FINAL REPORT

MOSQUITO POPULATION AND SPECIES IDENTIFICATION INCLUDING LARVAL / ADULT TRAPPING AND BREEDING SITE MAPPING

TOWN OF GEORGINA 2007

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1 Introduction

The quality of life for residents of Pefferlaw has been impacted by significant populations of "nuisance" mosquitoes. In discussions, individuals expressed concern over loss of business, depressed property prices as some people literally moved elsewhere due to the nuisance factor, and a general inability to enjoy the outdoors during major parts of the summer months. Residents initiated a petition requesting that Municipal council investigate new options for control.

Historically, the Town of Georgina controlled nuisance mosquitoes in Pefferlaw with a Malathion ULV adulticiding program. This program has been suspended since 2006.

GDG Environnement, a company specialized in the biological control of biting flies, has been mandated to collect, identify, and monitor adult mosquitoes and to map mosquito development sites. A total of 10 CDC light traps has been operated across the Pefferlaw region to monitor adult mosquitoes. The mapping of mosquito breeding sites developed in 2006 has been updated and we have performed larval monitoring in order to confirm the characterization of the mapped sites. This information will support the evaluation of mosquito population seasonal dynamics as well as of overall species composition for the period of the study.

The larval sampling results have shown the presence of *Ochlerotatus stimulans* and *Ochlerotatus provocans* (across territory in mid-April) and of *Ochlerotatus excrucians* (towards the end of April), three aggressive human biters that emerge after snowmelt. Larval monitoring in the month of May has indicated the presence of *Ochlerotatus fitchii, Ochlerotatus punctor,* of some *Culiseta* species and of *Aedes (Ae.) vexans*.

The catchment basin of the Pefferlaw area is part of the Lake Simcoe watershed system, and is drained by the Pefferlaw River which runs from south to north. Important mosquito development sites are situated within the Pefferlaw River flood plain.

The high water table and the flat topography create a haven for mosquito reproduction and favour the creation of large mosquito development sites, many of which remain flooded throughout the season. The goal of a biological control program is to dramatically reduce the numbers of mosquitoes emerging from development sites without otherwise impacting the surrounding flora or fauna.

This study is being undertaken in four phases: The first consists of identifying and delineating mosquito development sites by analysing aerial-photos and satellite imagery of the area. The second phase consists of field visits to analyse and validate sites identified in the first phase. This habitat analysis can indicate which species of mosquitoes are most likely to develop in each sector. The third phase consists of analysing the 2006 adult mosquito trapping results provided by last years study and analysing the current 2007 adult mosquito trapping results. Finally the information gathered is integrated, evaluating the number and size of development sites, their potential productivity and seasonality, optimal treatment strategies, and identification of issues that could arise in an operational control program for the Town of Pefferlaw.

The objective of this study is to identify the realistic requirements of a program which will have a real and noticeable impact on the quality of life for the residents and visitors while maintaining the ecological integrity of the area. A properly operated program can significantly improve the quality of life of citizens and tourists, thereby having a positive impact on business and property values.

2 Work progress

Our field technicians have been sampling mosquito breeding sites in Pefferlaw since mid-April 2007. Larval monitoring has been conducted on a weekly basis. Breeding site maps have been updated using data collected in the field.

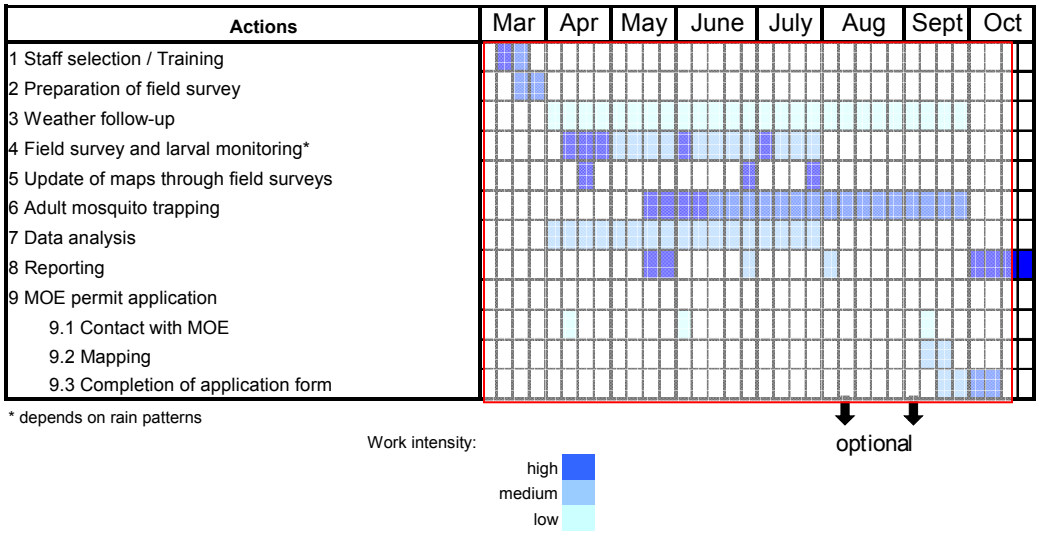
Weekly adult mosquito trapping started in mid-May, and has been conducted on a weekly basis. Collected data are analysed on a weekly basis and used to pinpoint problem sites.

Preliminary work has been undertaken to further understand MOE requirements for a Biological larvicide program. Mark Ardis, Jack Sloggett, of GDG, and Mike Baskerville, of the Town of Georgina, have met wih MOE pesticide specialists to discuss the requirements for such a program.

MOE permit application will start once the Ontario Ministry of Natural Resources (MNR) has given the authorization to treat the Morning Glory Swamp and the Pefferlaw Brook.

Figure 2.1 shows where we currently are situated in the studies timeline.

Figure 2.1. General schedule for the study



3 Mosquito development site typology

Mosquitoes establish their larval development sites in environments containing stagnant waters, such as wetlands and marshes, bogs, flood plains, poorly drained forests, ditches, etc... Certain species prefer temporary environments (rainfall dependant) while others prefer permanent sites (existing throughout the season). Some species have many generations per season (multivoltine) while others have only one generation (univoltine). In addition, only some of the approximately 30 species found in the area are a nuisance to humans. Because of these factors it is essential to analyse the mosquito species composition of the area as well as categorize the different habitat types. A scientific approach to the development of a program will maximize the impact on the “nuisance” factor while minimizing cost and potential impact on the environment.

At the overview level, larval development sites can be classified as either permanent or temporary standing water sites. Within these two broad classifications, sites can be further defined to create a noticeable and cost effective control program.

3.1.1 Permanent standing water sites

The definition of a permanent standing water site is where water is permanently present. This broad class is comprised of both natural and artificial bodies of water. Wetlands, abandoned swimming pools, used tire depots, catch basins, sewage lagoons, storm water management ponds and poorly drained ditches are all potential sources for mosquito larval development in the municipality.

For the Pefferlaw area the main biting species associated with these types of habitats are *Coquilletidia perturbans*, *Aedes vexans, and Oc. triseriatus.* All three species are aggressive human biters. *Cq. perturbans* larvae develop in permanent marshes, such as the Morning Glory wetland, with the eggs hatching immediately after being laid. *Ae. vexans and Oc. triseriatus* are mostly associated with temporary standing water sites. *Ae. vexans* females lay their eggs on the banks near water rather than directly on the water. Marshes and storm water management ponds with fluctuating water levels can generate new generations of *Ae. vexans* following rainfall events. The flatness of the drainage basins indicates that the permanent sites can expand rapidly following rains.

The principal species which develop in artificial permanent environments are *Oc. triseriatus* and *Oc. japonicus*.

It is important to note that permanent water sites can also produce species associated with temporary environments. After large rain events an increase in water levels will cause inundation along the periphery of the permanent water site. This will foster another generation of species such as *Ae. vexans.*

3.1.2 Temporary standing water sites

The definition of a temporary standing water site is where the ground is flooded on a daily, seasonal or annual basis. In the Pefferlaw region examples of such sites are snow-melt pools, the regional forest tracts and road side ditches.

Several types of mosquitoes are favoured by temporary standing water sites. The first group of mosquitoes are univoltine (one generation) spring species. Their eggs hatch during the snowmelt. Their eggs are very resistant to cold and desiccation. In order for the eggs to hatch they must be exposed to a period of freezing and short photoperiod for several months (winter). When temperatures rise and day length increases, the embryo is then ready for hatching. However, a second stimulus is required to provoke egg hatching. The water's oxygen content must drop rapidly. This drop in oxygen is generated by the rapid development of bacteria naturally present in the water. In the Pefferlaw region, species of this group are members of the genus Ochlerotatus (Oc.): *Oc. stimulans, Oc. provocans, Oc. excrucians, Oc. fitchii, Oc. eudes, Oc. punctor, Oc. abserratus, Oc. communis, Oc. implicatus.* As a group they are often called "springtime *Ochlerotatus*" species

The second group of species can have several generations in one season, these species are: *Oc. canadensis*, *Oc. cantator, Oc. trivittatus, Oc. sticticus, Ae. vexans and Ae. cinereus.* These species are dependent on rainfall events for development. They will lay their eggs between the low and high water mark of standing water sites. When the water level rises, the eggs then hatch. During the summer these species can have up to 10 generations.

4 Mosquito surveillance results

4.1 Larval sampling

Larval sampling has given insight on the spatial and temporal distribution of nuisance mosquito breeding sites. Sampling started on April 14th 2007 and has since continued on a weekly basis. Collected specimens are carefully stored in 70% isopropyl alcohol and sent to GDG's laboratory for identification to species level.

Since April 14th 2007, 1,014 site visits were completed. Visited sites are shown in Figure 4.1 and results are shown in table 4.1. Sites were visited several times during the season.

The mosquito season consists of three broad periods; spring snowmelt, transition and summer. Certain species have adapted to all three periods while some are only capable of being active in one or two periods. The spring snowmelt period starts in mid-April and ends towards the end of May. The transition period starts at the end of May and goes on until the end of June. During the transition period you will find both spring species and summer species. The summer period starts at the end of June and continues till the end of September.

During the spring snowmelt period (weeks 16 to 21 in table 4.1) 8 different species were collected. *Ochlerotatus provocans* and *stimulans* species were the most abundant. Site AB02 , located at the end of Donna street had the largest number of specimens collected.

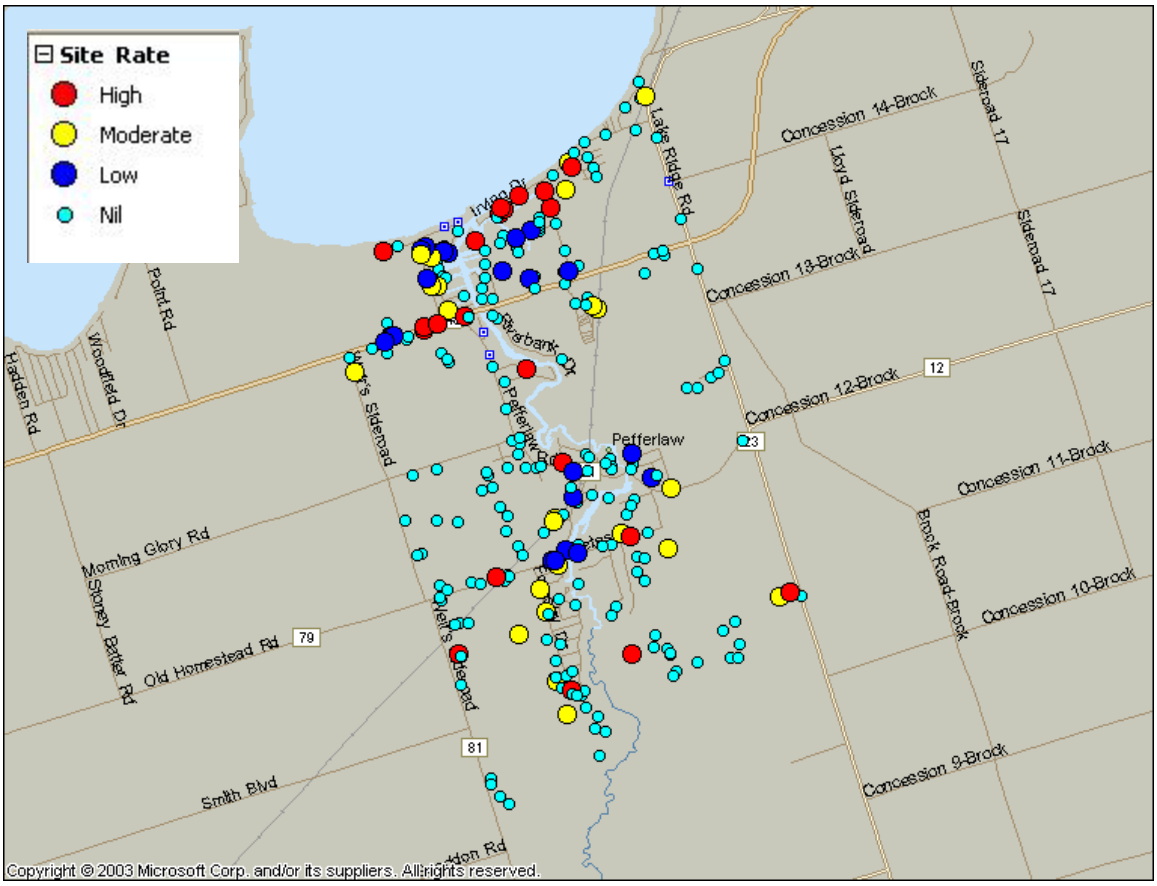
During the transition period (weeks 22 to 26) 5 different species were collected. The most abundant species was *Aedes vexans* . These specimens were collected in road side ditches following a rainfall event. The site with the largest number of specimens collected was site BB60, a road side ditch located along Pefferlaw road.

For the summer period (weeks 27 to 35) 10 different species were collected. The most abundant species was *Culex territans* followed by *Ocherotatus* species. *Culex territans* generally breeds in clean unpolluted permanent standing water sites. This species is not a concern for nuisance programs since it does not seek a blood meal from humans, but rather from frogs.

Table 4.1. Mosquito larvae sampling results for the Pefferlaw area.

Week	Aedes cinereus	Aedes vexans	Anopheles punctipennis	Anopheles quadrimaculatus	Anopheles sp.	Culex pipiens	Culex restuans	Culex territans	Culicidae sp.	Culiseta minnesotae	Culiseta morsitans	Ochlerotatus dorsalis	Ochlerotatus excrucians	Ochlerotatus fitchii	Ochlerotatus provocans	Ochlerotatus sp.	Ochlerotatus stimulans	Ochlerotatus stimulans gr.	Other	Total
16											1		71	87	54					213
17							3								38					41
19	2						2				4			4	1			13		26
20		1					29	1				2		69	9					111
21		186				2	9		1											198
22		4				7	10							199			1			221
23		126				1	3							24						154
24		324				4	5													333
26			6		9	1	51	16	5											88
27			1		1			44	4											50
28		362						26			1			461						850
29			4		50		24	53	45					1						177
30		46		1	6	23	1	177	9											263
31			9		24	4	5	142	7											191
32								61												61
35								3												3
Total	2	1048	21	1	90	28	81	536	131	1	1	1	5	2	71	845	102	1	13	2980

Figure 4.1. Map of sampling sites for mosquito larvae.



4.2 Adult sampling

Adult mosquito sampling allows us to get a clear portrait of what species are present across the territory. With this information we are able to determine what species are causing the nuisance and therefore it allows us to locate the source of the problem when integrated with larval sampling and breeding site mapping.

A total of 10 CDC light traps, baited with dry ice (CO_2) and UV blacklights, has been set on a weekly basis since May 13th, 2007, at specific sites, across Pefferlaw. The location of these sites is shown in table 4.3.

Table 4.3. Location of CDC light traps for mosquito adult surveillance.

Site	Longdec	Latdec	LocalityS	Location
GEO001	-79.2113	44.31868	Pefferlaw	9885 Morning Glory Rd.
GEO002	-79.191085	44.341732	Pefferlaw	31188 Lakeridge
GEO003	-79.194151	44.313862	Pefferlaw	22 James Street
GEO004	-79.209019	44.303743	Pefferlaw	83 Brook Crescent
GEO005	-79.203905	44.293429	Pefferlaw	26 Pinecrest
GEO006	-79.211604	44.338018	Pefferlaw	Golf Course off
GEO007	-79.216767	44.314115	Pefferlaw	Eaglenwood campground
GEO008	-79.222044	44.336348	Pefferlaw	End of Holmes Pt.
GEO009	-79.204138	44.328851	Pefferlaw	GreenAcres camp ground
GEO010	-79.194361	44.309333	Pefferlaw	Rixon Manor

Table 4.4 shows the number of specimens collected each week and the identification results. Earlier we spoke of three broad periods. These periods do not necessarily apply to adult populations since adults lifespan can be affected by several weather variables. It is evident that in the spring the most abundant species are spring time *Ochlerotatus.* Most of these species usually die off six weeks after emergence, but one long-lived species that continues to persist in Pefferlaw is *Ochlerotatus stimulans*. Its adult populations peak at week 24 and slowly decreases to week 35. The adult form of *Oc. stimulans* can live up to 3 months. This species is very important to control in the spring or else the consequences will last for the whole summer.

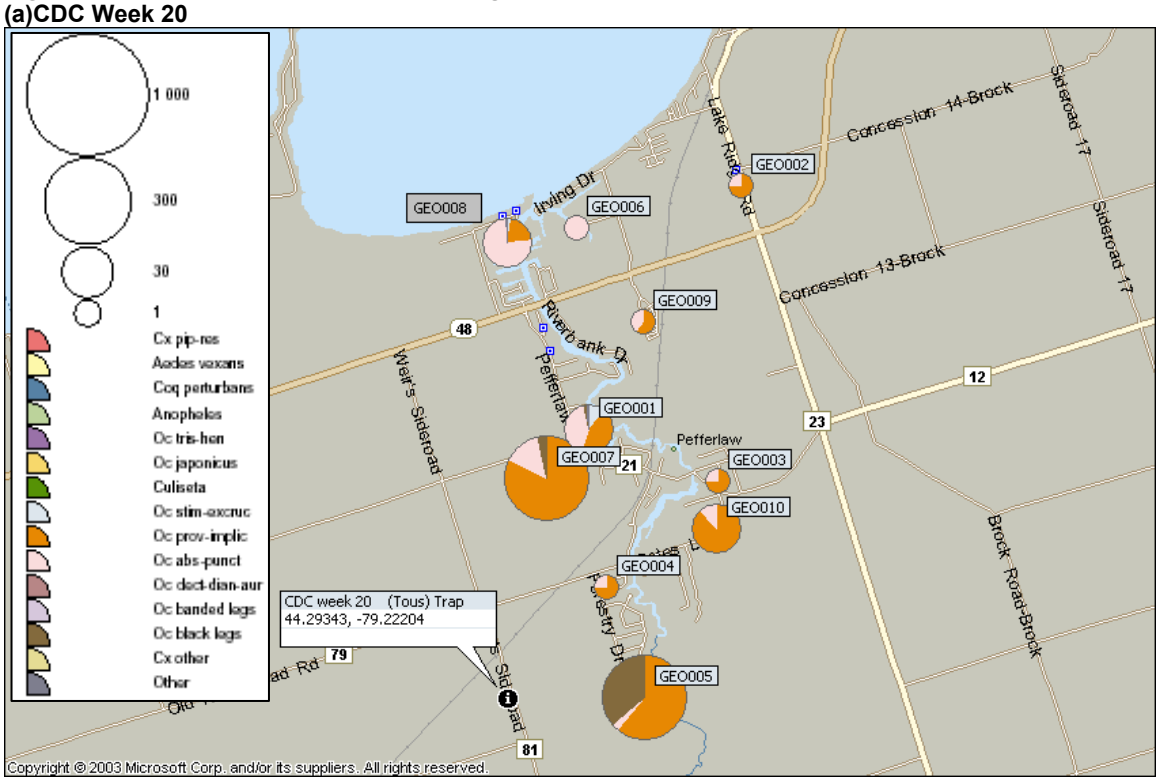
During week 24 we noticed the presence of *Coquilletidia perturbans* also known as the cattail marsh mosquito. This species is a very aggressive biter and will emerge towards the end of June. In Pefferlaw, adult populations persist up to 2 months. Because of its unique development the larvae cannot be controlled in the same way as other mosquito species. GDG has developed a safe biological method that effectively controls this species.

As the season progresses the dominant species is *Aedes vexans*. Adults of this species will emerge 5 to 7 days following a large rainfall event. They are aggressive biters and if not effectively controlled, their adult populations can accumulate quite rapidly. Late season control efforts would most likely target this species.

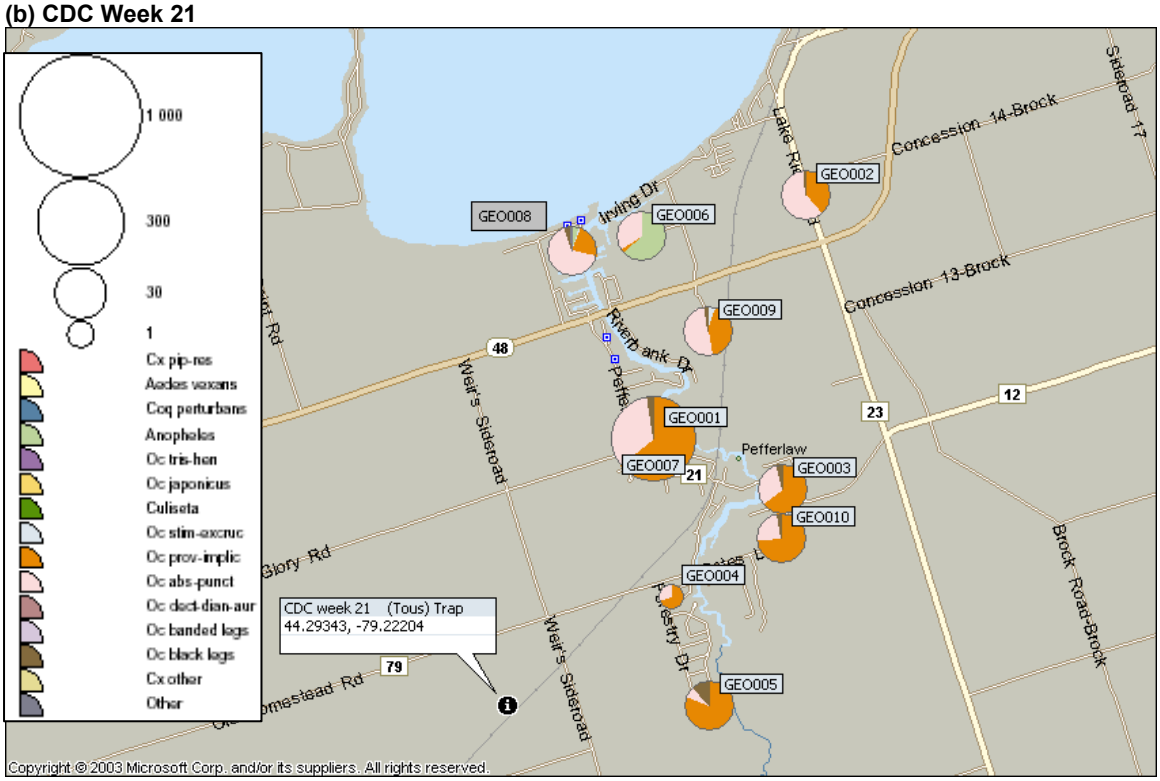
Table 4.4. Trapping results for cdc weeks 20-39.

Week	Cx pipiens/restuans	Aedes vexans	Anopheles	Cq perturbans	Culiseta	Oc japonicus	Oc tris-hen	Oc abs-punct	Oc banded legs	Oc black legs	Oc dect-dian-aur	Oc prov-implic	Oc stim-excruc	Other
20	0	0	0	0	0	0	0	336	0	161	0	1147	22	3
21	1	0	28	0	0	0	0	829	0	179	0	1521	13	37
22	22	2	107	0	0	0	0	814	12	101	2	536	1124	67
23	0	3	20	2	4	0	0	243	5	66	0	358	555	16
24	9	49	162	179	8	4	1	319	39	71	1	197	1179	72
25	1	27	23	491	6	0	0	82	8	8	0	43	1110	10
26	24	287	77	1412	22	4	12	28	39	50	0	13	751	72
27	5	80	137	620	9	4	12	36	23	43	0	27	702	58
28	10	53	74	662	7	4	28	0	9	41	0	0	552	87
29	9	58	94	444	11	2	34	0	13	26	0	4	317	12
30	8	130	62	350	3	3	14	0	4	5	0	0	178	10
31	1	158	22	104	0	0	24	0	0	15	0	0	66	5
32	1	135	73	25	3	4	20	0	0	12	0	0	32	9
33	2	237	40	8	6	2	17	0	2	2	0	0	8	5
34	1	64	29	2	3	2	2	0	0	0	0	0	1	2
35	1	227	37	10	0	6	12	0	0	3	0	0	1	4
38	0	11	3	0	1	1	0	0	0	1	0	0	0	0
39	2	63	2	2	4	4	2	0	0	0	0	0	0	0

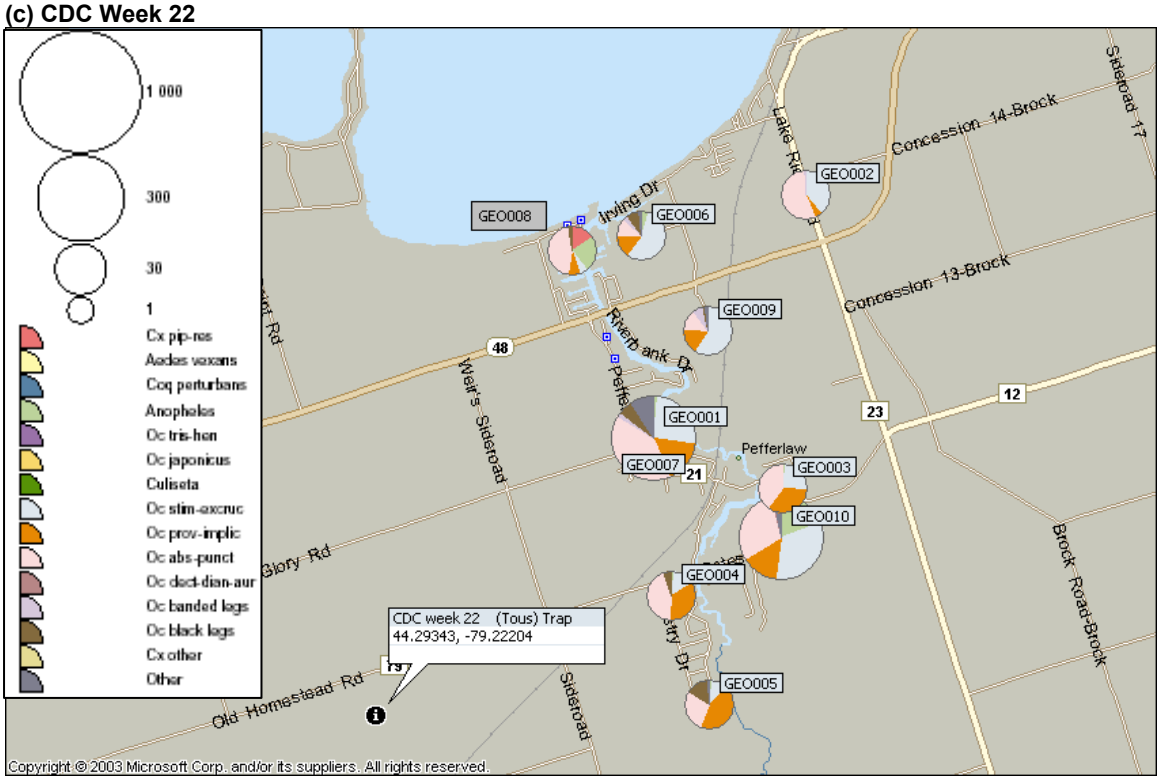
Figure 4.2. Maps of mosquito adult trapping results for Pefferlaw, CDC weeks 20-21.
(a)CDC Week 20



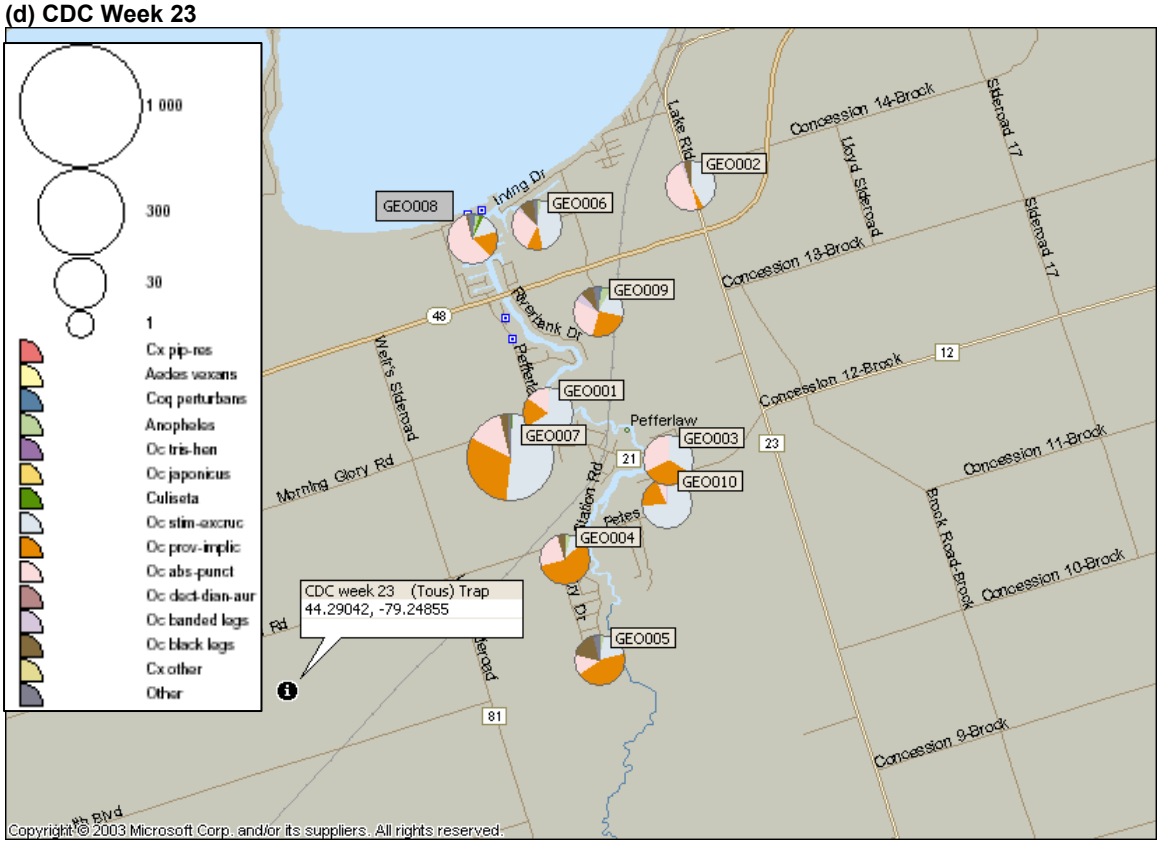
(b) CDC Week 21



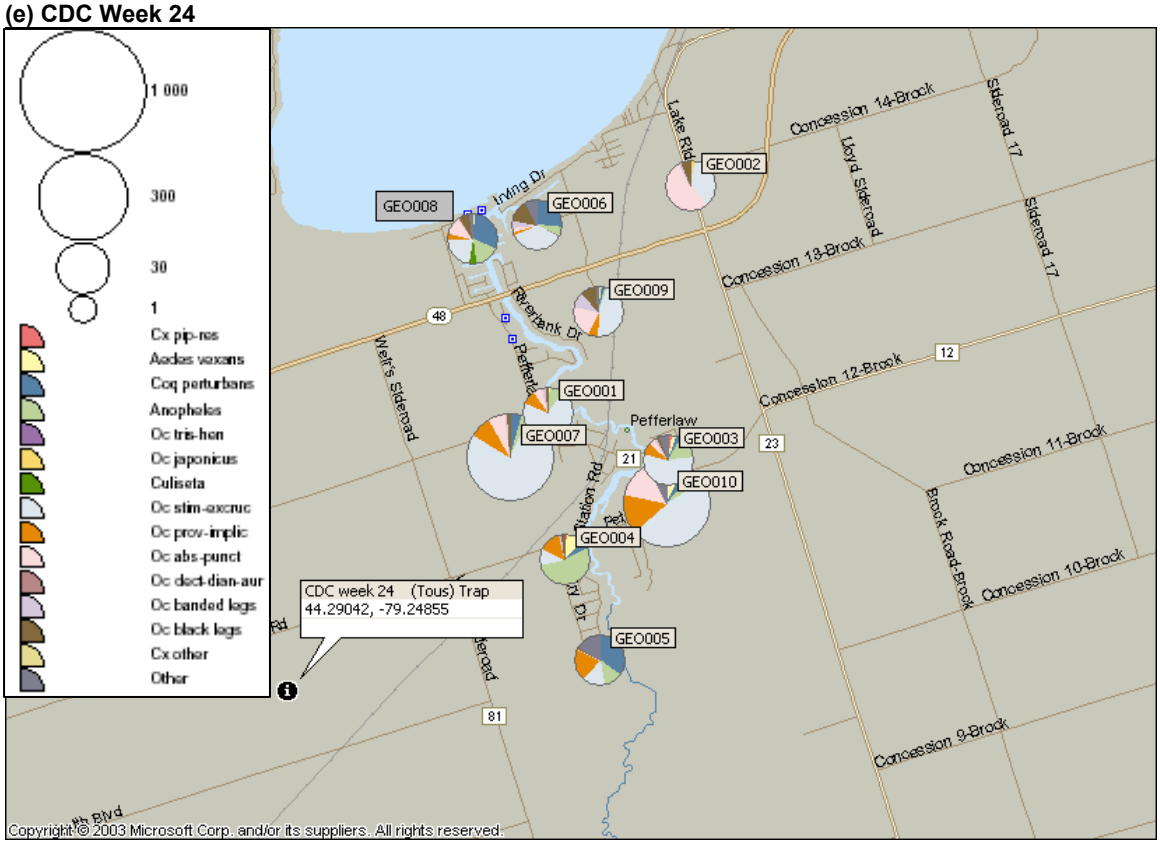
(c) CDC Week 22



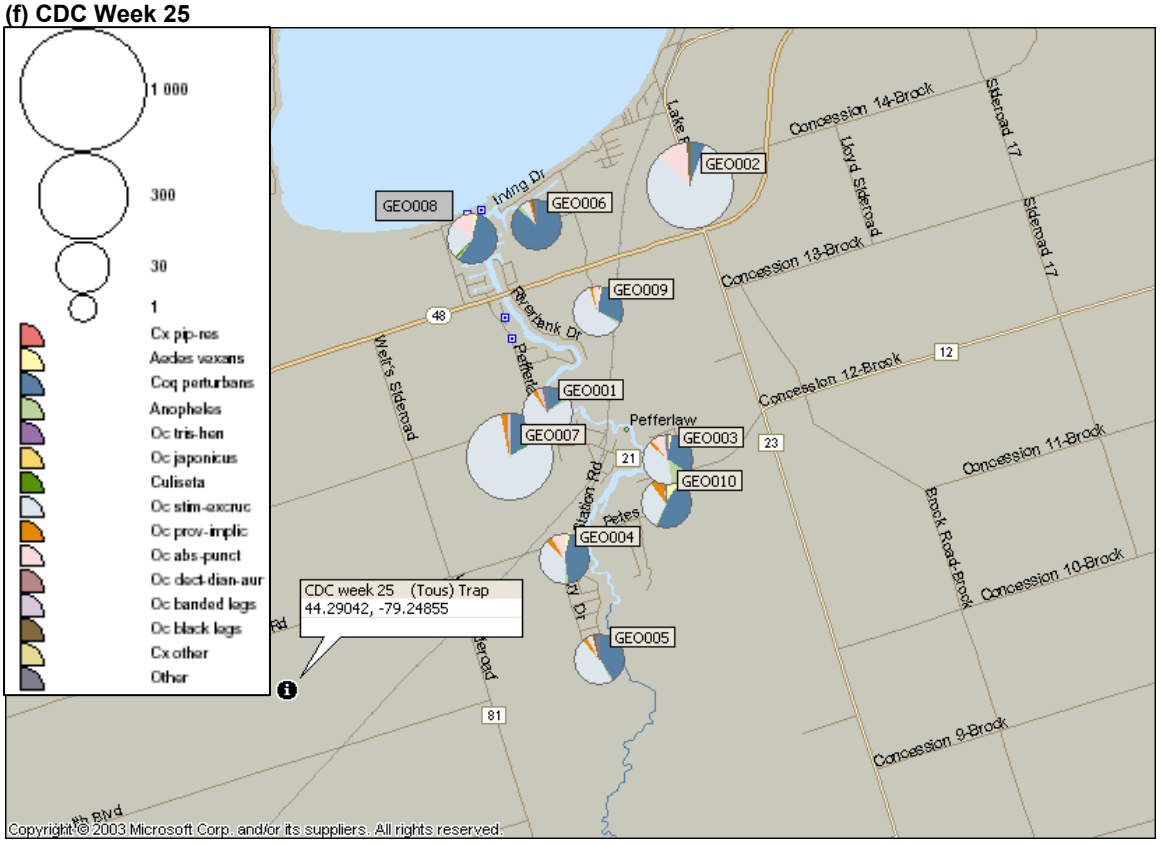
(d) CDC Week 23



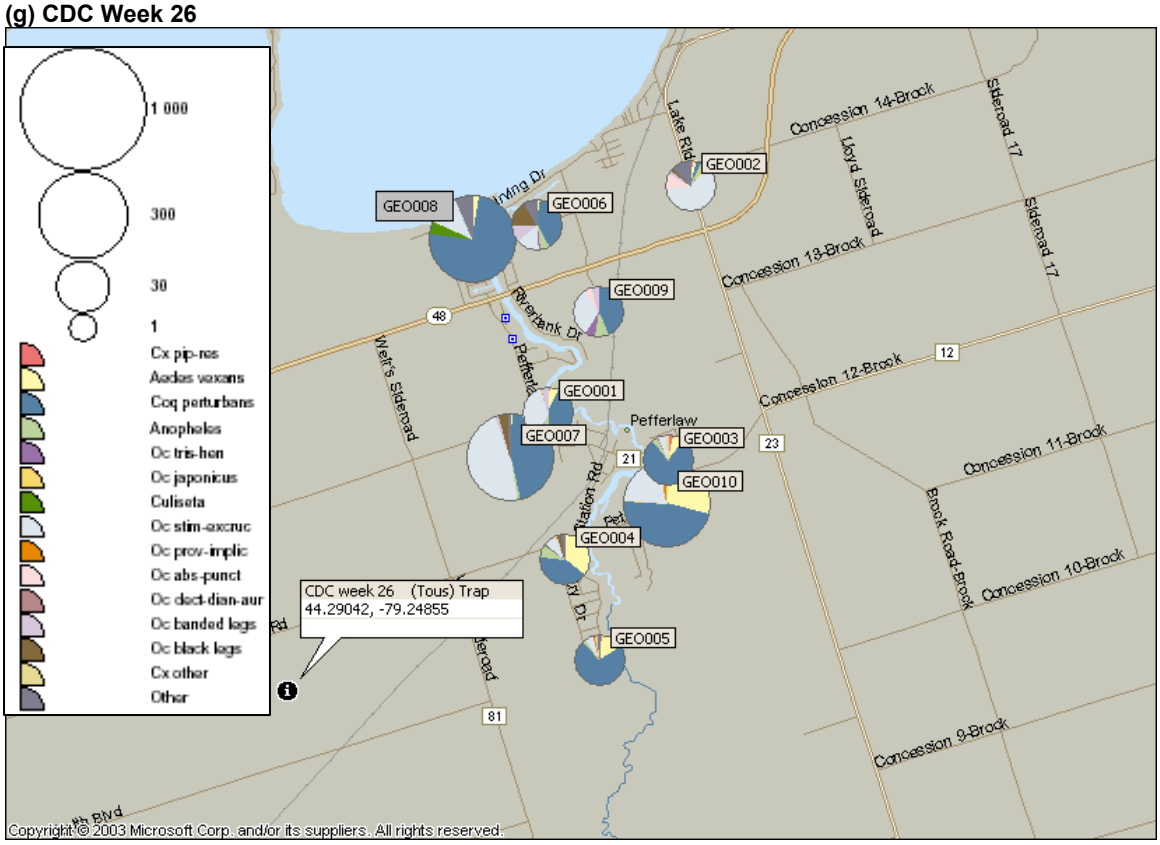
(e) CDC Week 24



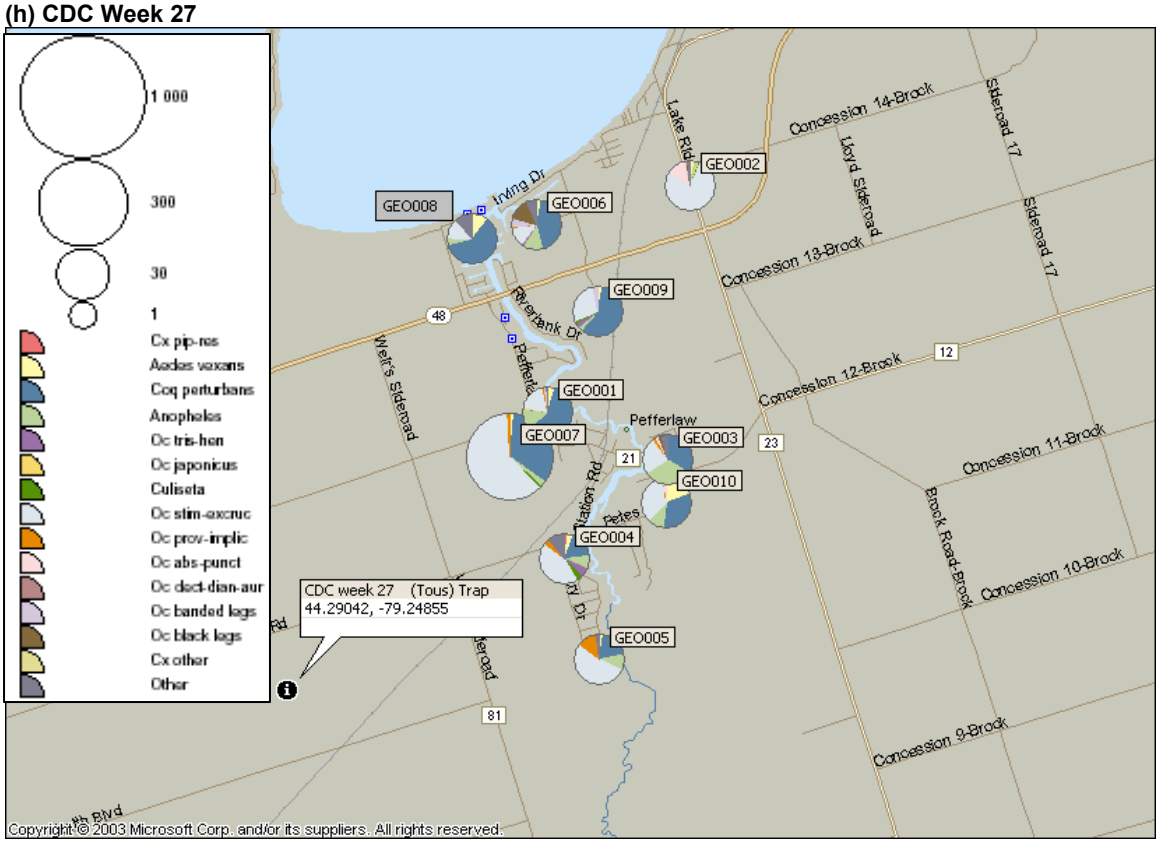
(f) CDC Week 25



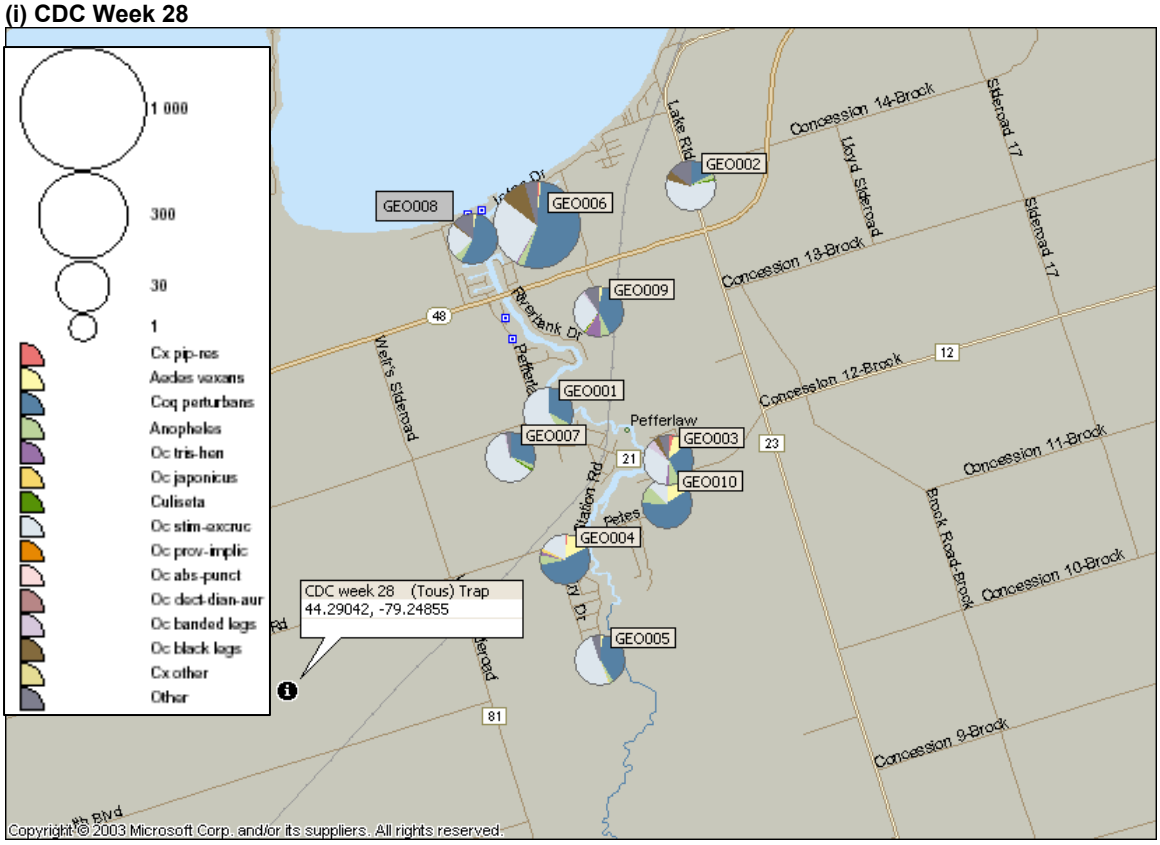
(g) CDC Week 26



(h) CDC Week 27



(i) CDC Week 28



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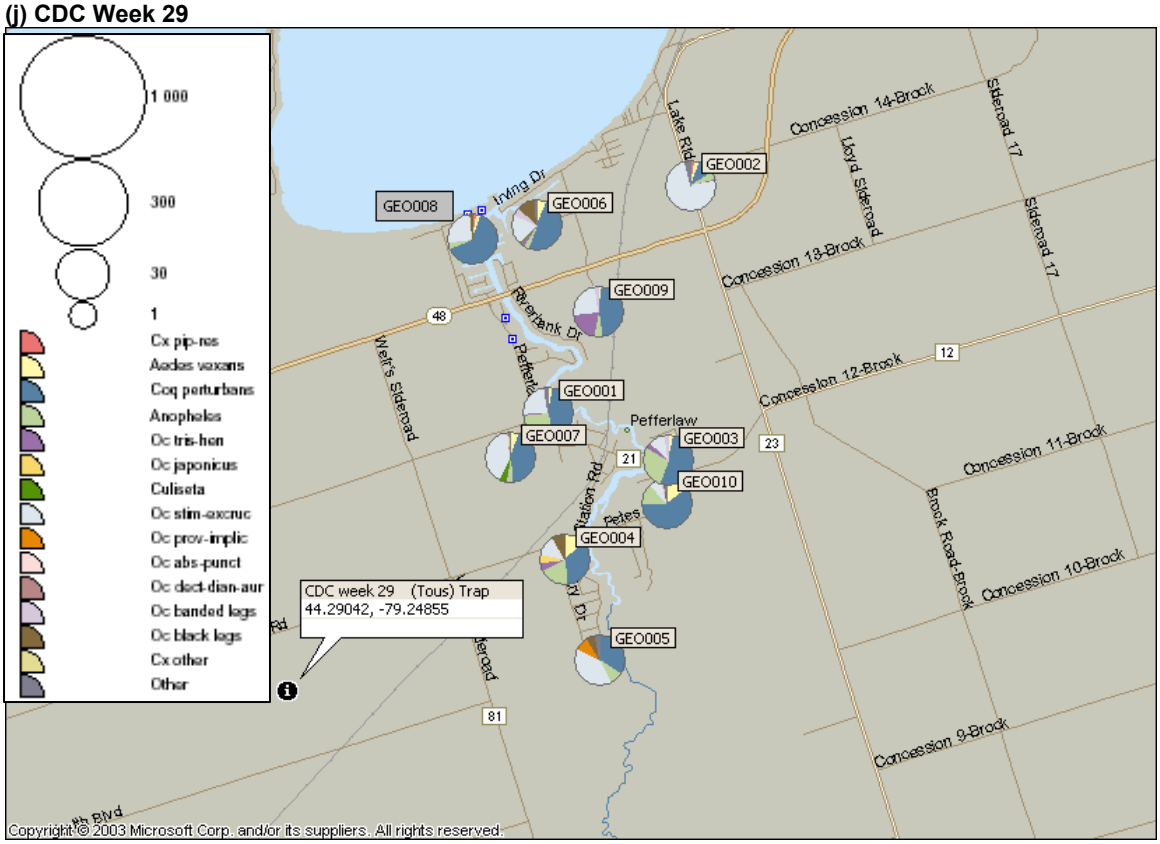

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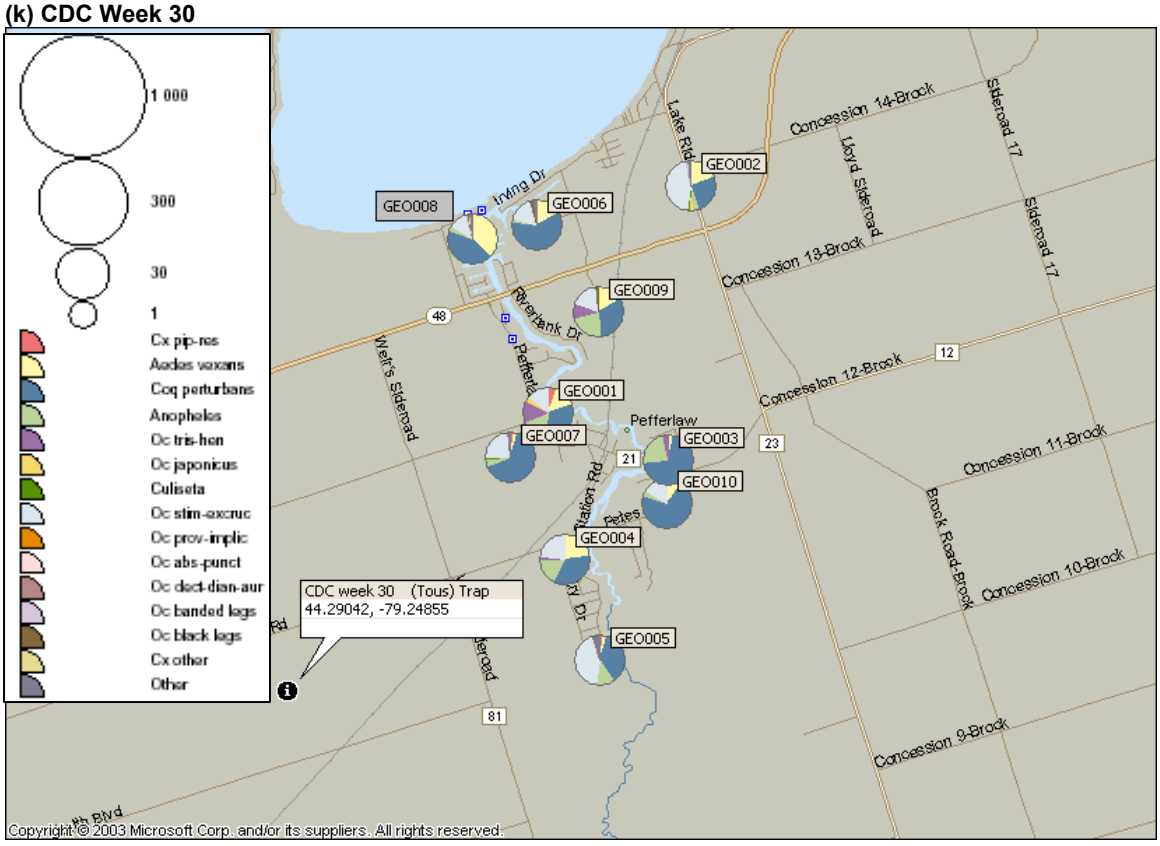
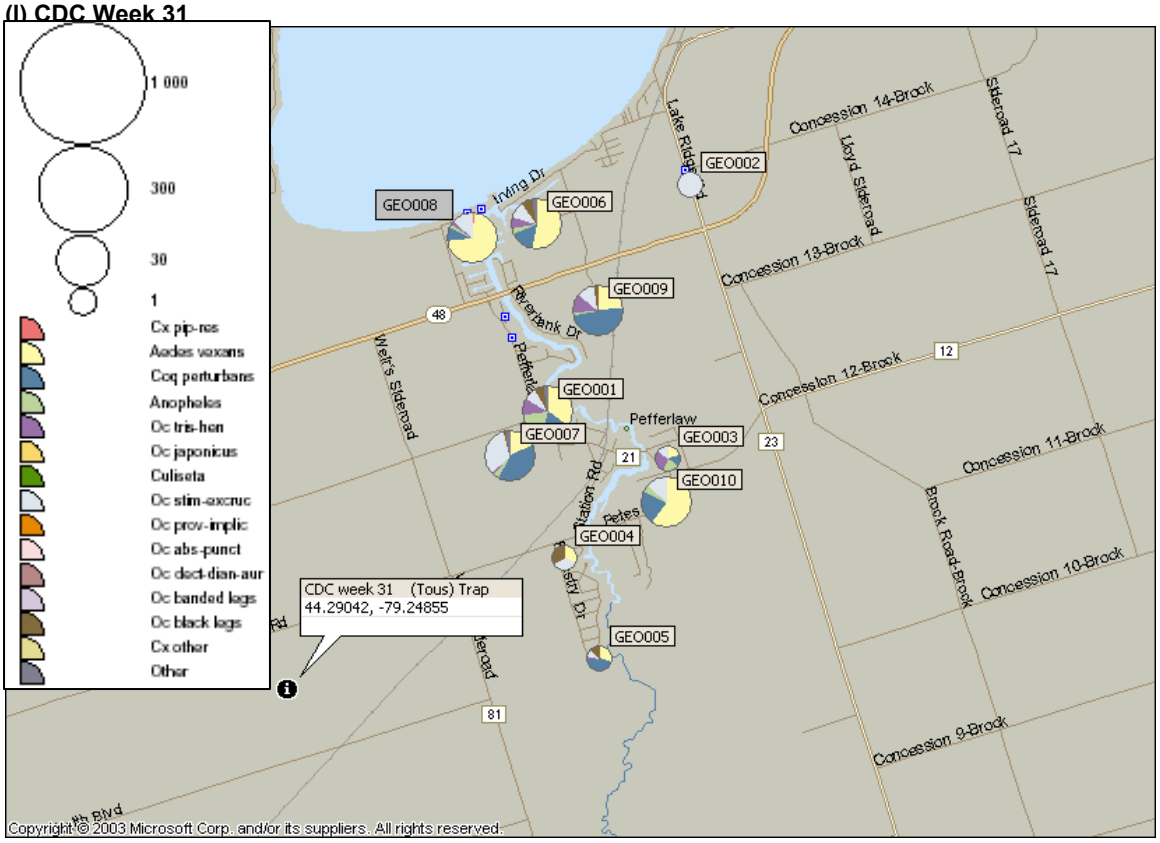


(l) CDC Week 31



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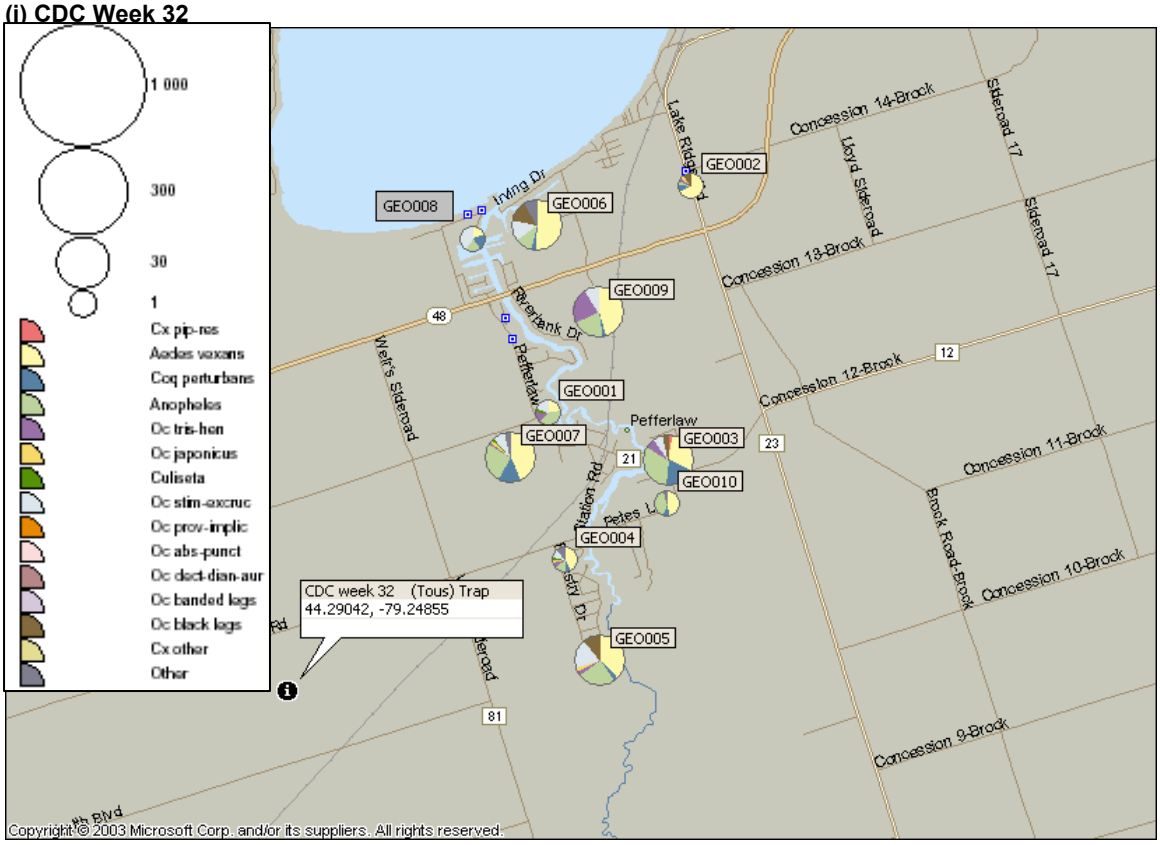

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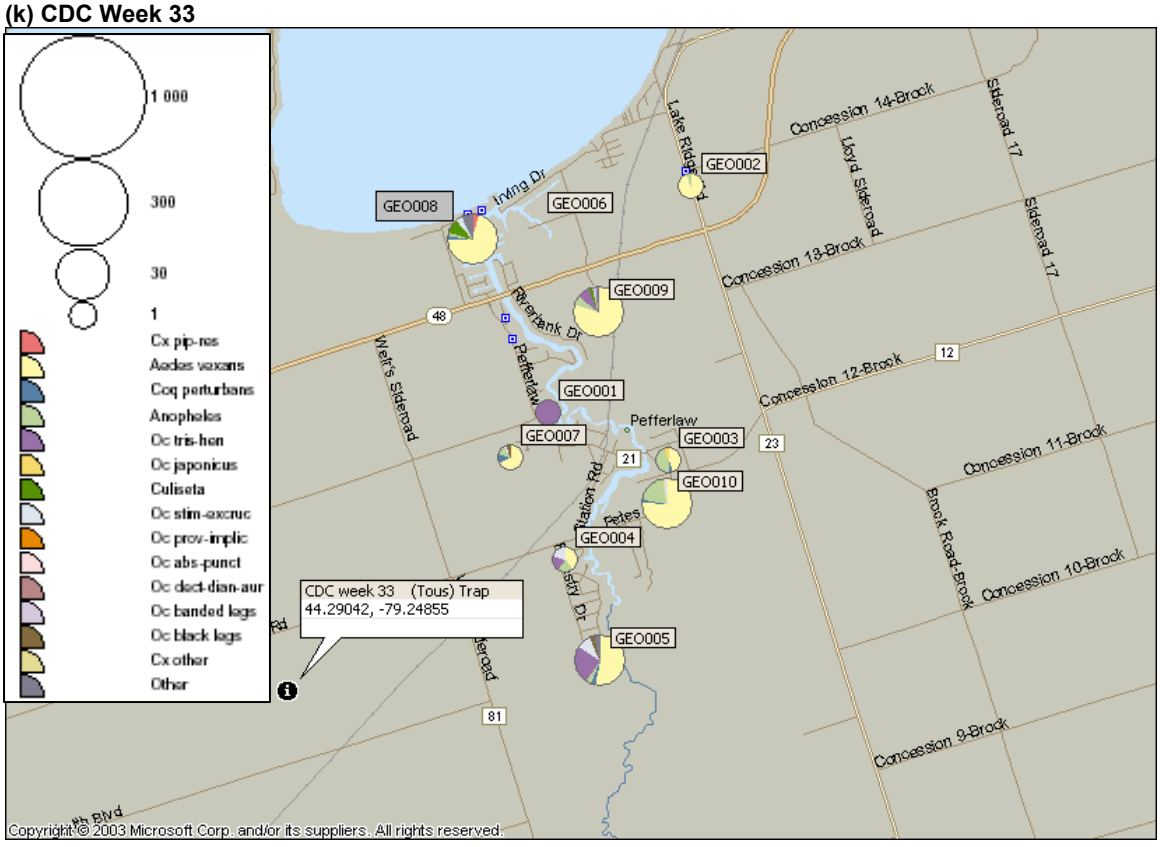
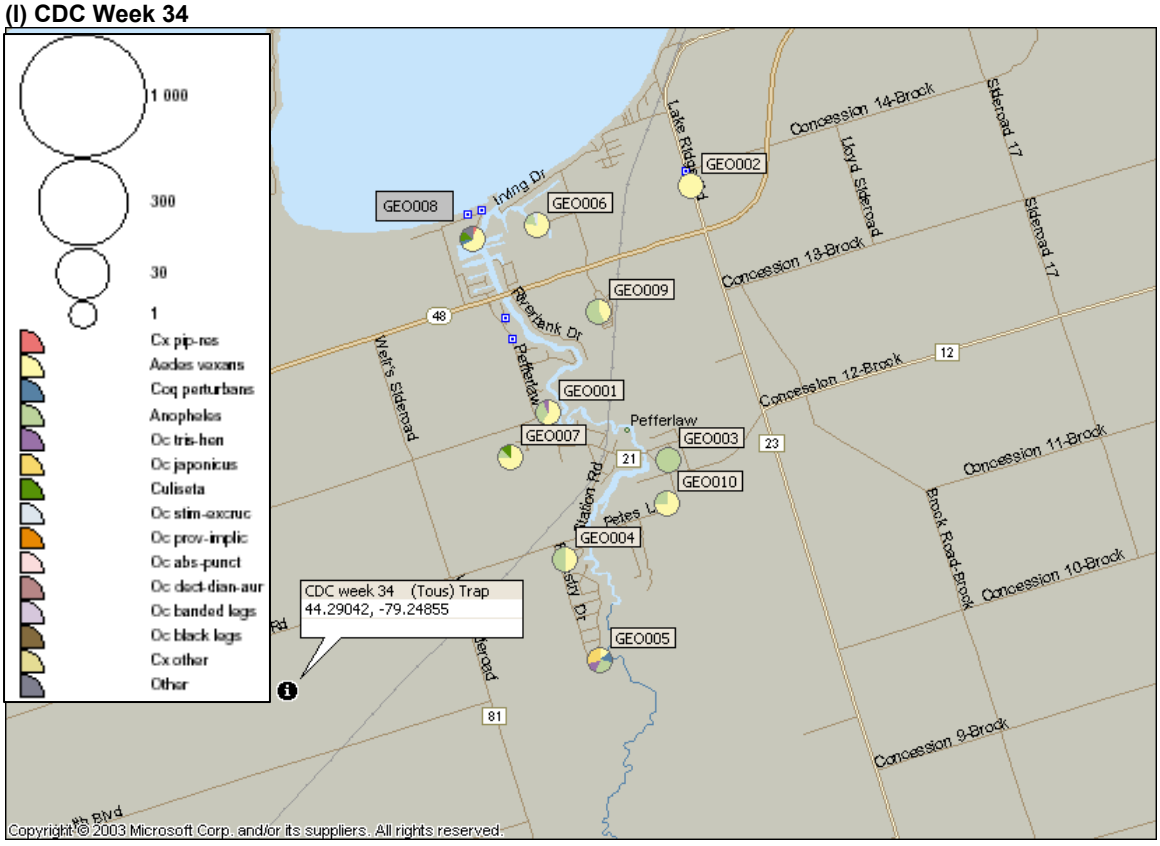
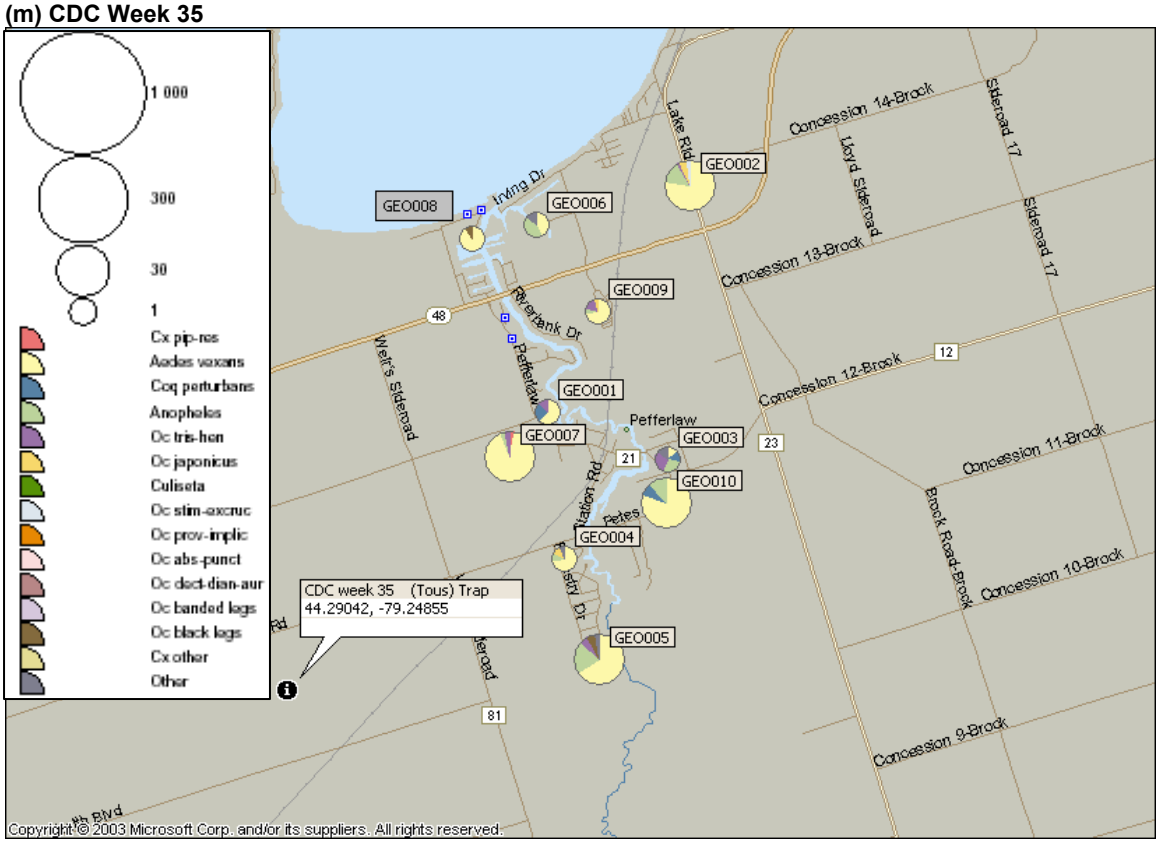


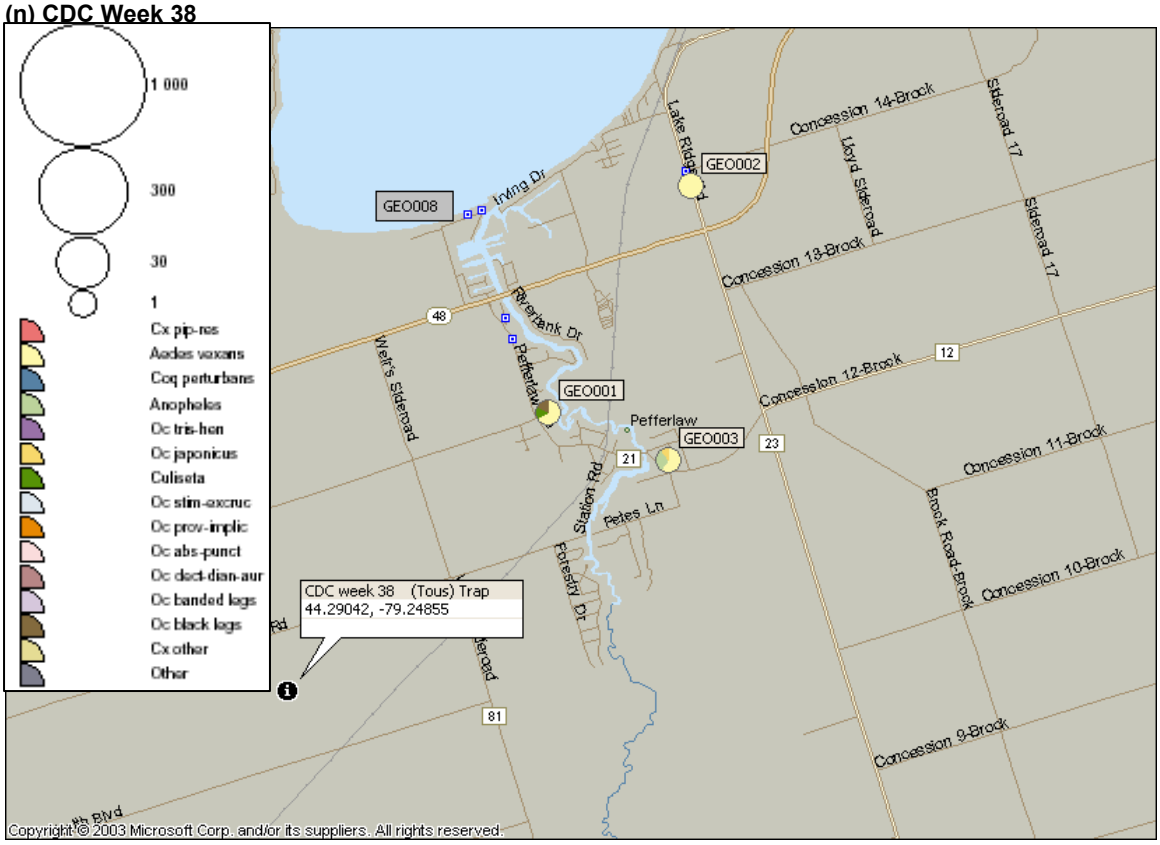
(l) CDC Week 34



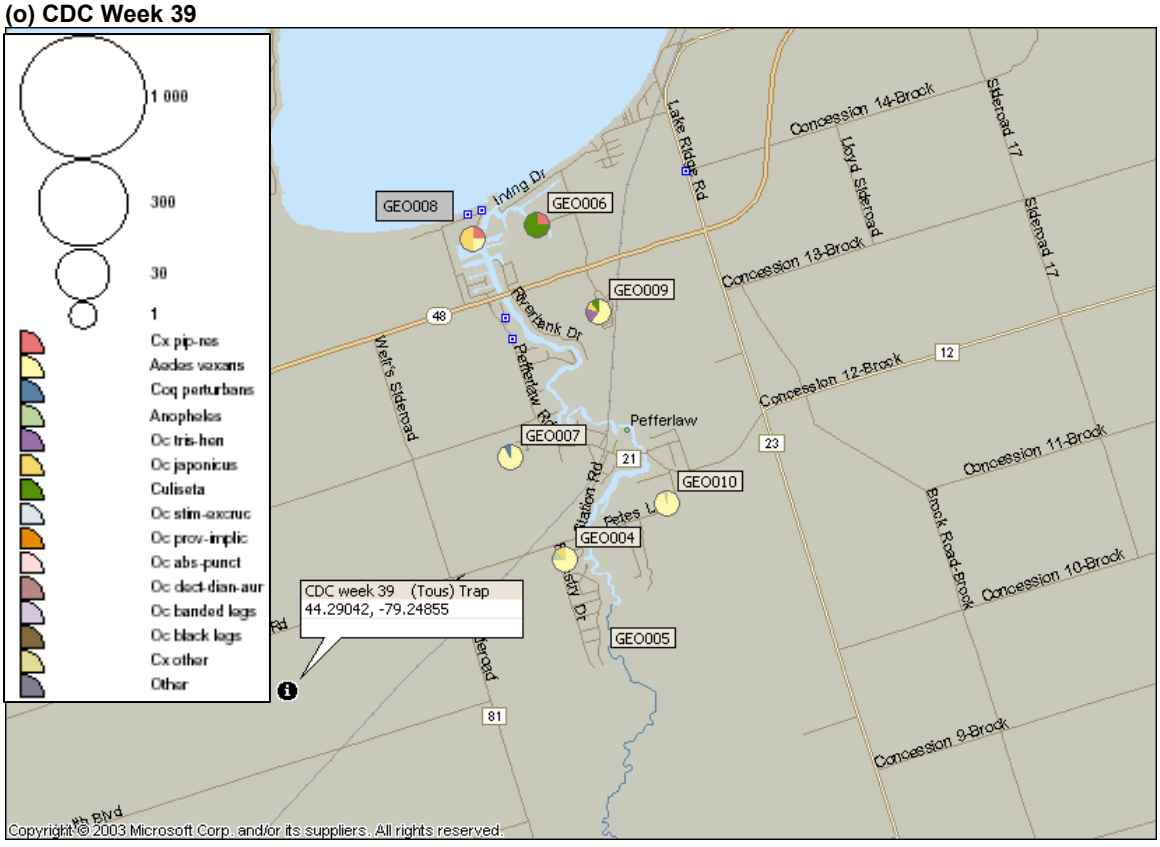
(m) CDC Week 35



(n) CDC Week 38



(o) CDC Week 39

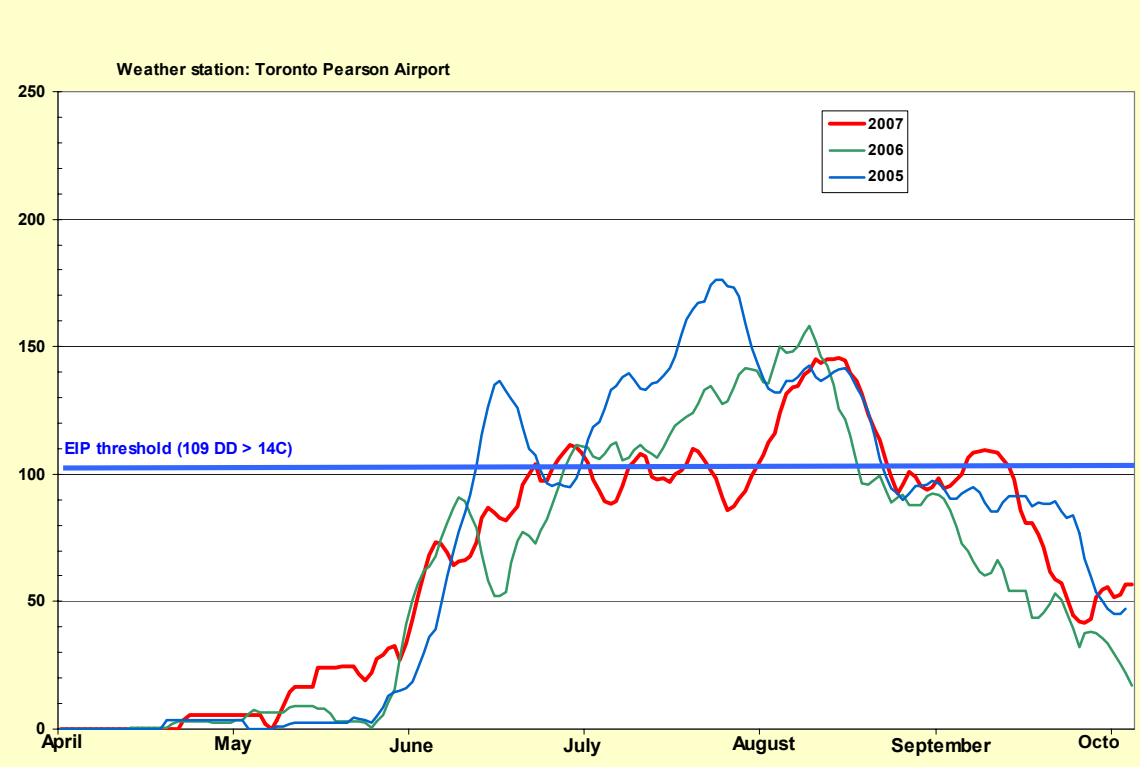


4.3 Weather Follow up

Weather plays an important role in nuisance control program. Weather affects the amount of time between egg hatch to adult emergence. The warmer it is the less time is required for larvae to develop into adults. Precipitation will also determine the surface area of breeding sites. Generally a warm wet summer will be more favourable to mosquito populations than a dry cool summer.

In general terms the 2007 season was a dry cool summer for Pefferlaw. Spring temperatures were pretty similar to those experienced in 2005 and 2006, however during the early and mid-summer months, temperatures were much lower than those recorded in 2005 and 2006. During the late summer months temperatures began to increase (figure 4.3). This increase might have caused adult populations to persist longer into September.

Figure 4.3. Total accumulated degree days for years 2005 to 2007.



Precipitation was lower than the normal for every month excepting for the month of May. Table 4.5 shows the total precipitation for the months of April to October for years 2004 to 2007 along with the normal for years 1971 to 2000.

Table 4.5. Monthly precipitation records from 2004 to 2007 along with the normal 1971 - 2000.

Year	April	May	June	July	August	September	October
Normal 1971-2000	62.4	72.4	74.2	74.4	79.6	77.5	63.4
2004	64.2	98.8	62.8	119.8	60	25.2	35.2
2005	97.6	14.4	31.8	20.4	135.6	79.6	47.4
2006	62.4	82	45.4	105.2	40.2	77.6	120.6
2007	60.8	73.6	43.2	47.4	21.8	28.6	21.4

Figure 4.4. Temperature and precipitation for the Perfferlaw area in 2007.

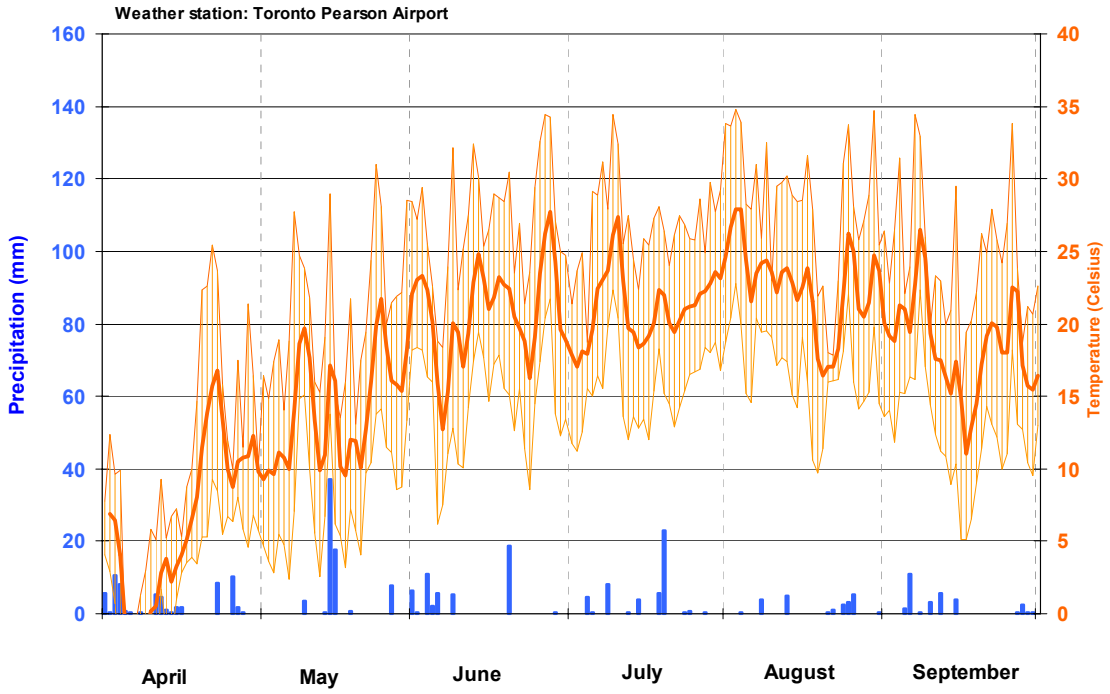
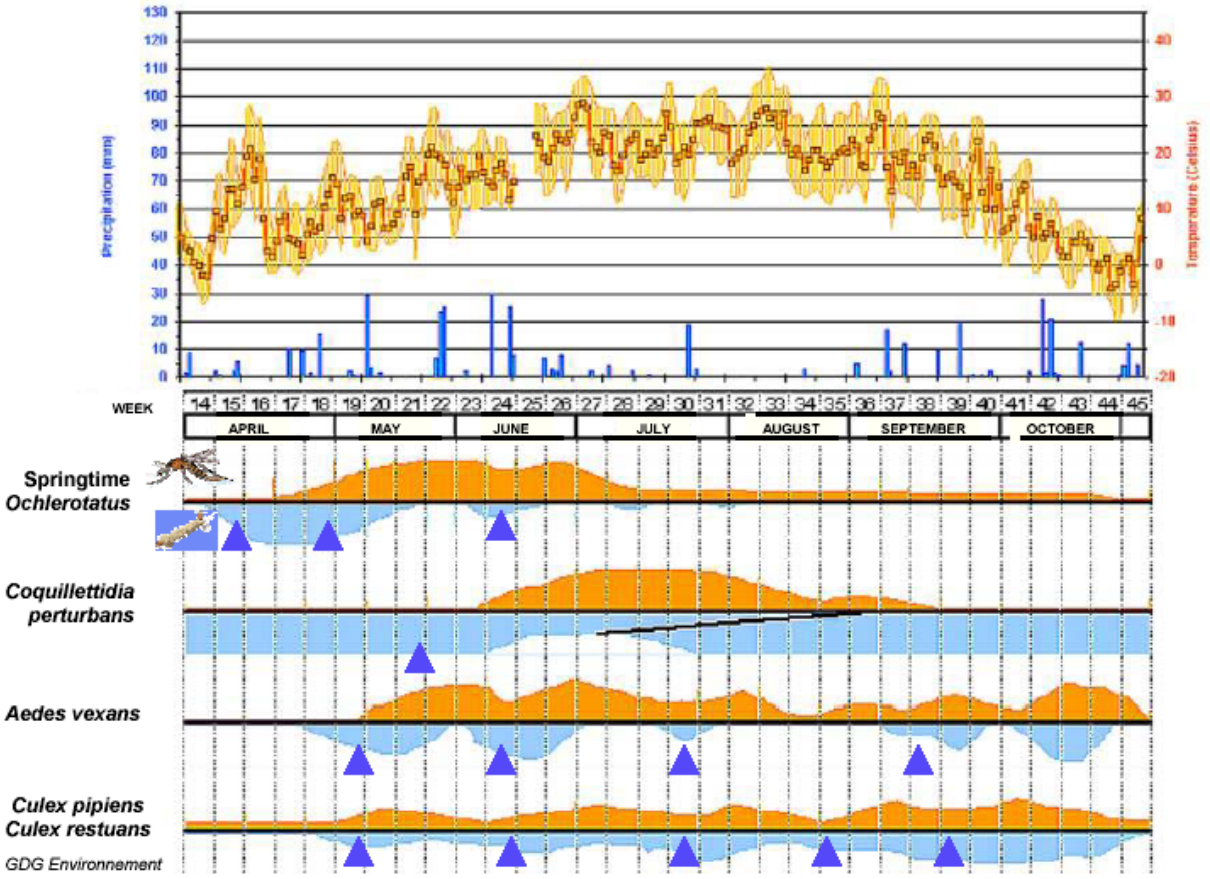


Figure 4.5 shows how weather affects mosquito development and larviciding operations. The top part of the figure is a graph that shows the temperature and precipitation, The lower part shows the abundance of larvae (in blue) and the abundance of adult mosquitoes (in orange) in response to weather conditions. The blue arrows indicate the ideal timing for larviciding. With historical data we will be able to estimate the number of treatments required in one season.

Figure 4.5. Mosquito development response to weather conditions.



5 Control Strategies

5.1 Available pesticide products

Biological pesticides, that have been designed for the control of mosquitoes are created from the bacteria *Bacillus thuringiensis var. israelensis* (*B.t.i.*). We recommend, among the products available (granular and liquid formulation), those that have the best overall stability and consistency in efficacy.

The available liquid formulations are the Teknar HP-S and Vectobac 1200L. The larvicides permit the bacteria crystals to easily mix within the water column in flowing and stagnant waters. The cost of other brands is comparable and the methods of production are similar. The concentration of the active ingredient, however, is variable and thus influences the amount of product utilised during control operations. The liquid formulation is mainly used for terrestrial treatments. The liquid products are used less and less for aerial applications because of its poor dispersal and penetrating properties (up to a 95% loss).

The Teknar G and Vectobac 200G are two examples of granular formulations available for aerial application. The granules are bits of corn soaked in the active ingredient. These formulations can easily penetrate dense vegetation. They have a higher cost then liquid formulations, for that reason, they should be used strictly for aerial applications.

A new product that has recently became available on the Canadian market is Vectolex CG. This larvicide uses *Bacillus sphaericus* as the active ingredient. It is a biological larvicide that offers a longer residual, thus permitting to lower the frequency of treatments. This product is much more costly than *Bti*, however it can be used in sites with higher organic content where *Bti* is not as efficient.

5.2 Program implementation

5.2.1 Legislation

The governing legislation for the application of larvicides for the nuisance control of mosquitoes is the Pesticide Act and Ontario Regulation 914. The Ministry of the Enivironment (MOE) regulates the sale, use, transportation, storage and disposal of federally registered pesticides in Ontario.

The federal government controls product registration under the Pest Control Products Act (PCPA). The federal Pest Management Regulatory Agency (PMRA) (under health Canada) is responsible for evaluating the pesticides for their effectiveness, safety, merit and value and assesses human health and environmental impacts. They are responsible for approving product labels and assigning product registration numbers under the PCPA..

5.2.2 Licencing

Private land owners are not required to hold a licence in order to apply larvicides to their own property. However, only licenced pesticide applicators may apply *B.t.i* for mosquito nuisance control on public lands and on private lands that do not belong to them. Three types of licences are available, the mosquito/biting fly licence, the aerial licence and the pesticide technician licence. For a nuisance control program, a technician holding a mosquito/biting fly licence can supervise up to three trained pesticide technicians. Therefore the number of licensed technicians required for a given contract depends on the size of the program and the number of technicians required to execute treatments. An aerial licence is necessary if applying larvicides from an aircraft.

5.2.3 MOE Permits

The permit serves to calculate the surface area to be treated and the amount of larvicides to be used for the operation. The time required to process a permit application once the file is completed is 6 weeks. Therefore it is important to start the application process early, well before April.

The permit application must include a detailed site map with a scale of 1:25,000. This map must include the location of the water bodies to be treated with larvicide and the treatment areas within these bodies of water. The location of all sensitive areas must be indicated on the map, these include:

- Critical fish habitat;
- Bee yards;
- Wwetlands-marshes;
- Susceptible crops grown in marsh areas (wild rice, cranberries, etc.);
- endangered species habitat;
- Headwater areas;
- Irrigation water sources;
- Potable and livestock water supplies;
- Areas where human recreational water activities may occur (swimming, wading etc.)

The application must include a description of measures that will be used to protect sensitive areas from possible movement of the larvicide from the target area.

Authorization is required by land owners/occupiers to treat public and private properties. All must agree in writing, to the use of larvicides. The application must include a statement that indicates that the pesticide applicator is willing and able to appropriately respond to the concern of property owners within the treatment area whose property abuts the affected water bodies.

A list of names and addresses of all objectors and the addresses of properties for which permission was not obtained

The use of written notices regarding the application of a pesticide allows the public the opportunity to make an informed decision as to whether or not to enter the pesticide treated area and to take suitable precautions to avoid exposure.

As a requirement of a permit issued for the use of a larvicide to control Mosquitoes and/or Black flies for nuisance control, the following forms of public notification must be used before each treatment to the body of water in which the larvicide will be applied:

1. Newspaper notice to be published at least 48 hours before but not more than seven days before performing the water extermination and, if necessary, repeated weekly in a newspaper of general circulation to the treatment area.

AND

2. Distribution of a written notice, at least 48 hours before but not more than seven days before performing the water extermination and, if necessary, repeated weekly to all property owners, occupiers or persons in charge of the property that is contiguous to and within the application area.

For areas not serviced by a newspaper or where the publication of a newspaper notice is unreasonable, an alternative form of notification may be authorized. This may include a public area sign at the access points to the treatment area or posting of a public notice. Two forms of public notification will be required under the approved permit conditions.

5.2.3.1 Environmentally sensitive areas (ESAs)

There are two ESAs that fall within the operational zone of the nuisance program. The Pefferlaw Brook ESA which covers most of the York regional forest tract, and the Morning Glory swamp ESA. Mosquito Breeding sites located within these ESAs will require treatment. It is therefore important that we obtain the proper documentation from MNR so we may proceed with the MOE permit application.

Several breeding sites located within the ESAs were visited, however due to the dry weather only a few sites were suitable for mosquito development. Table 5.1 show the larval sampling results for these ESA designated areas. In the Morning Glory Swamp the dominant species collected was *Ochlerotatus* species. It is important to note that Morning Glory Swamp is also a very productive site for *Cq. perturbans* however because of the sampling techniques utilised in this study we were unable to find any *Cq. perturbans* larvae. *Cq. perturbans* requires a special technique that requires pulling cattail plants and counting the larvae that are attached to the plant's roots.

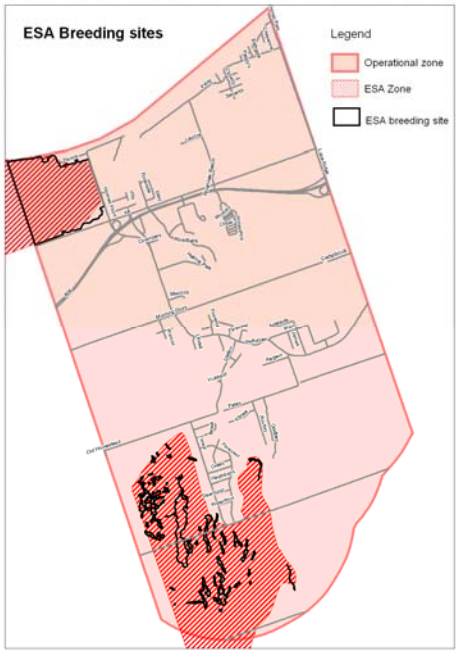
Table 5.1. Larval sampling results from ESA designated sites.

ESA_name	SiteID	Culex pipiens	Culex territans	Culicidae sp	Ochlerotatus provocans	Ochlerotatus sp	Total
Morning Glory Swamp	AB02a		27	5		69	101
Pefferlaw Brook	BD10b				9	3	12
	BD10r	4	30	2			36
Total		4	57	7	9	72	149

The ESA's should be treated either with *Bti* or *B. sphaericus*. Sites located within these ESA's should only be treated when larval monitoring shows the presence of nuisance mosquitoes.

Figure 5.1 shows the location of the ESA breeding sites.

Figure 5.1. ESA mosquito breeding sites.



5.2.4 Characterisation of mosquito development sites

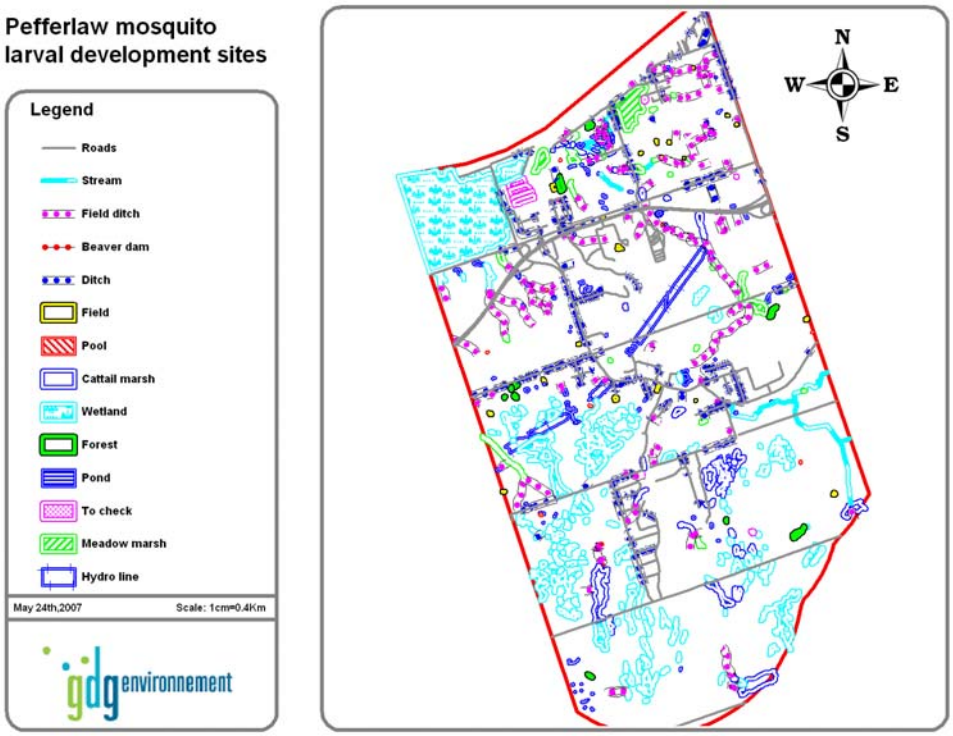
For permit application and before field work can begin, preliminary work must be done as to evaluate the number of hectares to be treated and what types of habitats need to be treated. Characterisation of mosquito development sites is one of the most important aspects of this evaluation.

The first step is to determine which areas will be protected. These areas are determined by consulting with town officials; generally it prioritizes areas with high human populations such as residential agglomerations. Once the area has been chosen, a buffer zone around the protected area is created. Depending on the topography of the territory the buffer zone will be between 1 to 1.5 kilometers.

A first characterisation of development sites is done through aerial photo interpretation. Digital elevation models are used to make land depressions more evident. This first characterisation is then validated by a field visit. By looking at the dominant vegetation and the extent of mosquito development sites a final operational map is then created.

A total 300 hectares of mosquito development sites have been identified. 4. Figure 4.1 shows the distribution of the mosquito development sites for the Pefferlaw area.

Figure 5.1. Pefferlaw mosquito development site map



5.2.5 Establishing a larval surveillance network

At the start of the operational season each sampling site must be visited as to determine the launch of treatments. Factors that play a role in triggering treatments are the apparition of third and fourth instar larvae, weather conditions and water temperature. Weather and water temperature help in predicting when pupal stages will occur. This helps in determining the amount of time before pupal stages are reached. In the spring this window is between 10 and 25 days. In the summer months this is reduced to between 5 and 10 days.

5.2.6 Field crew

The contractor must monitor the weather predictions on a daily basis as to determine the start of operations on the Pefferlaw territory. We suggest the permanent team be in the field in mid-April as to begin site monitoring and sampling.

5.3 Control methodology

5.3.1 Aerial and terrestrial pesticide application

Application of larvicides may be done by aircraft or terrestrially; this depends on the dimensions of the development sites as well as the type of vegetation and accessibility of the site.

Terrestrial application is required in a 50-60 meter buffer zone around residential areas. This buffer zone is required by legislation, as to protect residential zones from aerial treatments. Also treated terrestrially are development sites smaller that 5 ha, and sites close to environmentally protected areas.

5.3.2 Number of treatments

In general, the number of treatments is dependent on the amount of precipitation received in one season. The number of treatments can change from year to year. Generally the biggest treatment is the first spring treatment. As the season progresses, development sites normally dry up, requiring less resources to control mosquitoes.

Treatments are administered in consequence to monitoring results. Mosquitoes are insects that can travel a good distance. In order to obtain an important reduction in mosquito populations, it is necessary to control larvae up to 1.5 kilometers from residential areas. During the spring snowmelt, all flooded sites must undergo treatment, however during the summer months, important rain events could cause approximately 50% of sites to have water.

5.4 Quality control

Quality control is done in two distinct steps, that is, by post-treatment sampling to determine the efficacy of the treatment, and by nuisance test.

5.4.1 Post-treatment sampling

Sites must be revisited 24 to 48 hours after having been treated, as to determine the percent mortality of larvae. If results are below 98% mortality, the site must be retreated.

5.4.2 Nuisance tests

The nuisance test is used to determine the species composition and abundance within the control zone as well as outside the control zone. The values measured outside the control zone are similar to those we would find in Pefferlaw if no treatment had occurred. The relation between the values calculated within and outside the control zone indicates the percentage of reduction in adult biting flies. This method allows to measure the reduction in nuisance benefited by residents. Nuisance tests must be done in calm wind conditions between 6 pm and 8 pm, which corresponds to the period during which most mosquitoes seek a blood meal. The person conducting the test must wait five minutes on the site before capturing the adults.

6 Conclusion & Recommendations

The overall results of the study show that there is a constant influx of mosquito populations during the whole season. This study demonstrates that an effective biological mosquito control program would require treatments over the whole season. This will allow to control spring time species, summer and late summer species.

There are two ESAs within the Pefferlaw community. It is necessary to obtain the permission of the ministry of natural resources in order to proceed with the MOE permit application. The MOE application should be completed before the end of the month of January as to ensure enough time for MOE to process the application before the season starts.

7 Acknowledgement

We would like to thank the Town of Georgina and the members of the Pefferlaw community for their help in completing the study.