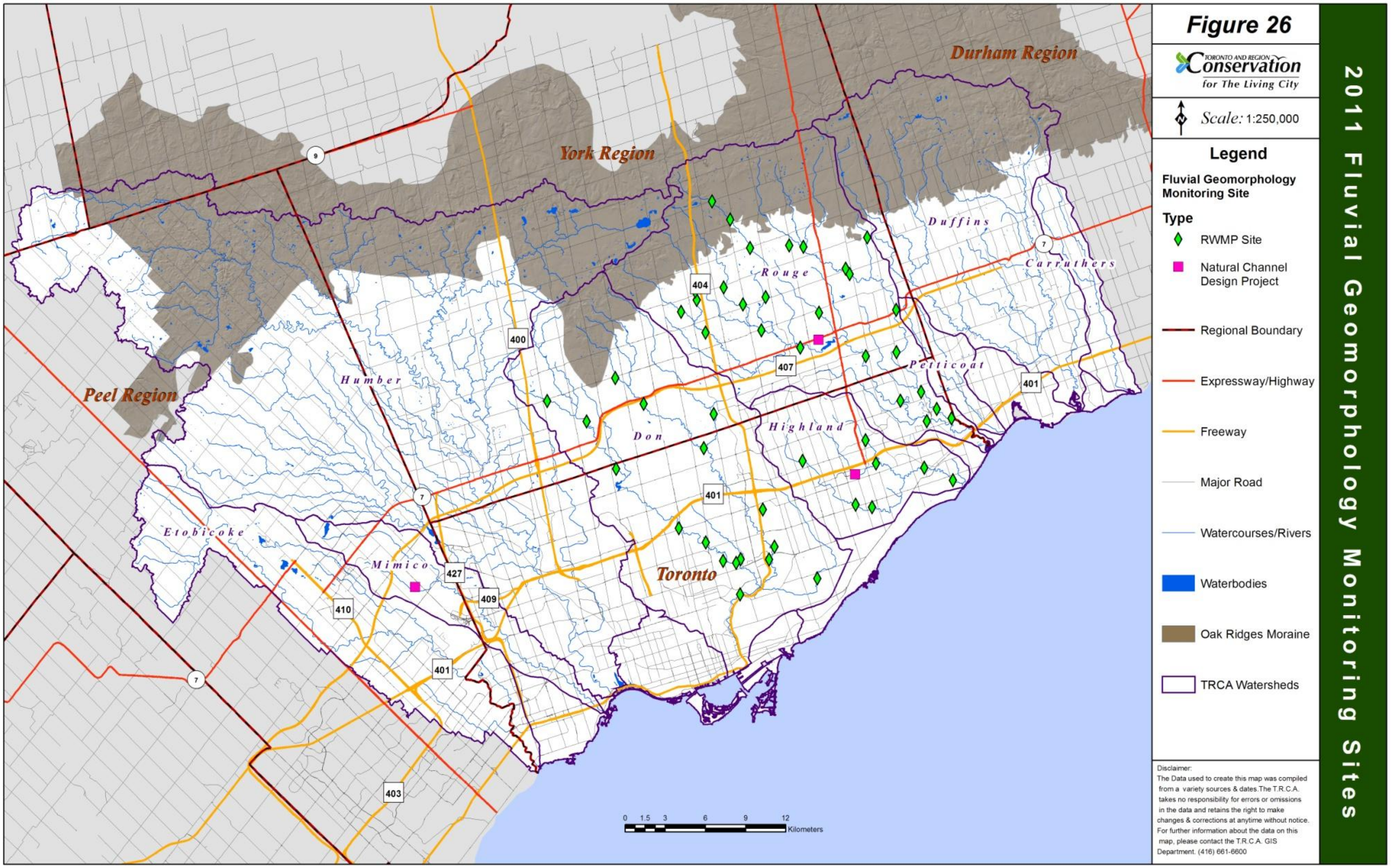

Figure 26: Fluvial geomorphology monitoring sites.

10 West Nile Virus Vector Monitoring

Staff Lead: Jessica Fang

Support Staff: Thilaka Krishnaraj and Sarah Scharfenberg

Funding: City of Toronto, Durham Region, Peel Region, and York Region

10.1 Background

West Nile virus (WNv) is primarily an avian pathogen that first appeared in Ontario in 2001. The disease is transmitted to humans by mosquitoes that become infected by feeding on infected birds. From 2003 to 2010, human WNv illness has declined. However, in 2011, the number of human WNv cases in Ontario rose to 64 compared to one case in 2010, four cases in 2009 and three cases in 2008 (Public Health Agency of Canada, 2011. <www.phac-aspc.gc.ca/index-eng.php>*)*.

TRCA initiated its WNv Monitoring and Surveillance Program in 2003. The core objectives of the WNv Monitoring and Surveillance program are to:

- Assess abundance of mosquito larvae in TRCA wetlands and select storm water ponds (SWMP's),
- collaborate with the Regional Public Health Units,
- investigate standing water complaints associated with TRCA properties, and
- educate the public,
- take proactive management to reduce risk of WNv transmission when warranted

Figure 27: TRCA staff collecting mosquito larva.

To monitor the mosquito population on TRCA properties, larval samples were taken from selected wetlands and stormwater management ponds (SWMPs) (**Figure 27**). The larval samples were analysed to determine the presence of WNv vector species larvae such as *Culex pipiens* and *Culex restuans*, to assess all mosquito species abundance, and to identify vector "hotspots". Collaboration efforts with the Regional Public Health Units within TRCA's jurisdiction (i.e. City of Toronto, Durham Region, Peel Region, and York Region) includes staff participation in WNv advisory committees, data/information sharing, notification and larvicide treatment of vector mosquito species hotspots. To investigate the standing water complaints, TRCA's Standing Water Complaint Procedure is followed. Public education involves responding to any public or staff inquiries about WNv, providing educational materials and updates of the program.

10.2 Methods

In 2011, monitoring began on May 30th and ended on September 6th. A total of 46 sites were monitored across TRCA's jurisdiction, including 37 wetlands and nine SWMPs (**Figure 28**). Each site was visited four times at approximately four-week intervals. Each site was divided into four approximately equal quadrants. One sample was taken at each of the four quadrants and each sample consisted of 10 larval dips using a standard larval sampling dipper. Mosquito larvae were transferred to specimen containers and the number of larvae per dip was recorded for each quadrant. Larvae were pooled by quadrant and brought back to Boyd Field Centre. Mosquito larvae were reared until they reached their fourth instar, then they were killed with boiling water, preserved in ethanol, and identified to species using taxonomic keys.

Figure 28: Image standard larval sampling dipper.

The risk ranking method (Wada, 1965) was applied to each vector species independently based on the average number of vector larvae found per 10 dips. Risk ranking was assessed for each vector species individually instead of the cumulative number of larvae of all vector species due to the individual species variation in biology, host preference and efficiency to transmit the virus.

A site was ranked as:

- **Nil/no risk -** if no vector larvae were present
- **Low risk -** if the average number of vector larvae collected was below 2 per 10 dips
- **Moderate risk -** if the average number of vector larvae collected was between 2 and 30 per 10 dips
- **High risk -** if the average number of vector larvae is greater than 31 per 10 dips

In addition to mosquito larvae collection, TRCA staff also collected water quality data such as pH, temperature, electrical conductivity, total dissolved solids and dissolved oxygen using an YSI meter (650 MDS). Field observation data such as water clarity, type of mosquito predator present, and vegetation type and coverage were also recorded during the time of site visit.

10.3 Data

Data are stored in the WNv Database Version 2.7 (a MS Access database). The data are available from year 2003 to 2011. Data includes site conditions, weather conditions, number mosquito per dip collected, mosquito taxa richness, the abundance of each mosquito species, and the mosquito mortality rate during the rearing process.

To ensure the quality of the data, 10% of the identified mosquito specimens were randomly selected and sent to the Peel Region Public Health Unit for identification verification.

Data collected in 2011 were used to determine vector mosquito hotspots, WNv vector and non-vector species composition and abundance at complaint sites, and to generate the Annual Report: *West Nile Virus Vector Mosquito Larval Monitoring and Surveillance – 2011*.

10.4 2011 Highlights

- In total, 8233 mosquito larvae were collected, including 6784 mosquito larvae collected from the 37 wetland sites and 1449 mosquito larvae collected from the 9 SWMP sites (**Table 3**).

- Wetland habitat supported a greater diversity of mosquito community; 13 different mosquito species (eight vector species and five non-vector species) were found in wetlands, and seven different species (six vector species and one non-vector) were found in SWMPs (**Table 3**).

Table 3. Mosquito Population Density in Wetlands and SWMPs - 2011

Species	Wetlands	SWMPs
Vector Species	**Abundance**	
Culex pipiens	1878	1015
Culex restuans	157	52
Culex salinarius	27	1
Aedes vexans	185	5
Anopheles punctipennis	241	52
Anopheles quadrimaculatus	284	26
Ochlerotatus japonicus	1	-
Ochlerotatus trivittatus	3	-
Non-Vector Species	**Abundance**	
Culex territans	3175	228
Anopheles earlei	5	-
Culiseta inornata	4	-
Psorophora ferox	1	-
Uranotaenia sapphirina	62	-
Missing/rearing mortality	761	70
Total	6784	1449
	8233	

- It was exceptionally hot and dry during the summer of 2011. Four of the routine monitoring sites dried up completed during the second sampling event (July), eight sites during the third sampling event (early August), and six sites during the last and the forth sampling even (late August).

- Among the wetland sites, 53.9% of the larvae collected were non-vector species, while the remaining 46.1% were vectors. The predominant non-vector species was *Culex territans*, and the predominant vector species was *Culex pipiens*. At the Grenadier Pond site in High Park, a high number of *Culex pipiens* were collected on August 2, 2011 (n=1336). If the Grenadier Pond site was removed from the data set, 71.5% of the larvae collected were non-vector species, while the remaining 28.5% were vectors among the other wetlands.

- Among the SWMPs sites, vector species comprised 83.5% of the mosquito population, while the non-vector made up the remaining 16.5%. *Culex pipiens* which represent 73.6% of the mosquito larvae collected was the predominant vector species found in SWMPs.

- Three wetland sites and two SWMPs sites were identified as vector mosquito hotspots in 2011 (**Figure 19**). The wetland sites include Grenadier Pond in High Park, Goldfish Pond in Tommy Thompson Park, and Lacey's Pond in Altona Forest. Grenadier Pond was treated by the City of Toronto, Lacey's Pond was treated by TRCA's contractor GreenLeaf Pest Control, and Goldfish Pond was not treated due to the environmental sensitivity of the site. The two SWMP hotspots were L'Amoreaux Park North Pond, and SWMP 279.1. L'Amoreaux Park North Pond was identified as a "hotspot" for *Culex pipiens* in July and August. This site is under management agreement with the City of Toronto and larvicide was applied by the City upon notification. SWMP 279.1 in Durham Region was identified as a hotspot in the end of July and larvicide treatment was applied by the Durham Region Public Health Unit.

- In 2011, TRCA received seven standing water complaints associated with TRCA properties. Two of these properties have been monitored as routine monitoring sites since 2010. One property, Guildwood Park, is under a management agreement with the City of Toronto; therefore, the information was provided to the City Park of Toronto. The other four properties were investigated and sampled on a weekly basis. None of the complaint case investigations resulted in larvicide application. In addition, TRCA also received three complaints associated with either public land or private property; these non-TRCA property complaints were forwarded to the respective Regional Public Health Units.

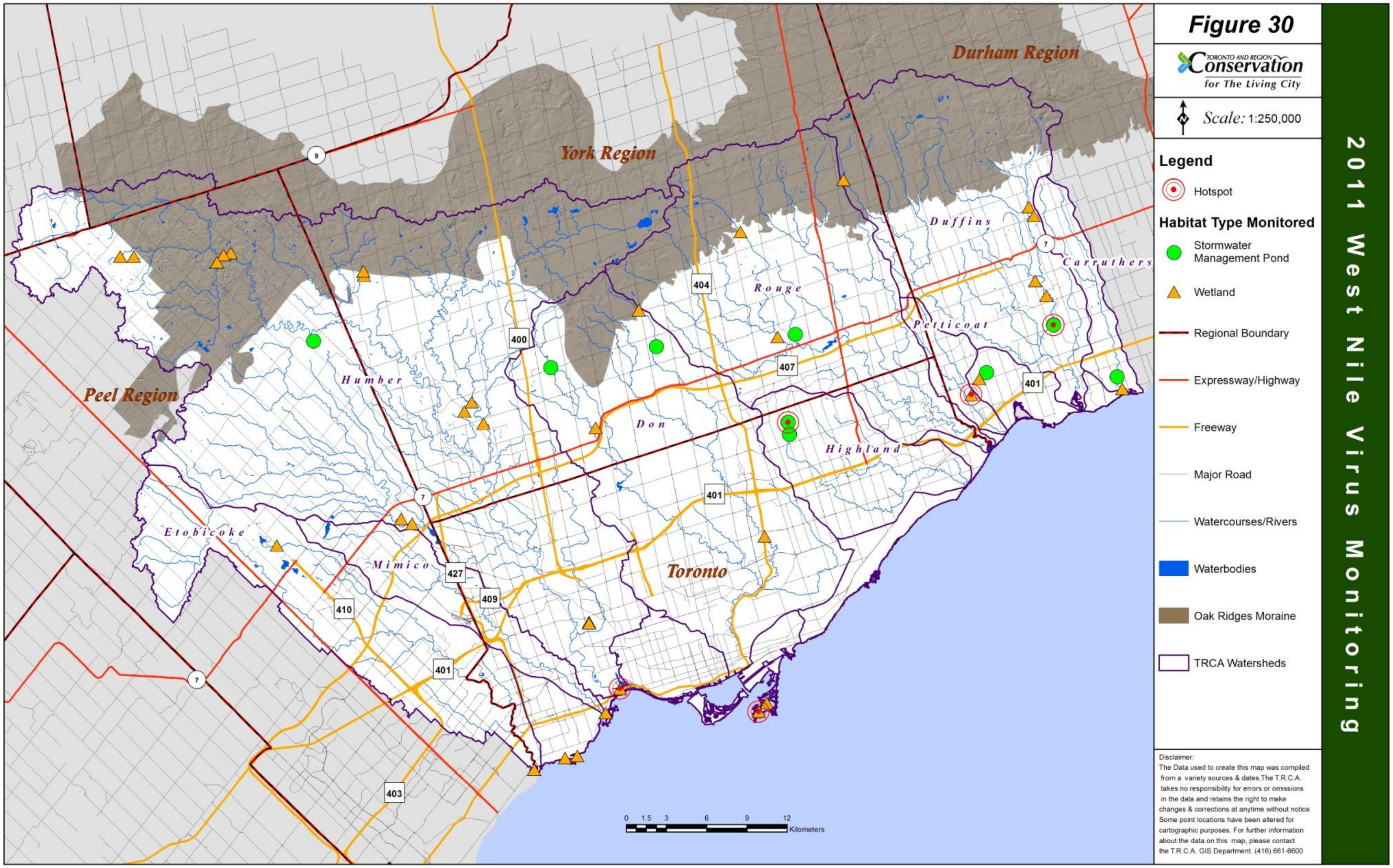

Figure 30: West Nile Virus monitoring sites.

11 Groundwater Quality and Quantity

Staff Lead: Jeff Vandenberg

Support Staff: Don Ford, Jehan Zeb, Andrew Taylor

Funding: Ministry of the Environment and TRCA

11.1 Background

Approximately three million residents in Ontario rely on groundwater from municipal and private wells as their primary source of drinking water. Many communities are dependent on groundwater supplies to maintain existing domestic, commercial, industrial, agricultural and institutional operations. The increasing demand for groundwater in Ontario is elevating the stress placed on this vital resource through overdrawing and contamination.

Figure 31: TRCA staff checking equipment at a groundwater well monitoring site.

Historically, there was no comprehensive data available that could provide a reliable description of the state of groundwater in the province. A need was identified for a network of ongoing monitoring sites to be created to assess current groundwater conditions. This network would also provide an early warning system for changes in water levels and water quality.

The Provincial Groundwater Monitoring Network (PGMN) was established to meet these needs. A partnership was formed between the Ministry of the Environment (MOE) and Conservation Authorities to efficiently utilize staff and resources. The fact that Conservation Authorities are watershed oriented has made them ideal partners that conduct all field operations and data analysis/reporting on a local level. The MOE's role in the network is to set policy direction, strategic objectives and maintain the Provincial Groundwater Monitoring Information System (PGMIS) database for the program. As a program partner, the mandate of the TRCA is to maintain the telemetry systems, collect water level data, and collect and arrange for chemical analysis of water quality samples at dedicated wells on an ongoing basis.

Seepage Meters

Due to projected growth within Caledon East, the Region of Peel completed a Class Environmental Assessment (EA) in November 2007 to examine increases to the current water taking within existing water supply wells. Over the past three years the Region together with TRCA have coordinated monitoring review efforts as part of a larger Environmental Management Plan(EMP) designed to mitigate the effects of water taking and to accurately identify areas where adaptive management may be required.

Seepage meters quantify the amount and rate of groundwater that is flowing up through the stream bed at a specific location. This measurement can be useful to understand if the groundwater discharge conditions are changing locally.

11.2 Methods

PGMN Wells

Each groundwater well in the program is equipped with a levelogger which is installed at least 5 metres below average standing water level. These loggers measure water depth and temperature every hour on the hour. There are currently 20 groundwater monitoring wells in the Toronto and Region Conservation Authority (TRCA) jurisdiction. Currently 17 sites are equipped with telemetry equipment, which allows for remote downloading of data from the leveloggers (**Figure 32**). The remaining sites were either deemed unsuitable for telemetry installation or have not yet been upgraded to the new digital system and have to be downloaded manually. One site has been equipped with a barologger in order to 'normalize' the data from wells across the TRCA jurisdiction by taking barometric pressure into account. In addition, five wells have been outfitted with dedicated (Redi-Flo 2) pumps allowing for water quality sampling.

Figure 32: PGMN well with telemetry equipment and dedicated pump installed.

Seepage Meters

A testing process was undertaken to determine an effective design to deploy seepage meters in streams (**Figure 33**). Once finalized, seepage meters were deployed at four sites in known brook trout spawning locations to determine if measurable flow rates were present, and if longterm deployment was feasible. It was determined that three sites were suitable and three meters were installed at each site. Measurements were collected during fall spawning with additional monitoring to be carried out in all seasons going forward.

Figure 33: Seepage meter with tubing attached.

11.3 Data

The data collected from the loggers at these sites are downloaded by the MOE and uploaded to the PGMIS website. The data collected is subjected to quality control checks performed by TRCA staff. The data is used internally for monitoring regional groundwater levels and for Source Water Protection Planning. The data collected is also supplied to the York-Peel-Durham-Toronto (YPDT) coalition and the Conservation Authorities Moraine Coalition (CAMC) who use the data to characterize and improve the understanding of the hydrogeology of the Oak Ridges Moraine.

11.4 2011 Highlights

- In 2011 a total of 14 sites were sampled as part of the yearly water quality sampling run. A full report on Groundwater Quality will be produced later in 2012.

- One well in the network at the Kortright Center was decommissioned this year due to a broken well casing. A new well is scheduled to be constructed and added back in to the network in 2012.

- The PGMN telemetry system was originally configured as an analog system, with 18 sites in TRCA's jurisdiction having telemetry installed. The phone company, which had been moving away from analog signals to digital, discontinued the analog system entirely as of December 2008. Because of this change, additional site visits were necessary in 2011 to download data manually. To date the MOE has been purchasing new digital telemetry equipment as funding becomes available. This year one additional site was converted to the digital system. This brings the number of sites with telemetry back to 17. Additional sites are expected to be upgraded to the digital system as funding becomes available.

- In 2010 the MOE wanted to address the problem of logger slippage as part of the recommendations for the PGMN program. When loggers were being removed from the well during downloading or maintenance it was noted that slight changes in depth were occurring which was affecting depth readings over time. To prevent logger slippage, TRCA started installing downrigger cables of a specified length to each logger where this slippage was likely to occur. These installations were started in 2010, and carried on into 2011 with an additional nine sites being equipped.

- Seepage meter testing, installation and monitoring was successfully undertaken this year, with monitoring ongoing in all seasons

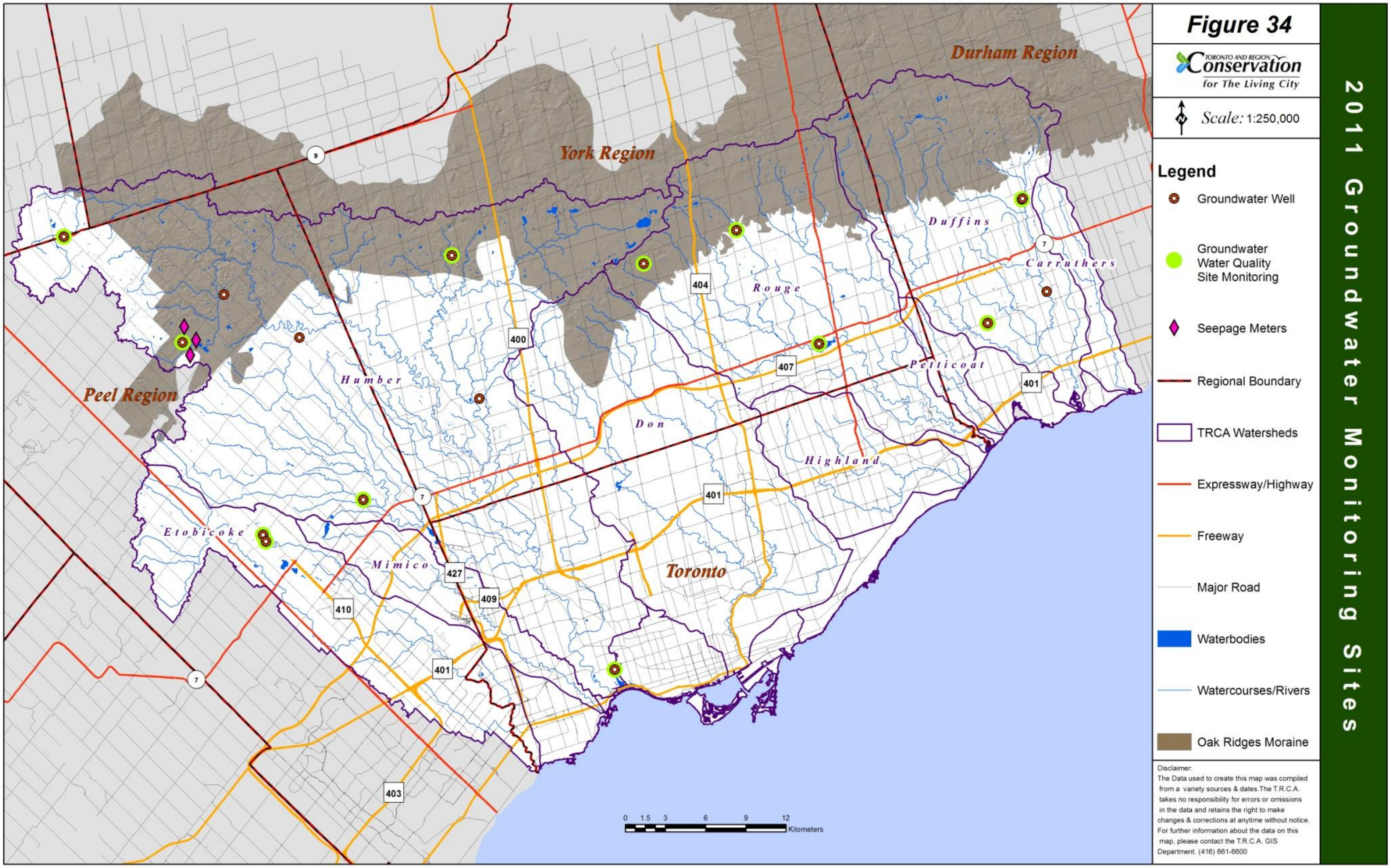

Figure 34: Groundwater monitoring sites.

12 Water Quantity - Stream Flow, Precipitation and Snow Course

Staff Lead: Derek Smith

Support Staff: Bill Kerr, Craig Mitchell, Lisa Moore, Jamie Duncan, Rita Lucero, Matt Derro, Paul Greck, Greg Dillane, Leland Wilbur

Funding: City of Toronto, Peel Region, Durham Region, York Region and Toronto Remedial Action Plan

12.1 Background

One of the indicators monitored under the RWMP is water quantity which includes stream flow, rainfall, and snowfall. Stream flow data has been collected in TRCA's jurisdiction for over 50 years and was originally implemented by the federal government to meet its international obligations related to the Great Lakes. Today, the TRCA has installed numerous stream gauges as part of the RWMP and Flood Management Services (FMS). Typically, the data is used for stormwater management, water budget development, flood control structure operation and flood warning, infrastructure modeling, and land use influences to watercourses.

Similarly, precipitation gauges are widely used to document storm flows, annual discharges, and for flood forecasting. The data is regularly found in road and sewer design details, water balance and flood models, water quality/quantity reports, and emergency bulletins. In Toronto and the surrounding area there are over 100 rain gauges which are owned and operated by all levels of government, educational institutions, and the private sector. Of that total, the TRCA owns and operates 33 gauges. Stations in this network were strategically located approximately ten kilometers apart from one another in order to provide good coverage of TRCA's jurisdiction and all of its watersheds. Originally conceptualized for flood warning purposes, it has evolved into a regional database regularly utilized by government and non-government organizations, educational institutes, and the TRCA.

Unlike the TRCA's stream and precipitation networks, which are fully automated, the TRCA manually monitors snow accumulation at ten locations in order to determine the antecedent condition of the watershed prior to the spring thaw. The stations were selected to provide a jurisdictional assessment of snow characteristics including: snow depth, water equivalent, snow density, snow crust, and underlying soil attributes (e.g. frozen). The data is submitted to the Ministry of Natural Resources (MNR) and TRCA flood duty officers (FDO) bi-weekly in order to assess the snow melt flood threat in our watersheds.

12.2 Methods

12.2.1 Stream Flow

In 2011, flow and water level data was collected at 36 TRCA stream gauges and 21 Water Survey Canada (WSC) gauges (**Figure 38**). Water level data is averaged and recorded every 15 minutes. Monthly, each station is downloaded, corrected (if applicable) and converted to flow. Stage-discharge checks are carried out annually at each stream gauge location and rating curves are either verified or generated depending on the hydraulic conditions.

Each stream gauge station is maintained annually by flushing wells, sensor and benchmark calibrations, desiccant checks, and logger battery replacement (where applicable). Of the 36 TRCA stream gauges, 16 stations are part of the TRCA Real Time (RT) Flood Warning Network, of which five are used to observe dam reservoir levels and storage (**Figure 35**). The RT stations are strategically located in flood risk areas or at dams and is a web accessible system that posts precipitation, water level, alarms, video, and stream discharge data in real time. The remainder of non-RT gauges are used for regional ambient monitoring. The addition or decommissioning of gauges is solely determined by its drainage area attributes and is assessed annually.

Figure 35. Various RT stream gauge stations (from left) Taylor Massey Creek, McFall Dam, and the real-time gauging home page.

12.2.2 Precipitation (Rainfall and Snowfall)

In 2011, precipitation data was collected from 33 stations (**Figure 39**). The precipitation network consists of 27 three-season tipping bucket gauges and 6, four-season gauges (3 weigh gauges and 3 heated tipping buckets) (**Figure 36**). Of the 33 stations, 13 are telemetered; of which 8 are part of the TRCA RT gauging network.

All three-season tipping bucket rain gauges are shut down for the winter season while the four-season gauges monitor all seasons. All tipping bucket gauges are maintained every four weeks which includes data downloads, station cleaning, and power checks. In contrast, the weigh gauges require less maintenance because they use a 12 litre collection bucket (600 mm of precipitation) which is emptied every three months. Each station is calibrated twice a year in the spring and fall.

Tipping bucket data is recorded as counts per 5 or 15 minutes. The number of tips (counts) measured during the allotted recording interval is then multiplied by the gauges bucket value (0.2 mm). Database records also include station details, the maintenance schedule, and monthly summaries.

Figure 36. Various precipitation gauges. From left to right: 3-season "stand-alone" rain gauge, a 4-season RT weight gauge with windscreen, and a 4-season heated rain gauge.

In contrast, while four-season precipitation gauges are capable of measuring snowfall (water equivalent), the TRCA also conducts snow course measurements at ten stations across for both the MNR and TRCA FMS (**Figure 39**). They include:

1) Clairville Dam
2) G. Ross Lord Dam
3) HeartLake Conservation Area
4) Boyd Conservation Area
5) Albion Hills Conservation Area
6) Claremont Conservation Area
7) Greenwood Conservation Area
8) Bruce's Mill Conservation Area
9) Milne Conservation Area
10) Glen Major Conservation Area

Each snow course is visited twice a month during the winter season (approx. the 1st and 15th day of each month). At each snow course, ten samples spaced 30 m apart are taken along a 270 m transect, however in cases where the full linear distance is not feasible, the transects are arranged in a "T", "Z", "L", "+" or any pattern in order to accommodate the distance (**Figure 37**).

Figure 37. Snow course sampling: Albion Hills CA (upper left), Mount Rose sampling kit (upper right), and Greenwood CA 3 of 10 sample points (above).

At each sampling location, a snow core is taken and the depth of snow is measured in centimeters. The snow core is then weighed and used to calculate its water equivalent. Underlying soil condition and the presence of a snow crust is also recorded. The snow depth and water equivalent values are then averaged over the ten samples to estimate the amount of water contained in the snow pack for each snow course.

12.3 Data

12.3.1 Stream Flow

Due to the large number of gauges, the TRCA has been working with Ontario Hydrometric Services (OHS) to develop rating curves, maintain equipment, data QA/QC, and generate reports. The reports are used to identify any known interferences with data collection. The data files provided by OHS are stored on the TRCA network water resources database and ultimately placed in the TRCA Envirobase. The majority of data records for the stream gauge network date back to 1997 however, additional stream flow data is available prior to 1997 for some gauges.

The primary use for this information is for flood structure operations (e.g. dams) and flood warning, however its value is much more than that. The data is also used by decision makers to design infrastructure, assess public risk, forecast severe weather events, develop watershed plans and water budgets, and is commonly used to assess risks to habitat. While discussed later in Section 14, with the onset of climate change and increased extreme weather events, the data has now become vital to the on-going and future operations municipal stormwater management.

12.3.2 Precipitation (Rainfall and Snowfall)

The majority of data from the TRCA precipitation network dates back to 2002. Prior to this date, the TRCA typically relied on local governments for the information. On a monthly basis the data is exported electronically to a spreadsheet stored on the TRCA network and it is ultimately uploaded to Envirobase.

In contrast, snow survey data at several of the network locations has been collected since 1957 by the MNR and the measurements were taken over by TRCA staff in 2000. The data is submitted to the Ministry of Natural Resources and also archived on the TRCA local network. During the winter and spring months, the snow depth and water equivalent data is crucial to determining the antecedent conditions of each watershed in context with snowmelt and the snow "ripeness" (potential for liquid precipitation storage in the snowpack before generating runoff).

Precipitation and snow course data is used much the same way as the stream gauge data described above (12.3.1). However, in many cases the data is also used in stormwater management modeling, meteorological, thermal, and agricultural studies.

12.4 2011 Highlights

- Updates/modifications to the stream and precipitation gauge networks in 2011 included the following;
    - A new stream gauge was installed on Spring Creek in Chinguacousy Park near Highway 7 and Central Park Drive, Brampton. The information collected by the station will be used for both flood warning and in the Etobicoke Creek 2D hydrological modeling update.
    - A new stream gauge was installed on the Don River in Toronto near Dundas Street and The Don Valley Parkway. The station is part of the TRCA's and the City of Toronto's flood warning system for the Lower Don River.
    - Instrumentation upgrades were made to both the Mimico Creek and Plunkett Creek stream gauges. In attempts by hydrometrics staff to standardize equipment and protocols, the addition of these new sensors completes the upgrades for the west network. Upgrades will begin on the east network in 2012.
    - Hydrometrics staff put in close to 100 hours of job shadowing training with OHS in anticipation of task transfer to TRCA hydrometrics technologists.
    - All 2011 rating curve development contracted by OHS was completed in winter 2012.

- Water quantity data collected by the TRCA's stream and precipitation gauging stations are being used for the City of Toronto's Wet Weather Flow Monitoring study. Moreover, in 2011 numerous requests for stream flow, precipitation, and snowcourse data collected by the TRCA have been made by all levels of government, other Conservation Authorities, educational institutions, private industry (e.g. consultants), and various students.

- A temporary stream gauge was installed and a stage-discharge curve is being developed in a small tributary draining into Spring Creek in Brampton near Dixie Road and Queen Street. The information collected by the station will be used in the Etobicoke Creek 2D hydrological modelling update.

- Hydrometric staff supervised and implemented automated baseflow monitoring for the Region of Peel Groundwater Study.

- In 2010, fisheries staff identified the need for RT water temperature data to assist them with directing field activities and collect data without regular downloading of instrumentation. A pilot demonstration was installed at both the Todmorden and McFall Dam stream gauges and continues to operate. Expansion of the network has been proposed and is intended to be installed in the spring of 2012.

- Due to the vast amount and complexity of the data collected by the hydrometrics networks (meteorological, stream, precipitation, snow course); a report summarizing selected jurisdictional observations collected by the Hydrometrics program is expected to coincide with the RWMP report. The report is expected to be finalized in the summer of 2012.

- TRCA Hydrometrics staff again field tested and attended a training seminar on the Sontek River Surveyor system to assess its potential to streamline TRCA's stage-discharge curve development process and increase staff safety when working near water during high flows. This time the device was used to measure high flow on a wide channel (the mouth of the Humber River). Manual measurements were also taken at the same time for comparison generating less than a 1% difference and increasing user confidence in its accuracy.

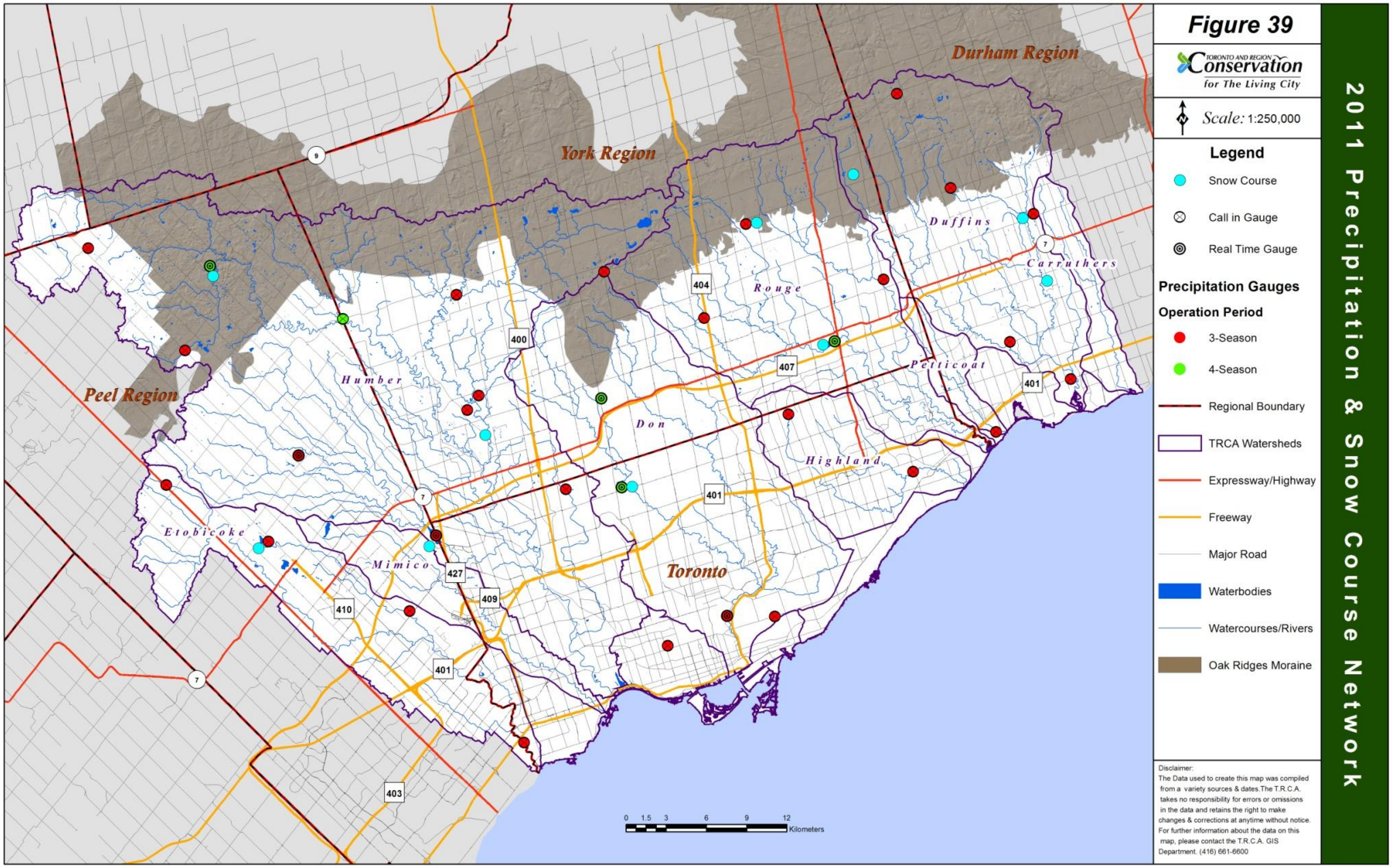

Figure 38. Water quantity monitoring sites (stream flow gauges).

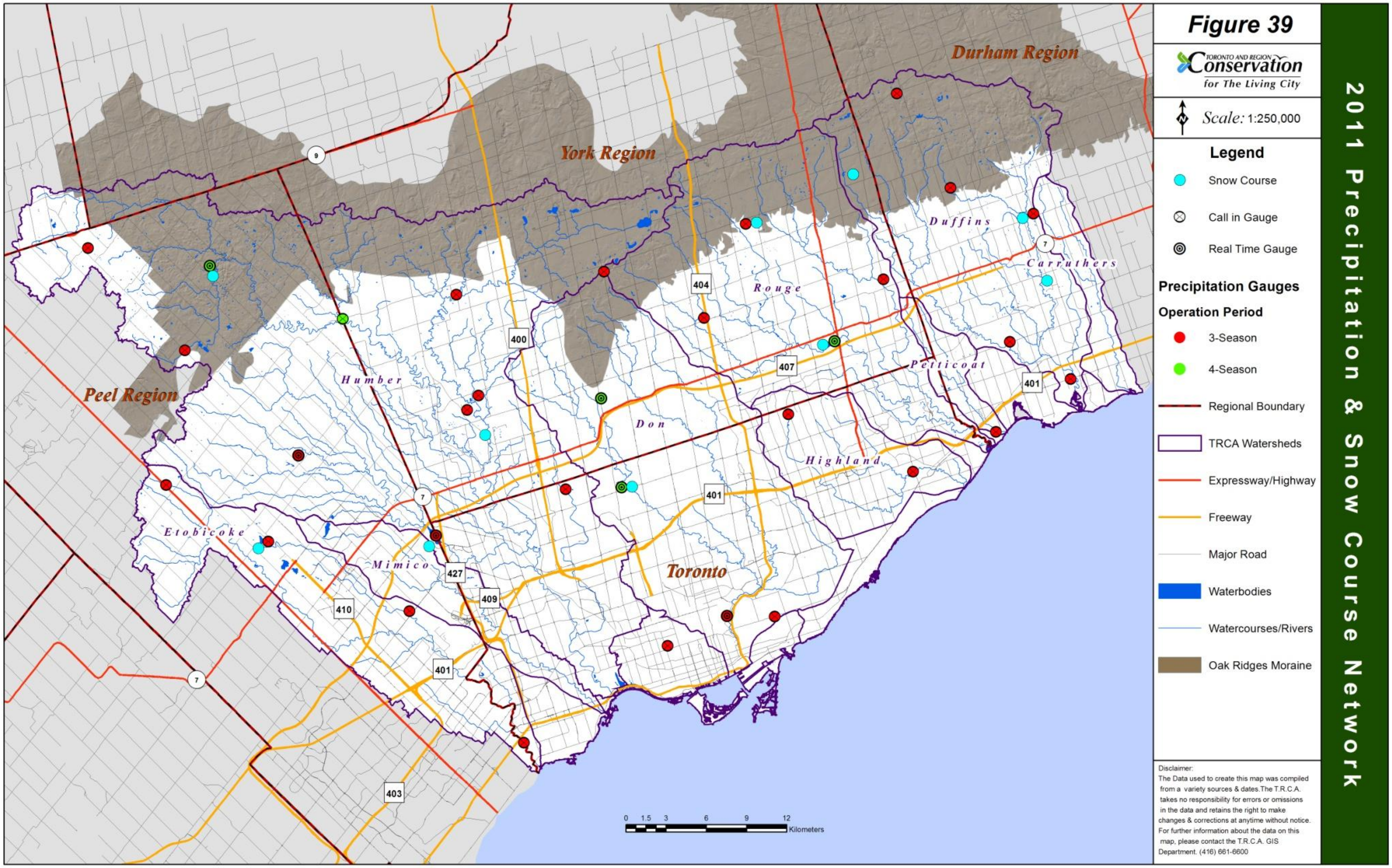

Figure 39. Precipitation and snow course network.

13 Water Quantity - Baseflow

Staff Lead: Jamie Duncan, Rita Lucero and Leland Wilbur

Support Staff: Jan Siwierski

Funding: City of Toronto, Peel Region, Durham Region, York Region and Toronto Remedial Action Plan

13.1 Background

Baseflow conditions represent the lowest stream flows that typically occur in a watercourse, and are usually supplied primarily by groundwater discharge occurring along the stream corridor and the gradual release of water from wetlands. The term low flow refers to the amount of stream flow that is sustained in a watercourse during extended periods of dry weather. In the case of the TRCA Low Flow Monitoring Program, low flow conditions occur in the drier summer season between June and September. The TRCA Low Flow Monitoring Program was established in 2000 and conducts ongoing jurisdictional monitoring of low flows during the drier summer season and is an important contribution to the Regional Watershed Monitoring Program (RWMP). The program consists of more than 1100 individual monitoring stations, with ongoing summer monthly monitoring occurring at an average of 68 stations per year. These 68 stations are called "indicator stations" and are usually located at the outflow of each major subwatershed. The other stations are more intensely distributed within each watershed and are measured systematically every five to seven years in order to obtain provide a higher resolution of ground and surface water interactions.

The main purpose of the Low Flow Program is to develop data that allows for a better understanding of the interconnections between the groundwater and surface water systems. The program also helps to establish contacts and relationships with water users as a basis for promoting awareness and stewardship activities. The long term goal of the TRCA Low Flow Program is to guide the management and protection of baseflow levels to protect aquatic life and sustainable human use of surface water.

13.2 Methods

The low flow monitoring data are all collected according to Geological Survey of Canada protocols and methodologies (Hinton 2005). The protocol requires that all overland runoff has ceased after a storm event and river flows are comprised solely of baseflow before any sampling can be done. Given the hydrologic response of the TRCA watersheds, a 72-hour period was established as the minimum time to wait following a rainfall event prior to any baseflow measurement. Upon arrival at the sampling location, a suitable transect must be found. For accuracy of measurements the stream segment should have a uniform bed, and be free of debris such as logs and rocks. The transect should be well away from any bends or meanders, and the riverbanks should not be undercut. Transects must be at a 90° angle to the streamflow. Once a suitable transect has been located, the channel is broken into 20 panels (or 5% of river per panel). These panels are measured for depth, width and water velocity. This is the velocity-area method of stream gauging (**Figure 40**). Depth and velocity are measured using a Marsh McBirney portable flow meter and depth rod. Velocity measurements are taken at 60% of the depth from the water surface. The width is acquired from a graduated tape spanning the transect. The collected measurements are recorded into an Excel spreadsheet where the panels are calculated and the total discharge of that stream segment is given. Field crews are also required to record any comments regarding that segment of the river. Permitted and non-permitted water takers are noted, as well as any land use that may be surface water dependant.

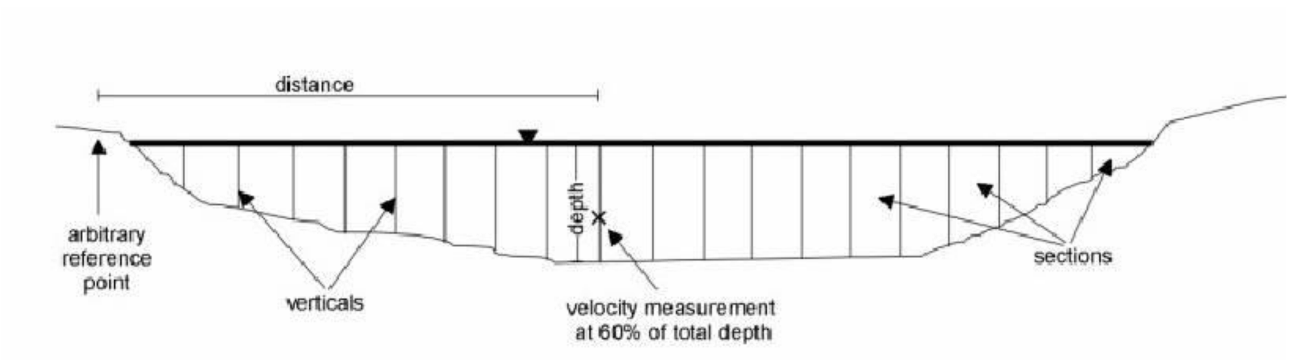

Figure 40: Cross section of a stream – baseflow transect.

13.3 Data

Baseflow data has been measured annually since 2000; however data availability varies, depending on the site of interest. Currently, baseline data exists for all TRCA watersheds, with additional monthly data available from the indicator stations. All collected data is archived annually into an MS Access Database for future storage and analysis. Data is typically used for:

- Permit to Take Water (PTTW) review
- Development review
- Groundwater Model Calibration / Validation
- Ontario Low Water Response
- Fisheries Management Plans
- Source Water Protection Planning

Fieldwork for the 2011 summer was focused on extensive watershed wide sampling in the Don and Highland watersheds. A total of 149 transect measurements were conducted in 2011, which included 62 of the 68 indicator stations (**Figure 42**). Some sites were measured more than once due to special circumstances. The measurements were conducted from the start of June to the end of August with the help of a crew leader and a summer student.

13.4 2011 Highlights

- Don and Highland watersheds were gauged at every location, while the remaining watersheds were only gauged at the indicator sites.
- July received lower than average rainfall, roughly 50% of normal and baseflows were shown to decrease when compared to historical readings. Precipitation was above normal in August and flows returned to average levels.
- While the winter months generally received about 85% of normal amounts the spring months saw values far above normal averaging about 130% of normal average values. This precipitation is likely the driver for the higher than normal baseflows seen through the summer, in spite of the unusually dry July.
- Summer outflow baseflows were seen to have increased over the summer average on a whole. While there is variability seen between measurements, the Rouge, Humber and Don watersheds, have shown a slight decrease in the last three years while over the same period the Highland, Petticoat and Mimico watersheds have been the same or have increased (**Figure 41**).

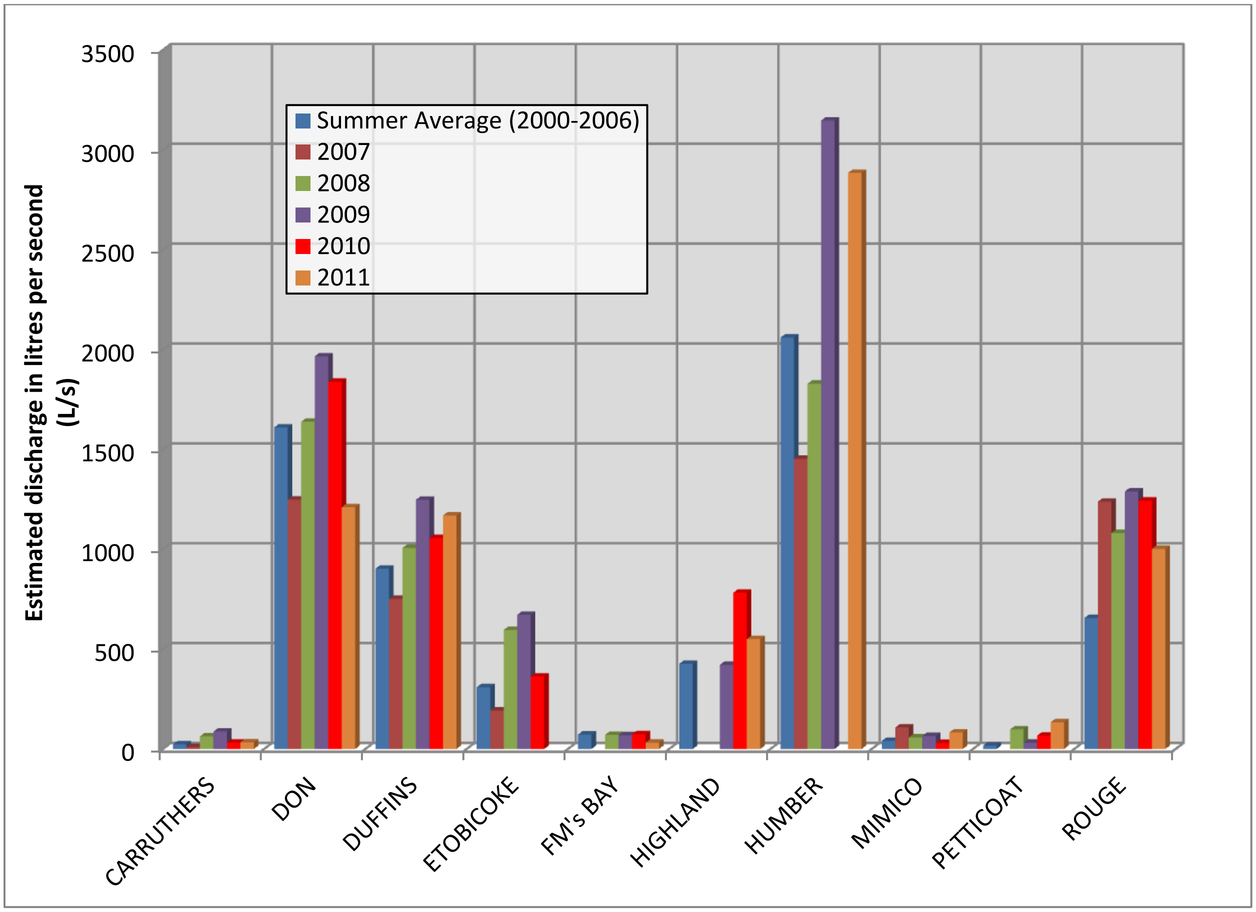

Figure 41: Change in estimated discharge over 5 years in each watershed.

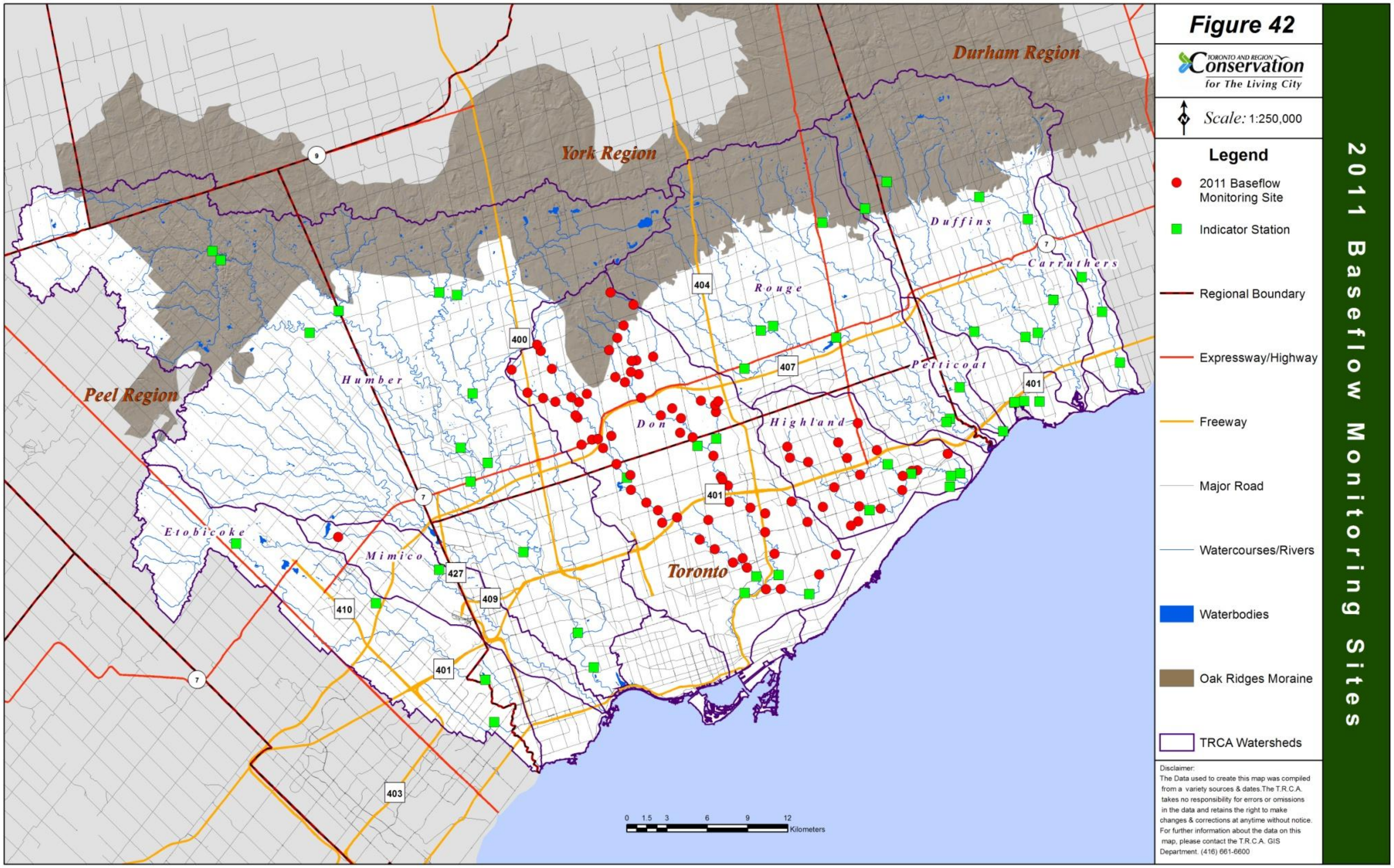

Figure 42: Baseflow monitoring sites.

14 Meteorological (Climate Monitoring)

Staff Lead: Derek Smith

Support Staff: Craig Mitchell, Bill Kerr, Rita Lucero, Jamie Duncan, Leland Wilbur, and Greg Dillane

Funding: City of Toronto, Peel Region, Durham Region and York Region

14.1 Background

No longer just a buzz word, *climate change* has become a national issue for governments and is a commonly discussed concern among the public. Today, there is strong scientific evidence that climate change is a reality which is having environmental, social, and economic impacts. Socially and economically we are witnessing the evolution of alternative energy technology, shifts towards sustainable development and even the auto industry is making cars lighter, smaller, and more fuel efficient. Environmentally, we are seeing global temperature increases, weather pattern shifts, and range shifts of both flora and fauna.

The Intergovernmental Panel on Climate Change (IPCC) expects that warming changes will be most noticeable over land masses and even greater in the higher northern latitudes. They further suggest that it is very likely that heat waves and heavy precipitation events will continue to become more frequent (IPCC 2007). In Ontario for instance, rising air temperatures, less snowfall, winter rainfall, increased summer evaporation, extreme weather events, suspect flora and fauna range shifts and lower lake levels have already been observed and/or predicted in Ontario (CCIARN 2005).

The TRCA identified Climate Change as an important issue related to its watershed management mandate in the mid 1990's. While it is well known that urbanization has an impact on natural systems, the additional stress of climate change will serve to further modify our natural systems and create new or increased challenges to the TRCA's management objectives (Haley 2006). For example, early attempts to deal with increased volumes of water in waterways were centered on stormwater management by reducing peak flow to match pre-development conditions. While this practice is now commonplace, urban infrastructure falls short of dealing with extreme weather such as rainfall greater than a 100 year storm (Haley 2006) (**Figure 43**).

Figure 43: Finch Avenue culvert failure August 19th, 2005 Toronto, >125mm in less than 1 hour.

Conservation Authorities are in a unique position to be able to deal with climate change from both an adaptive and mitigation perspective since we are strategically placed to provide our clients with effective direction and input around managing local ecosystems under the challenges that climate change can create (Haley 2006). TRCA partners continue to rely on our data collection services and monitoring expertise to provide them with as much information regarding their watersheds as possible. This, in context with the TRCA's flood warning, infrastructure/water budget modelling, and natural heritage needs lead to the development of the TRCA's meteorological (MET) network (**Figure 47**). Currently, the MET network consists of a variety of sensory devices including generic climate stations, evaporation pans, air temperature stations, and speciality instrumentation (designed by York University).

14.2 Methods

Similar to our water quantity monitoring, the MET network is designed for remote operations and long-term deployment (>15 years). Construction of the TRCA MET network began in the spring of 2006 with the acquisition of two MET stations from Natural Resources Canada (NRC) and one from Guelph University. Since that time, partnerships with both Guelph and York Universities have surfaced where they are investigating wind eddy covariance and evapotranspiration respectively. Currently, the TRCA has six MET stations deployed (**Figure 44**).

Each station is fully automated and requires little human intervention. Various meteorological and land attributes are recorded every five or fifteen minutes. Sensor selection was determined to suit the needs of both modelling and generic MET observations. Monitored parameters include: rainfall, wind direction and speed, air and soil temperature, relative humidity, solar radiation, snow depth, barometric pressure, soil moisture, evaporation, evapotranspiration (ET) and leaf wetness. Each station is maintained monthly which includes sensor cleaning (if applicable), data downloads, and calibrations are done bi-annually.

Figure 44: Various TRCA MET stations, pictured from left to right: Claremont (Transport Canada), data logger (Glenn Haffey CA), and Richmond Hill (16th Ave Fire Hall).

It should be noted that not all of the parameters listed above are monitored at each MET station; outfitting varies depending its capabilities and siting criteria. For instance, evaporation is monitored at only two of the six existing stations. Evaporation is measured using a class A evaporation pan and stilling well (**Figure 45**). The stilling well is connected to a logger which records the water level in the pan every five minutes. Because the pans are located in remote areas, the pans are filled automatically via a 950 L water tank and float switch. As part of the monthly maintenance protocols, technicians simply screen floatable and sunken debris (e.g. insects, airborne deposits) from the pan, test the float switch, landscape grass to a perimeter of 10 metres, and note tank water levels.

Figure 45: Automated evaporation pans located at Glenn Haffey Conservation Area (left) and Kortright Conservation Area (right). Glenn Haffey station depicting operational setup and Kortright station prior to spring deployment.

Similarly, ET is currently being monitored at two stations (Kortright Conservation Area and Downsview Park) using an automated Bowen Ratio Energy Balance (BREB) system (**Figure 46**). Because of the complexity of ET monitoring, York University maintains the BREB system and use TRCA MET data to determine localized ET. The stations were designed to be portable and can be relocated to differing parts of the TRCA jurisdiction. Ultimately, all MET stations will be telemetered which will drastically reduce site visits for data acquisition.

Figure 46: Automated Bowen Ratio Energy Balance system used to determine “actual” evapotranspiration values, located at Kortright Conservation Area (left) and Downsview Park (right).

Since 2005, eight air temperature stations were also deployed by request of TRCA fisheries biologists with the intent to correlate air temperature fluctuations with tributary water temperatures (**Figure 47**). The sensors have been recording data every five minutes and record 365 days a year. The data is ultimately incorporated into the MET station database.

14.3 Data

Data at two of the MET stations has been collected since 2000 (stations acquired from Natural Resources Canada). The data are entered electronically into spreadsheet format and are stored on the TRCA network. Ultimately the data is uploaded to the TRCA Envirobase and Environment Canada's Inventory of Climate Observing Networks in Ontario (ICONO). All MET data are available to outside agencies and the general public upon request.

The initial purpose of this data was for flood warning and infrastructure modeling purposes. However, the general consensus of TRCA personnel and clients has confirmed that the data is necessary to document long term climate changes, and for both natural heritage and biological studies.

Using the TRCA RT flood warning website as a portal, TRCA staff is working to post the MET station data for public use once telemetry is established. While not all stations will be posted, a request by flood warning staff to have strategically chosen stations connected to the RT network will significantly advance flood warning bulletins.

14.4 2011 Highlights

- All MET stations continued to operate normally in 2011. However, the Downsview Park MET station was shut down because of long term construction on the property. Hydrometrics staff anticipates the station will be redeployed back on the property once development activities have ceased.

- Precipitation gauges at the Bayly, Transport Canada, and Glenn Haffey CA MET stations were upgraded, standardized, and incorporated into TRCA's precipitation network.

- Both the Kortright and Downsview ET monitoring stations continue to operate normally and are maintained by York University.

- In 2011, York University reported that water loss due to evaporation from the field at the Kortright Conservation Area was far greater than the paved surface at Downsview Park. Furthermore, early spring temperatures extended the monitoring season by over a month and activities were able to start as early as March. Data QA/QC and processing is now complete up to November 2011 and will be uploaded to TRCA's Envirobase database.

- The Interim results of the ET study were presented to industry professionals at the Canadian Water Resources Association and the Canadian Association of Geographers annual meetings by Shishir Handa (MSc candidate at York University). The presentations, co-authored by TRCA's Glenn MacMillan and Professor Richard Bello demonstrated the profound differences in water/energy budget fluxes at the Kortright and Downsview stations caused by urbanization.

- Continued air temperature monitoring for TRCA aquatic biology program in 2011.

- Due to the vast amount and complexity of the data collected by the hydrometrics networks (meteorological, stream, precipitation, snow course), a report summarizing selected jurisdictional observations collected by the Hydrometrics program is expected to coincide with the RWMP report. The report is expected to be finalized in the summer of 2012.

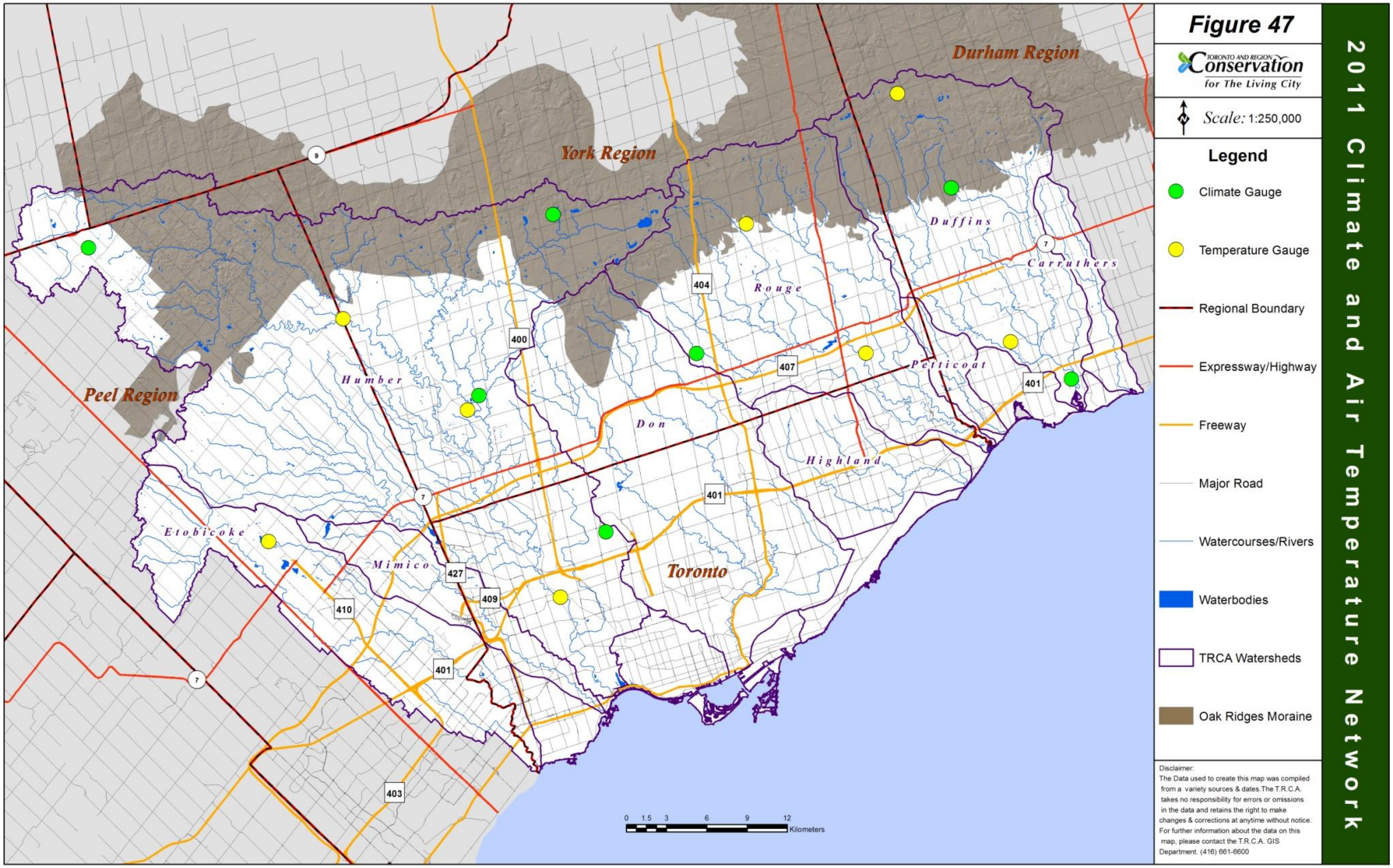

Figure 47: Climate and air temperature network.

15 Staff Contributions

15.1 Staff

Nelson Amaral
Technologist, WM&R
Restoration Services Center
T: (416) 661-6600 ext. 5636
namaral@trca.on.ca

Melanie Croft-White
Technician, WM&R
Restoration Services Center
T: (416) 661-6600 ext. 5754
mcroft-white@trca.on.ca

Jamie Duncan
Water Resources Data Management Analyst
TRCA Head Office
T: (416) 661-6600 ext. 5286
jduncan@trca.on.ca

Cheryl Goncalves
Technologist - Algae Biomonitoring Project
Boyd Office
T: (416) 661-6600 ext. 5766
cgonsalves@trca.on.ca

Sue Hayes
Project Manager, Terrestrial Field Inventories
TRCA Head Office
T: (416) 661-6600 ext. 5356
shayes@trca.on.ca

Scott Jarvie
Manager Watershed Monitoring & Reporting Section
Restoration Services Center
T: (416) 661-6600 ext. 5312
sjarvie@trca.on.ca

Jessica Fang
Technologist, WM&R
Boyd Office
T: (416) 661-6600 ext. 5665
jfang@trca.on.ca

Leland Wilbur
Flow Management Technician
TRCA Head Office
T: (416) 661-6600 ext.5239
lwilbur@trca.on.ca

Theresa McKenzie
Coordinator, Terrestrial Volunteer Monitoring
TRCA Head Office
T: (416) 661-6600 ext. 5658
tmckenzie@trca.on.ca

Jan Moryk
Technologist, WM&R
Restoration Services Center
T: (416) 661-6600 ext. 5755
jmoryk@trca.on.ca

Derek Smith
Hydrometrics Specialist
TRCA Head Office
T: (416) 661-6600 ext. 5362
dsmith@trca.on.ca

Jeff Vandenberg
Environmental Technician
Boyd Office
T: (416) 661-6600 ext. 5655
jvandenberg@trca.on.ca

Angela Wallace
Analyst, WM&R
Restoration Services Center
T: (416) 661-6600 ext. 5333
awallace@trca.on.ca

15.1.1 Technical Advisory and Support Staff

Ming Guo	Kelly Purves	Rita Lucero	Matt Derro
Roger Hau	Paul Greck	Jamie Duncan	Craig Mitchell
Jason Tam	Gavin Miller	Leland Wilbur	Bill Kerr
Paul Prior	Natasha Gonsalves	Greg Dillane	

15.1.2 Seasonal Staff

Michael Brestansky	Bruna Peloso	Andrew Nelson	Derek Tune
Michael King	Danielle Gustaw	Sarah Irvine	Priscilla Lai
Allison Scovil	Matt Wilson	Sarah Scharfnberg	Rivka Shachak
Natalie Racette	Tyson Reid	Jan Siwierski	Ellen Fanning
	Claire Crowley	Mark Szonda	

15.2 Training and Workshops

The TRCA's Ecology Division is committed to the belief that both the transfer of knowledge and continuous education are critical elements to effective management of our environmental resources. In addition to attending various training sessions, staff in the Watershed Monitoring and Reporting Section conducted several workshops for both internal and external participants.

15.2.1 Conducted by TRCA Staff

- Terrestrial Volunteer Monitoring Seasonal Training for 2011 was conducted during November 2010, March 2011, May 2011 and September 2011 with a total of 133 attendees (Theresa McKenzie)
- WNV vector mosquito larvae Identification Course conducted for 19 people (Durham, Hamilton and Halton Health Unit staff), during April – May at Boyd Office (Thilaka Krishnaraj)
- Class 2 Backpack Crew Leader Electrofishing Course conducted for 20 people (6 internal, 14 external), on May 31 2011 at Boyd Office (Jeff Vandenberg, Nelson Amaral, Scott Jarvie, Michael Brestansky)
- Ontario Stream Assessment Protocol Training course – Internal training session June 2011. (Jeff Vandenberg)
- Sedge Identification Technical Training course conducted for 30 participants (external). June 2012. (Kelly Purves, Gavin Miller and Natasha Gonsalves).
- Water safety Training Course – Internal May 31 2011– (wader safety instructor – Jeff Vandenberg
- Algae Bioassessment Protocol sample collection training conducted for nine internal TRCA staff, in July 2011 at Boyd office (Cheryl Goncalves)

- Ontario Stream Assessment Protocol Training course – Durham College, Oshawa. June 7-11, 2011. (Scott Jarvie – course administration, Jeff Vandenberg, Jan Moryk, Jessica Fang)
- Ontario Benthos Biomonitoring Network Training course- University of Toronto at Scarborough, Scarborough. November 4-7, 2011 (Cheryl Goncalves assistant trainer)

15.2.2 Attended by TRCA Staff

- Ontario Forestry Association Conference. February 4, 2011 (Theresa McKenzie)
- 46th Central Canadian Symposium on Water Quality Research, Burlington. February 22, 23 2011 (Angela Wallace, Cheryl Goncalves).
- Second International Conference on Urban Drainage and Road Salt Management in Cold Climates. February 27, 2011. (Angela Wallace)
- Ontario Road Ecology Group Annual General Meeting, Toronto Zoo. March 2011 (Paul Prior)
- Soils and Urban Trees Conference, Toronto Botanical Garden. April 2011 (Gavin Miller)
- Ontario Society for Ecological Restoration Symposium and Annual General Meeting. October 2011 (Gavin Miller)
- Ontario Benthos Biomonitoring Network (OBBN) workshop. June 5-6, 2011 (Jessica Fang)
- Sontek River Surveyor Workshop, Environment Canada, Burlington, Ontario. June 9-10, 2011 (Derek Smith, Greg Dillane, Leland Wilbur).
- Provincial Flood Forecasting and Warning Workshop, Black Creek Pioneer Village, Toronto, Ontario. September 13, 2011 (Derek Smith, Craig Mitchell, Greg Dillane, Leland Wilbur).
- Sutron Advanced Programming Workshop, Environment Canada, Burlington, Ontario. September 21, 2011 (Derek Smith, Greg Dillane, Leland Wilbur).
- Bats of Ontario, Monitoring Methods Workshop, June 27, 2011 & Sept. 20, 2011 (Theresa McKenzie, Paul Prior, Sue Hayes)
- Family Level – all Phyla Taxonomic Certification. Society For Freshwater Science. October 20, 2011 (Jessica Fang)
- A.D. Latornell Conservation Symposium. Conservation Ontario. November 17-19, 2011. (Angela Wallace, Melanie Croft-White, Jan Moryk, Scott Jarvie, Nelson Amaral, Jessica Fang, Jeff Vandenberg, Cheryl Goncalves)

15.3 Professional Activities

Watershed Monitoring and Reporting Section staff annually participates in a variety of professional activities such as presenting at conferences and contributing to numerous committees. In addition numerous reports or journal articles are completed based on the data collected under RWMP or through special projects.

15.3.1 Presentations

- Canadian Conference for Fisheries Research: *9 years of monitoring: Stream and River fish biodiversity and urbanization within 9 watersheds across the Toronto Region.* January 11th 2011 (Jan Moryk)
- Ontario Forestry Association Conference: *A Citizen Science Approach to Long-term Monitoring of Forests in the Toronto Region.* February 4, 2011 (Theresa McKenzie)

- Southern Ontario Conservation Authorities Terrestrial Monitoring Network: *The Value of Incorporating Local Rank of Conservation Concern (L rank) into the Native Indicator Species Richness Metric.* April 6, 2011 (Theresa McKenzie)
- Second International Conference on Urban Drainage and Road Salt Management in Cold Climates: *Chloride in the Toronto Region and its Relationship with Three Aquatic Communities*. April 2011. (Angela Wallace).
- Loretto Abbey Catholic Secondary School: *Streams and Rivers: The role of the TRCA and objectives of the RWMP.* May 2011 (Jan Moryk)
- Lake Ontario Evenings: *Stream and river fish biodiversity and urbanization: 9 years of monitoring within watersheds across the Toronto Region.* December 5th 2011 (Jan Moryk)
- Bolton District Horticultural Society. *Native Plants of Ontario: Reclaiming Biodiversity*. April 2011 (Natasha Gonsalves)
- A.D. Latornell Conservation Symposium November 2011:
  - Water Quality in the Toronto Region as Indexed through Water Chemistry and Benthic Macroinvertebrates. (Angela Wallace)
  - Stream Fish Community in the Toronto Region: Spatial and Temporal trends (Melanie Croft-White)
  - Effect of Urbanization: Nine years of monitoring stream fish and macroinvertebrate biodiversity within nine watersheds across the Toronto Region (Jan Moryk)
  - Can diatom community composition be used to evaluate water quality in southern Ontario Streams? Poster presentation (Cheryl Goncalves)
- Fall SOSMART meeting: *Monitoring water quality using an algae bioassessment protocol* December 1, 2011. (Cheryl Goncalves)

15.3.2 Reports and Publications

- 2010 Surface Water Quality Report. March 2011.
- Draft Characterizing streams of different Strahler order between Watersheds within the Toronto Region. April 2011.
- Draft Comparing Methods of Assigning Strahler Stream Order: Digital Elevation Model vs. TRCA Water Course Layer. April 2011
- Regional Watershed Monitoring Program: Fish Community Summary 2001-2009. August 2011.
- Duffins Heights Neighbourhood Aquatic Features Baseline Monitoring Report (Draft). December 2011.
- Draft Highland Creek Update October 2011.
- Regional Watershed Monitoring Program: Surface Water Quality Summary 2006-2010. December 2011.
- Regional Watershed Monitoring Program: Benthic Invertebrate Summary 2001-2008. December 2011.
- Draft Regional Watershed Monitoring Program: Fish Habitat Summary 2001-2009. December 2011.
- Terrestrial Biological Inventory and Assessments
  - Port Union Waterfront Study Area. March 2011
  - Markham East Woodlot. March 2011

  - Brock Lands. November 2011
  - Rouge Park South of Steeles Ave. December 2011
  - Humber Source Woods. December 2011.
- Ontario Power Generation: Terrestrial Long-term Monitoring Project (Year 2). February 2011.
- Caledon East: Terrestrial Long-term Monitoring Project (Year 2). March 2011.
- Terrestrial Fixed Plot Monitoring: Regional baseline conditions report. December 2011.
- Annual Fish Collection Records Report 2011.
- Draft Land Owner information reports 2010 and 2011.
- Effect of aquatic vegetation and water quality on West Nile virus vector larval abundance in Toronto Region wetlands and stormwater management ponds. February 2011
- West Nile Virus 2010 annual report. March 2011.

15.4 Committees

Watershed Monitoring and Reporting Section staff participated on the following committees:

- Database Working Group – Toronto and Region Conservation (Scott Jarvie, Angela Wallace, Nelson Amaral, Sue Hayes)
- Southern Ontario Stream Monitoring and Research Team (SOSMART) (Scott Jarvie)
- Southern Ontario Conservation Authorities Terrestrial Monitoring Network – Toronto & Region Conservation, Conservation Halton, Credit Valley Conservation, Central Lake Ontario Conservation (Theresa McKenzie & Sue Hayes)
- Ontario Ministry of Natural Resources Ecological Land Classification Update Technical Team (Gavin Miller)
- City of Toronto Biodiversity Series: Reptiles and Amphibians of Toronto Guide Production Team (Paul Prior)
- Natural Areas Inventory Management and Technical Team – Credit Valley Conservation (Sue Hayes)
- Jefferson Salamander Recovery Team – Ontario Ministry of Natural Resources (Sue Hayes)
- Durham Regional Health WNV Committee meeting, Whitby, (Thilaka Krishnaraj, Jessica Fang)
- PGMN Central Working Group - (Jeff Vandenberg)
- Conservation Ontario Watershed Report Card – Technical Working Group (Scott Jarvie)
- York Region Low Water Response Team – York Region (Jamie Duncan and Rita Lucero)

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Appendix A

Appendix A. 2011 Regional Watershed Monitoring Activities by Watershed

		Etobicoke	Mimico	Humber	Don	Highland	Rouge	Petticoat	Duffins	Carruthers	Other[1]	Total
Regional Watershed Monitoring Program	**Fish Species & Aquatic Habitat**	0	13	1	23	11	15	4	0	0	4	71
	Algae Biomonitoring	3	0	8	2	0	3	1	7	1	1	26
	Benthic Macroinvertebrates	14	9	43	24	11	34	4	24	3	4	170
	Fluvial Geomorphology	0	0	0	17	7	26	0	0	0	0	50
	West Nile Virus Monitoring	2	0	17	6	2	3	1	6	2	7	46
	Surface Water Quality	4	3	12	5	1	8	1	9	1	1	44
	Baseflow	4	2	13	77	25	4	2	8	3	4	142
	Stream Flow	4	1	7	8	2	3	1	7	1	2	36
	Precipitation	4	0	10	5	2	4	1	6	0	1	33
	Snow	1	0	3	1	0	0	2	3	0	0	10
	Groundwater Quality & Quantity	2	0	9	0	0	3	0	6	0	0	20
	Terrestrial Natural Heritage[2]	*0*	*0*	*685*	*75*	*0*	*130*	*0*	*130*	*0*	*280*	*1300*
	Terrestrial Volunteer Monitoring	5	1	19	8	2	7	1	7	1	4	55
	Meteorological (Climate Monitoring)[3]	1	0	6	0	0	3	0	4	0	0	14
	Water Temperature	0	5	1	23	11	0	4	0	0	4	48

[1] *Other minor watersheds including tributaries of Frenchman's Bay and Toronto Waterfront*

[2] *Italicized numbers are the number of hectares monitored*

[3] *Includes both meteorological stations and "stand alone" air temperature stations*

Appendix B

Appendix B. 2011 Regional Watershed Monitoring Activities by Region

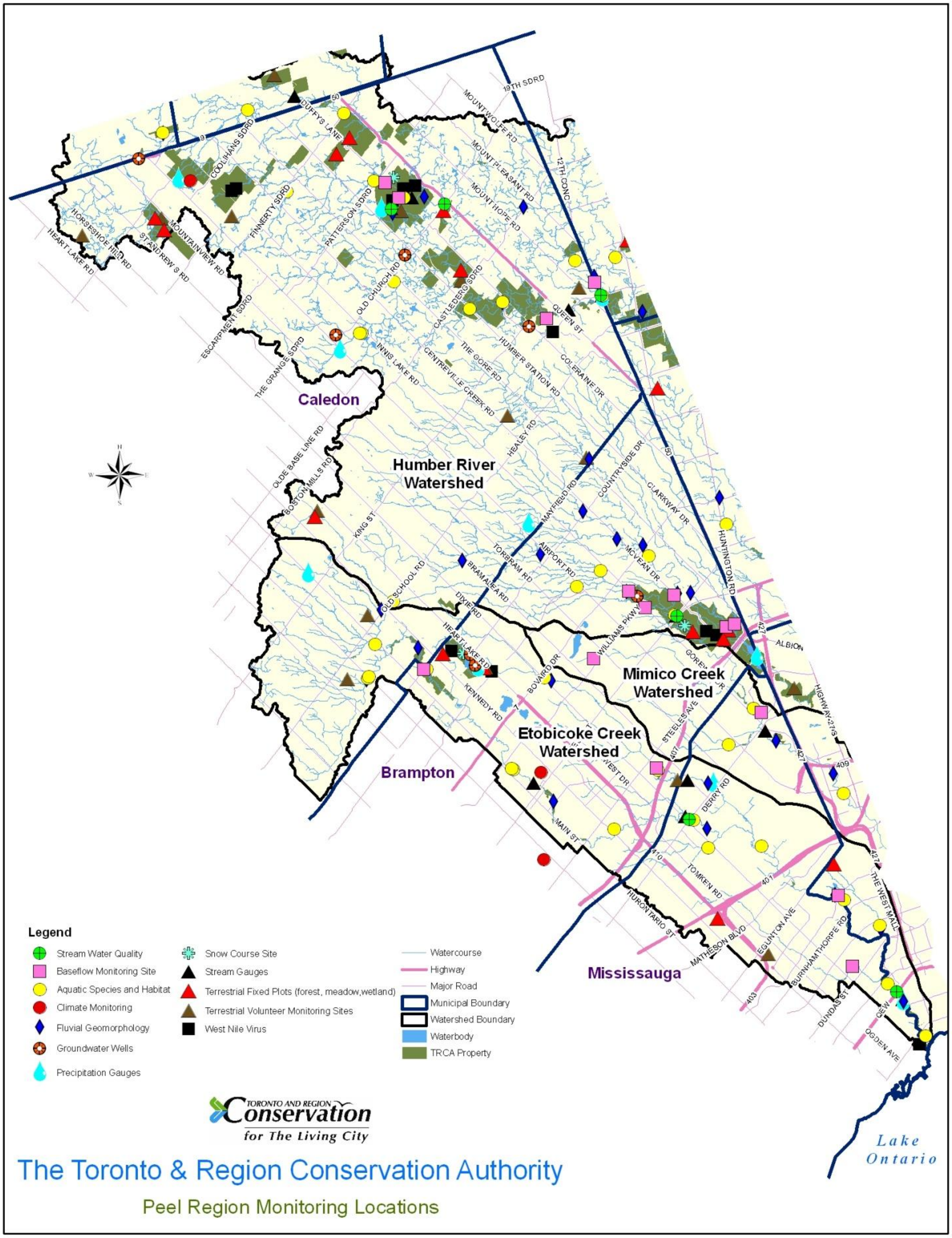
		Durham	Peel	Toronto	York	Other[1]	Total
Regional Watershed Monitoring Program	Fish Species & Aquatic Habitat	7	11	33	20	0	71
	Algae Biomonitoring	10	5	4	7	0	26
	Benthic Invertebrates	34	35	53	48	0	170
	Fluvial Geomorphology	0	0	24	26	0	50
	West Nile Virus Monitoring	10	9	12	15	0	46
	Surface Water Quality	12	7	13	12	0	44
	Baseflow	16	8	66	52	0	142
	Stream Flow	10	8	9	5	4	36
	Precipitation	6	9	7	11	0	33
	Snow	3	3	1	3	0	10
	Groundwater	6	7	1	6	0	20
	Terrestrial Natural Heritage[2]	*130*	*226*	*354*	*590*	0	*1300*
	Terrestrial Volunteer Monitoring	10	13	18	13	1	55
	Meteorological (Climate Monitoring)[3]	4	2	1	7	0	14
	Water Temperature	7	3	27	11	0	48

[1]Dufferin/Simcoe

[2]Italicized numbers are the number of hectares monitored

[3] Includes both meteorological stations and "stand alone" air temperature stations

Appendix C

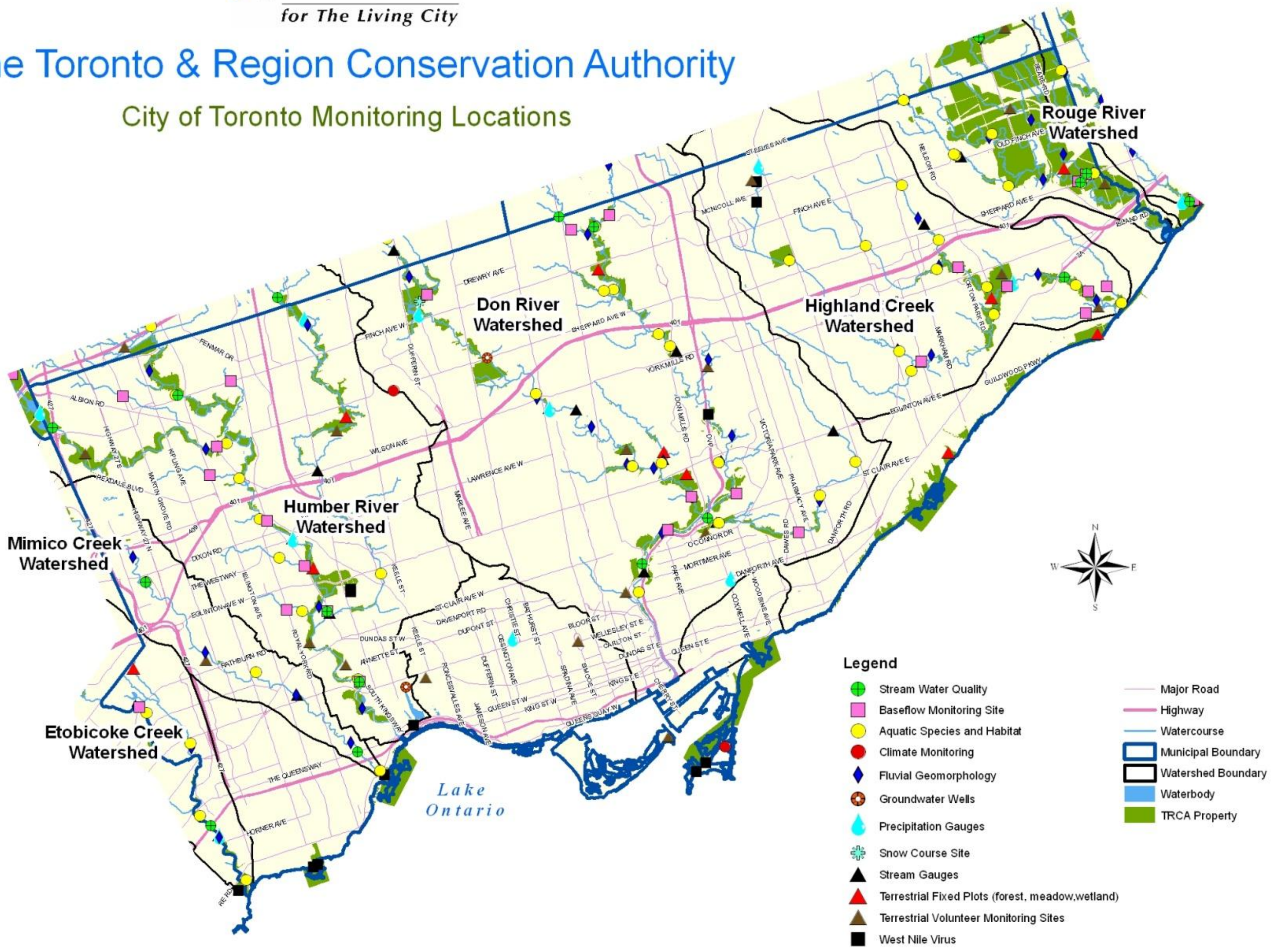


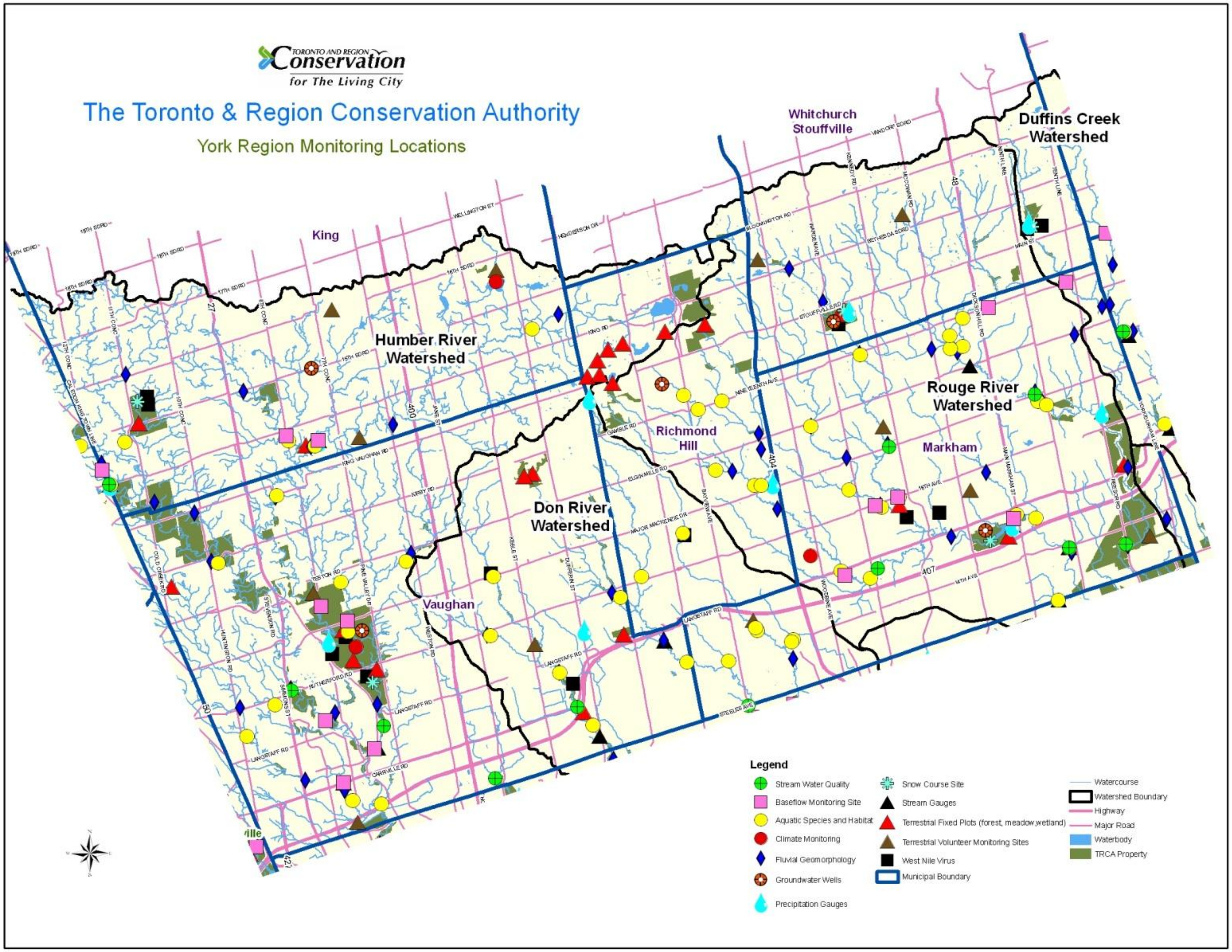
Caledon
Humber River Watershed
Mimico Creek Watershed
Etobicoke Creek Watershed
Brampton
Mississauga
Lake Ontario
Legend
Stream Water Quality
Baseflow Monitoring Site
Aquatic Species and Habitat
Climate Monitoring
Fluvial Geomorphology
Groundwater Wells
Precipitation Gauges
Snow Course Site
Stream Gauges
Terrestrial Fixed Plots (forest, meadow,wetland)
Terrestrial Volunteer Monitoring Sites
West Nile Virus
Watercourse
Highway
Major Road
Municipal Boundary
Watershed Boundary
Waterbody
TRCA Property
TORONTO AND REGION Conservation for The Living City
The Toronto & Region Conservation Authority
Peel Region Monitoring Locations

Conservation for The Living City

The Toronto & Region Conservation Authority

City of Toronto Monitoring Locations





Toronto and Region Conservation for The Living City
The Toronto & Region Conservation Authority
York Region Monitoring Locations
King
Whitchurch Stouffville
Duffins Creek Watershed
Humber River Watershed
Rouge River Watershed
Richmond Hill
Markham
Don River Watershed
Vaughan
Legend
Stream Water Quality
Baseflow Monitoring Site
Aquatic Species and Habitat
Climate Monitoring
Fluvial Geomorphology
Groundwater Wells
Precipitation Gauges
Snow Course Site
Stream Gauges
Terrestrial Fixed Plots (forest, meadow,wetland)
Terrestrial Volunteer Monitoring Sites
West Nile Virus
Municipal Boundary
Watercourse
Watershed Boundary
Highway
Major Road
Waterbody
TRCA Property