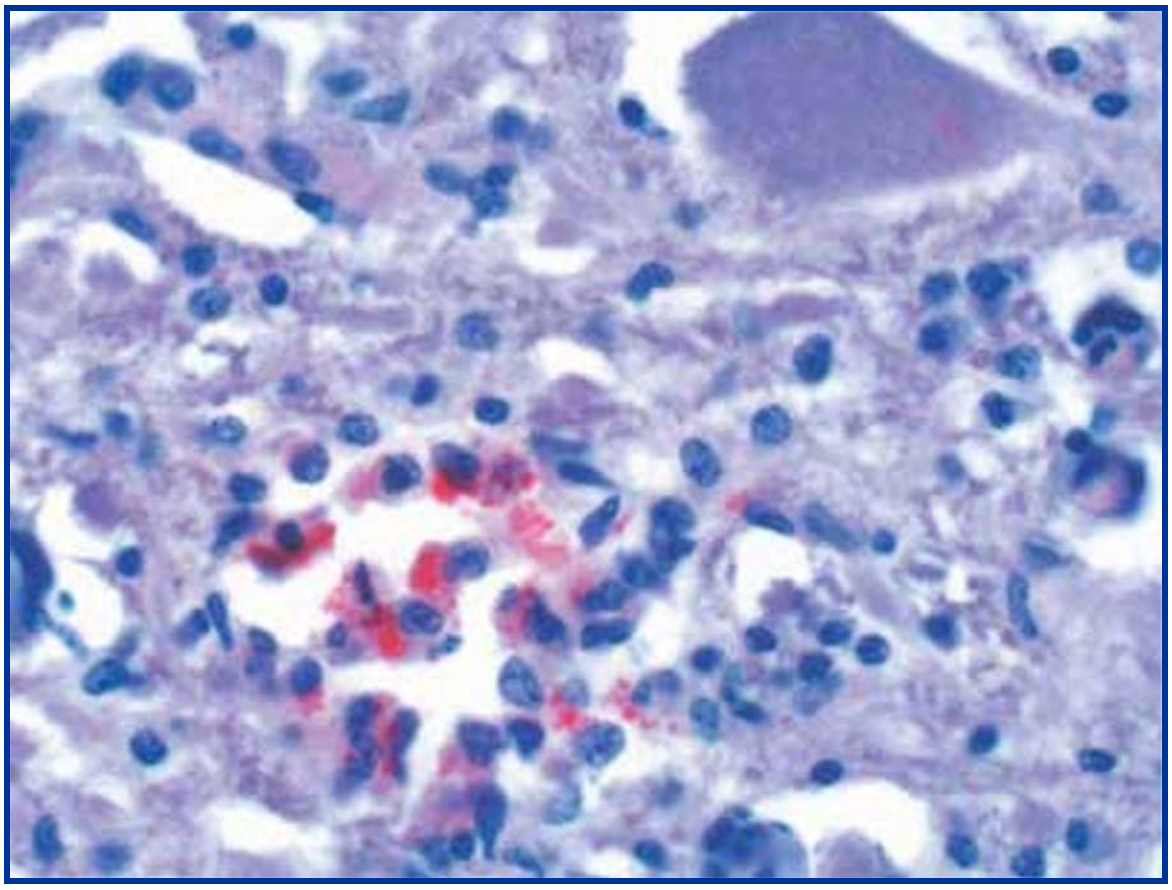
2004 Annual Report
City of Fort Collins
Mosquito Control Program



November 9, 2004

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ON THE COVER:

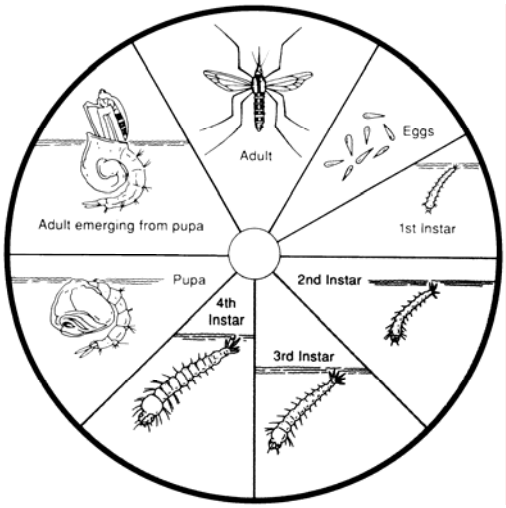
WEST NILE VIRUS IMAGE

FALSE COLOR IMAGE OF WEST NILE VIRUS PARTICLES (RED) IN HUMAN TISSUE. RESEARCHERS CONTINUE TO STUDY THE WEST NILE VIRUS. FROM UNDERSTANDING THE PROTEIN STRUCTURE OF THE VIRUS PARTICLE TO WEATHER PATTERNS, TO AVIAN ECOLOGY, WORK CONTINUES IN THE WAR AGAINST WNV DISEASE.

DURING THE SUMMER OF 2003, THE STATE OF COLORADO EXPERIENCED THE WORST EPIDEMIC OF HUMAN MOSQUITO-BORNE DISEASE ON RECORD IN THE WESTERN UNITED STATES WITH NEARLY 3,000 CASES AND 63 DEATHS.

AS OF OCTOBER 4, 2004, 271 HUMAN CASES OF WEST NILE VIRUS HAVE BEEN REPORTED IN COLORADO WITH 3 DEATHS. THE VAST MAJORITY OF CASES OCCURRED ON THE WEST SLOPE AND WERE CONCENTRATED IN GRAND JUNCTION AND MESA AND DELTA COUNTIES. SIGNIFICANT NUMBERS OF HUMAN CASES CONTINUED TO SHOW UP ACROSS COLORADO, PARTICULARLY THE NORTHERN FRONT RANGE WHICH WAS HARD HIT IN 2003.

THE MOSQUITO LIFE CYCLE



City of Fort Collins
Mosquito Control Program
2004 Annual Report

1. Introduction

A. Background

The City of Fort Collins Mosquito Management Program has completed its 1st year of cost effective bio-rational integrated mosquito control. By contracting with Colorado Mosquito Control, Inc. (CMC) the City has: 1) reduced the number of disease-vectoring mosquitoes, most before they can arise from the water to spread disease; 2) provided all residents with effective mosquito control using trained biologists who are able to concentrate on constantly changing mosquito populations; 3) freed up municipal personnel to perform their regular duties; and 4) provided a cost savings to the City.

B. Program Goals

Integrated Pest Management:

"A process consisting of the balanced use of cultural, biological, and chemical procedures that are environmentally compatible and economically feasible to reduce pest or disease vector populations to a safe and tolerable level."

"To control insect pests in a safe, efficient, and economic manner while preventing damage to humans, wildlife, and the natural environment."

The goal of Colorado Mosquito Control, Inc. (CMC) is to provide all residents of the City of Fort Collins with the best in safe, effective, modern integrated mosquito management. This environmentally friendly program always uses cultural and biological control choices first, with low toxicity chemicals used as a last resort. These efforts are all designed to reduce target mosquito populations to below established action thresholds, especially those species which vector West Nile Virus (WNV).

If left unmanaged, large segments of the City could be at a high risk for disease transmission .

2. 2004 Season Summary

West Nile Virus (WNV) dominated all aspects of the Fort Collins's mosquito control program in 2004. Very few discussions did not somehow include, "how should we approach that in the face of West Nile?"

All aspects of the mosquito program were designed to minimize the number of WNV human cases in Fort Collins. First, CMC field staff identified and mapped approximately 650 potential mosquito sources in early spring. These included farm fields, gravel pits, stormwater structures, irrigation ditches (and related leaks and seeps), and many other locations. Second, field staff immediately began checking and, if mosquito larvae were present, treating these mosquito sites to minimize the exponential growth of *Culex* mosquitoes. Third, in mid-May the full field staff was trained to recognize *Culex* larvae, thus enabling them to target those sites more likely to produce *Culex* throughout the summer. Fourth, a new trap was introduced to specifically collect adult *Culex* mosquitoes. Fifth, CMC worked with Fort Collins staff to establish adulticiding "triggers" which would allow adulticiding only if WNV was a clear threat and only in those areas where the threat was highest. And finally, field staff targeted *Culex* production sites late in the season to reduce the populations in the spring of 2005.

The season in summary:

- The summer of 2004 was slightly cooler than the last historical average, and nearly 2.3 degrees cooler than last year. The total rainfall in Fort Collins was 2.1 inches more than 2003. However, the timing of rainfall throughout the summer allowed for effective larviciding by CMC staff. (See Figure 1).

- The Mosquito Control Area consisted of all land within the City limits and a 0 to 2 mile "buffer zone" in unincorporated lands around the City. The total area was approximately 109 square miles. A very large percentage of the mosquito production sites are outside the City limits, but are easily within the flight range of "migratory" mosquitoes. In fact, our data indicates that the majority of mosquitoes are produced outside the City, but then fly in and "settle in" for several weeks in residential yards and parks.

- CMC field staff increased the number of larval sites from approximately 650 at the beginning of the season to 867 by the end. A dramatic increase such as this is common during the first year of a program because many sites cannot be found until they produce for the first time.

- 1,000 calls taken at CMC from Fort Collins residents, half of which were to request notification if adulticiding should occur. (See Figure 2).

- Approximately three-quarters of the larviciding products used were bio-friendly bacteria (See Figure 3).

Figure 1
Fort Collins Summer Data
(May-August Only)

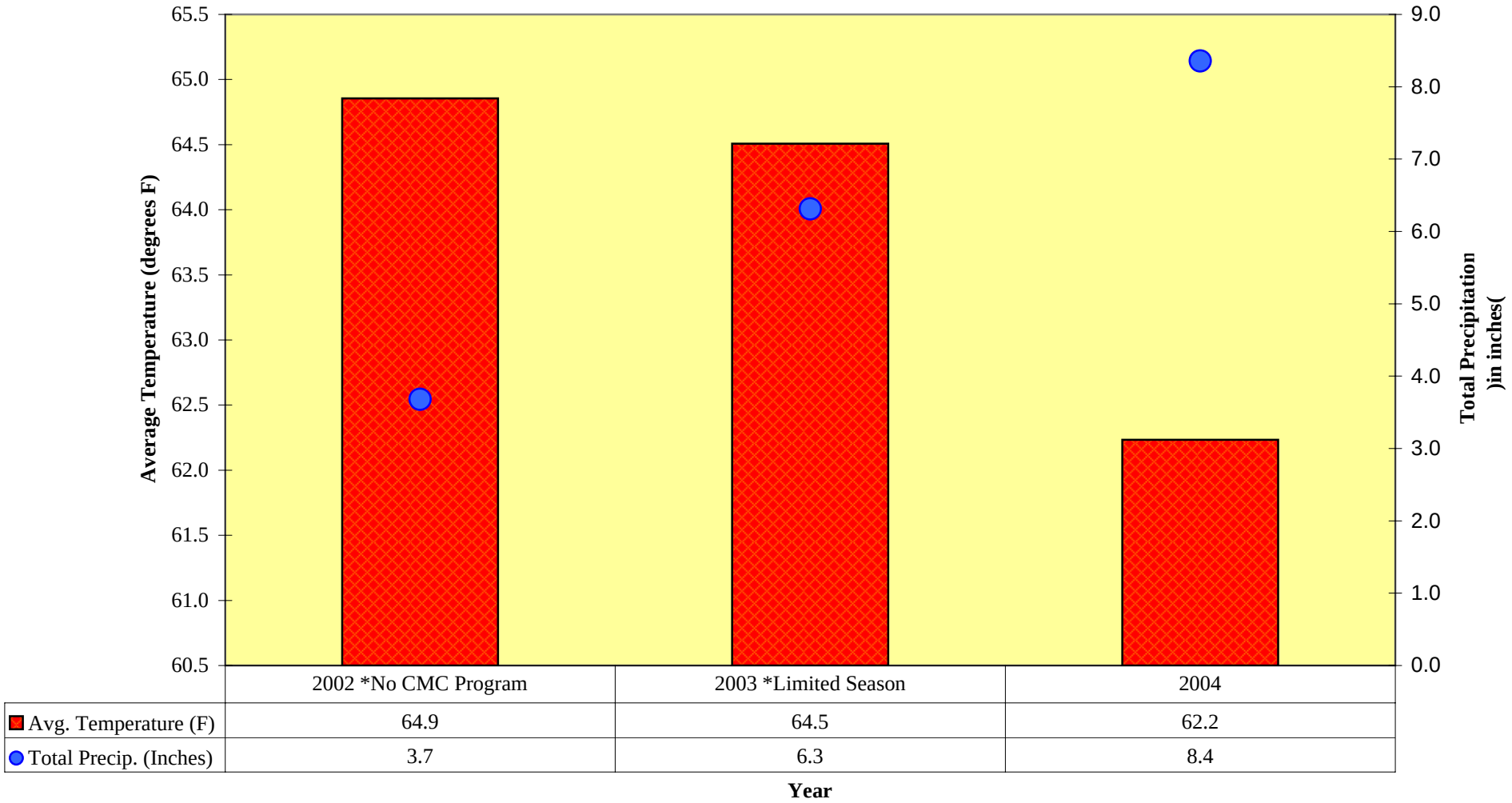
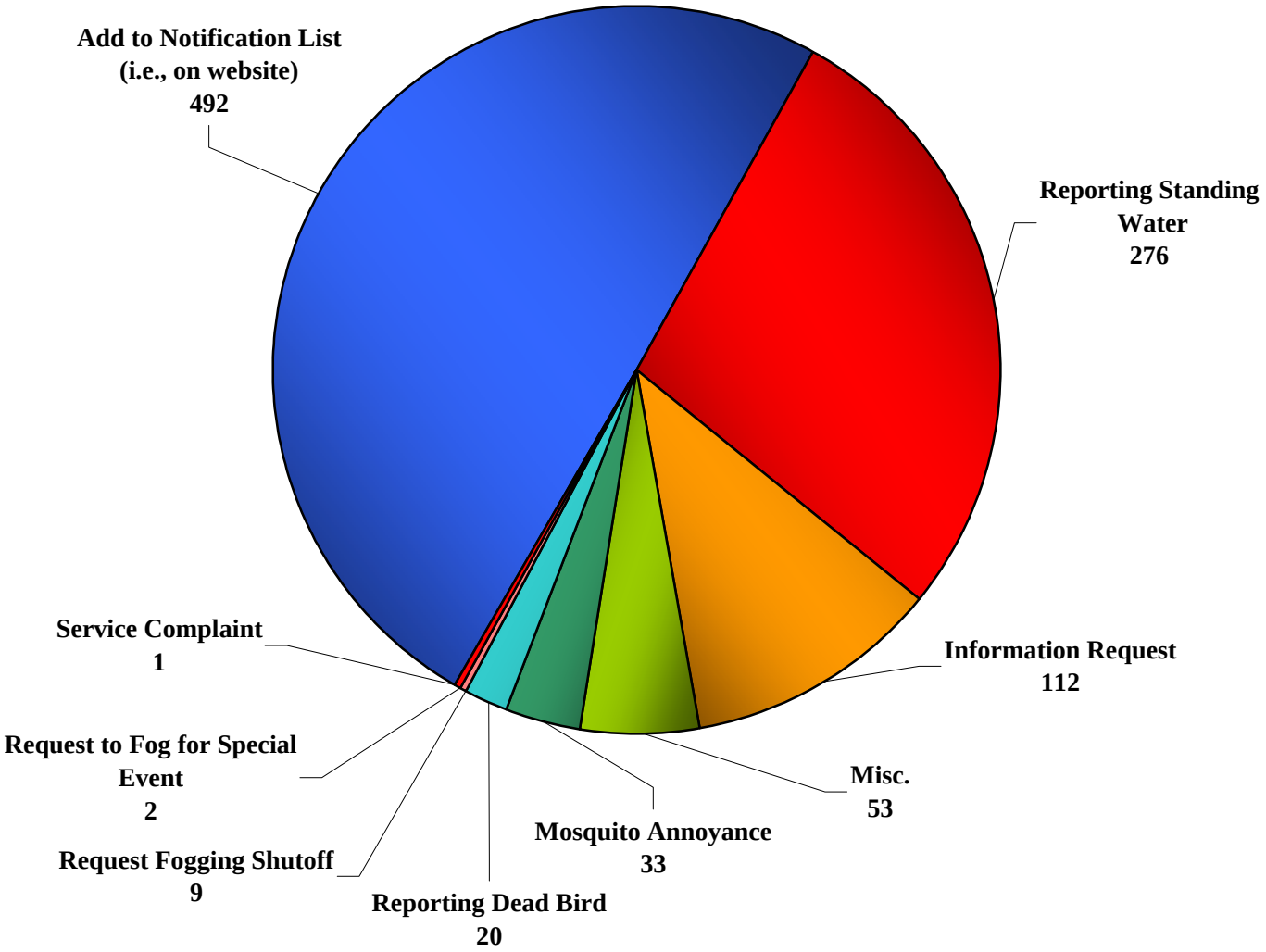


Figure 2

Number of Calls to Colorado Mosquito Control Office
Fort Collins Residents 2004
1,000 Calls



- The number of adult mosquitoes decreased dramatically compared to last year. (See Figure 4).

- The policy for notification prior to adulticiding, and the policy regarding who could request to have adulticiding stopped at their property line, changed dramatically from 2003.

- The 2004 Fort Collins staff consisted of 17.5 full-time equivalent employees. Specifically, we had approximately 11 full-time Field Staff, 1 Urban Programs Technician, 2 ½ full-time surveillance staff, 1 half-time Maintenance Technician, and 4 half-time Office Staff, and 1 full-time Manager.

- There were only 2 WNV-positive mosquitoes collected in Fort Collins

- There were very few human cases of WNV in Fort Collins compared to last year.

Many have asked what the future of WNV will be like here in Fort Collins. No one knows for sure, but it seems certain that it will not be like the other mosquito-borne diseases in Colorado. Unlike Western Equine Encephalitis and St. Louis Encephalitis, which appear at low levels every 7 to 10 years, WNV looks like it will be present every year at widely varying levels. To paraphrase the words of an epidemiologist at the Colorado Department of Health and Environment, "2003 was likely as bad as it gets, 2004 is likely as good as it gets -- every year from now on will be somewhere in between."

Figure 3
Larvicide Products Comparison
Fort Collins Area 2004

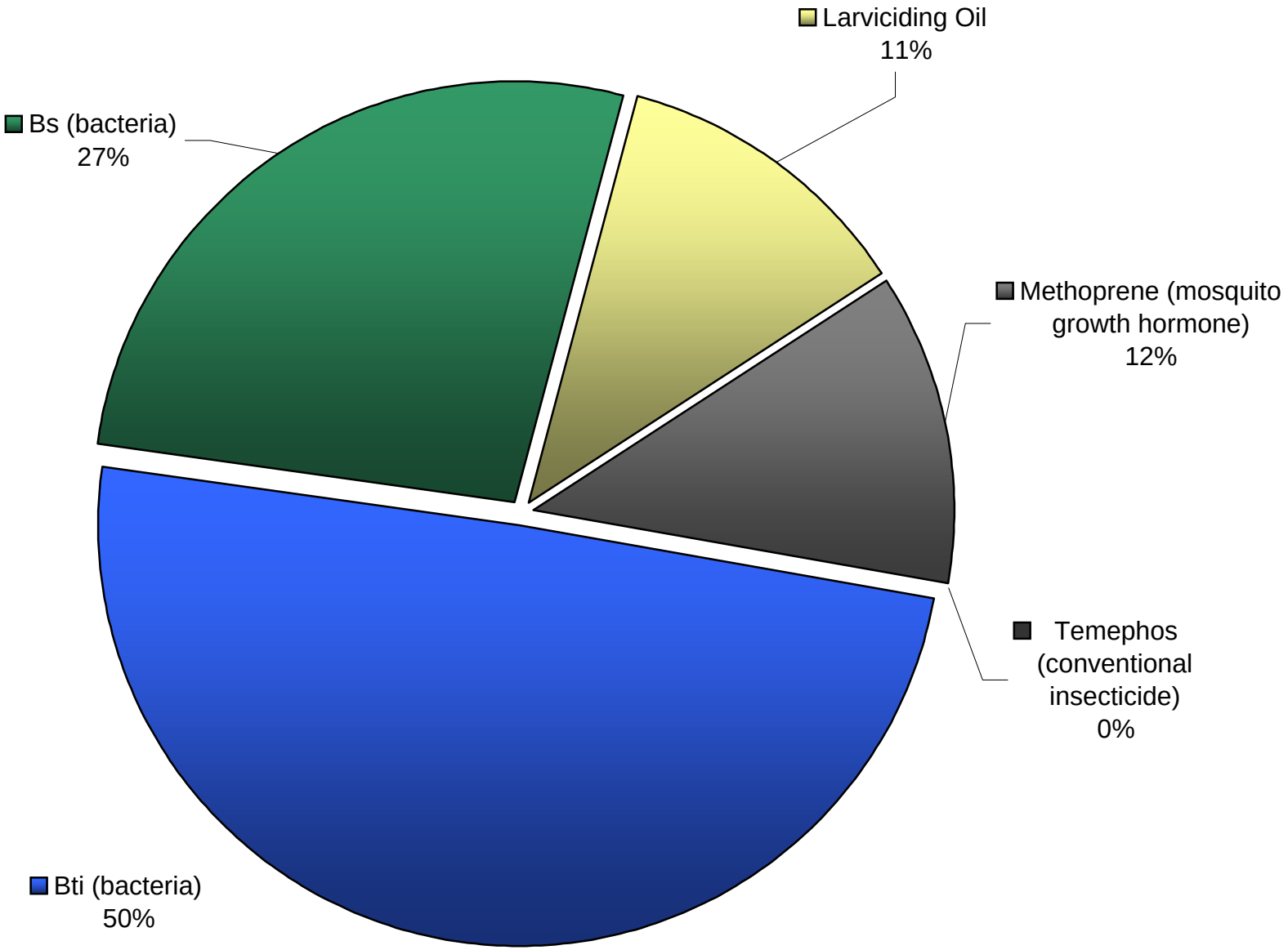
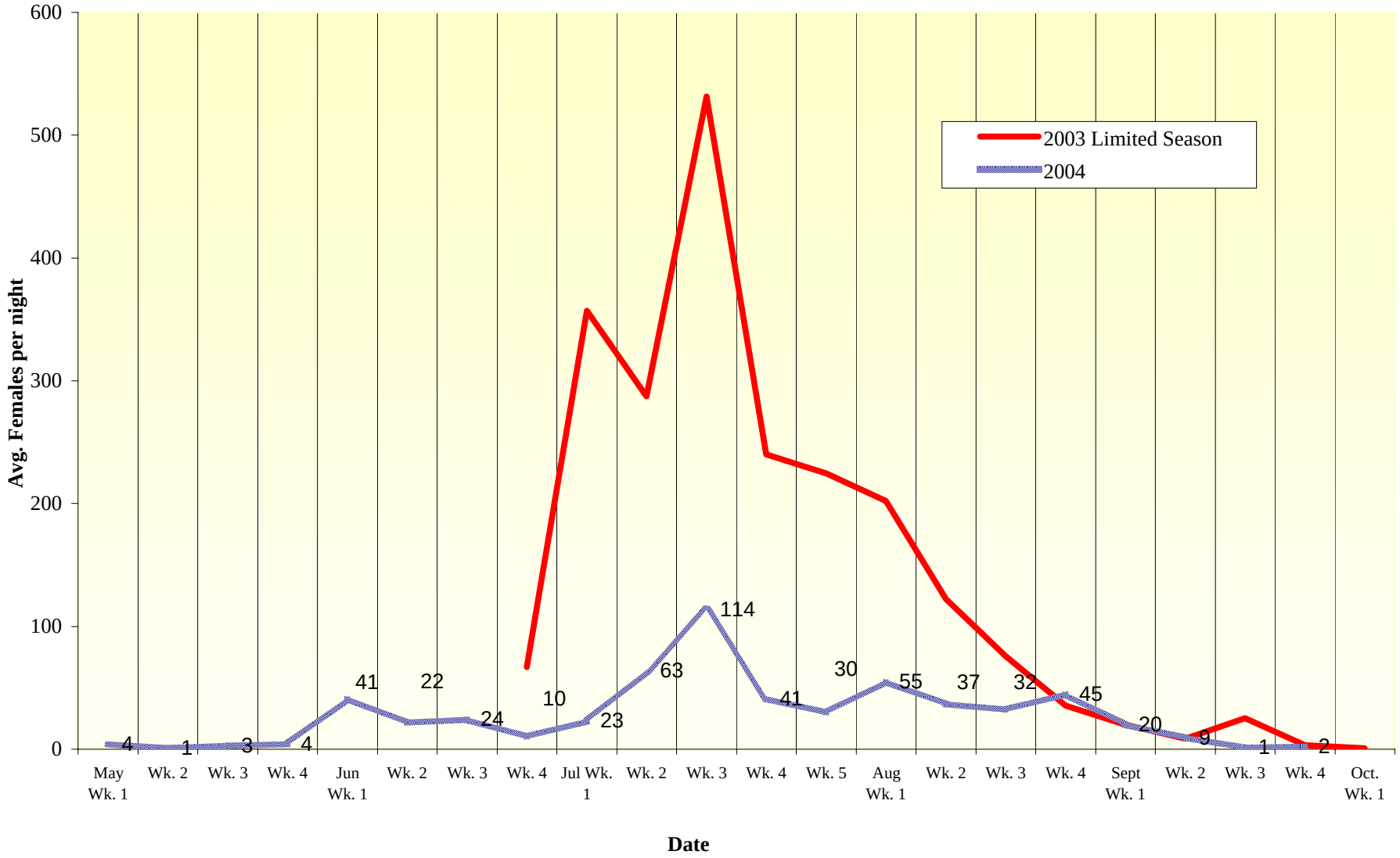


Figure 4
City of Fort Collins
Weekly Mosquito Population Trends



3. Customer Calls

The majority of the 1,000 mosquito calls taken by CMC staff in 2004 were positive. Approximately half (492 calls) were residents requesting to be added to the City's Automatic Notification List. CMC staff reported that approximately half of these 492 residents were in favor of adult mosquito spraying, and half were opposed.

Approximately one quarter of the calls were to report standing water. When these calls came in, CMC staff looked at our GIS mapping system to see if the area was already mapped as a potential larval site. If not, the site was mapped and a field technician visited the area to assess its capability to produce mosquitoes. All promising areas were mapped and subsequently visited for the remainder of the season.

The remainder of the calls were information requests (112), mosquito annoyance (33), dead bird reports (20) and others. See Figure 2 for details.

On the whole, more people called to assist us in finding the source of mosquitoes (the solution) than called to complain about biting mosquitoes (the problem).

4. Larval Mosquito Control Efforts

In 2004, we did not have as much precipitation in April, May, and June as we did in 2003. Therefore, the larviciding staff was able to keep larval populations in check from the very beginning of the summer.

Larviciding in 2004 consisted of inspecting every potential larval development site in the Fort Collins area (now 867 sites) approximately once a week to check for the presence of larval mosquitoes, and checking every potential storm drain once per month. Many sites were checked more often if an irrigation event was expected and/or a large rainstorm occurred. The sites were reached on foot or by using an All Terrain Vehicle (ATV). Use of the ATV is critical in the large and/or hard to reach areas. The ATV allowed the field staff to cover large sites quickly and efficiently. The staff checked for larvae at each site by taking water samples with a plastic dipper. If larvae were present, the site was treated with one of the products described below.

The product most commonly used in 2004 was a virtually non-toxic substance derived from a bacterium called *Bacillus thuringiensis* sub. *israelensis* (Bti). The active ingredient is used in a form marketed as "Vectobac". Byproducts from Bti kill mosquito larvae within approximately 24 hours of application, and require additional treatments every 7 days as long as larvae are present. Approximately 49 % of the acreage was treated with Vectobac products in 2004.

A second bacterium, *Bacillus sphaericus* (H-5a5b), referred to as "Bs," was utilized much more in 2004 than in previous years. Bs was used throughout the season in a form marketed as "Vectolex". Bs kills mosquito larvae within approximately 48 hours, and has a longer period of effectiveness (approximately 21 days). It is effective longer because the Bs bacteria have the ability to reproduce in the cadavers of dead larvae, whereas the Bti bacteria disappear after a few days. Approximately 27 % of the acreage was treated with Bs products in 2004.

Other larval products used consisted of larviciding oil, a specific mosquito hormone, and at the end of the season, a broad-spectrum organophosphate chemical. The larviciding oil used in 2004 is marketed as "Bonide Larviciding Oil." It consists of mineral oil with a small percentage of spreading agents. It is normally used only where mosquitoes developed to the late larval or pupal stage, or if larval populations were so high that Bti would not be effective. The oil was used quite a bit less than in the 2004 season because the staff was able to visit the sites more quickly, thus catching most mosquitoes in the larval stage.

The oil acts by spreading thinly over the water surface, suffocating the larval and pupal mosquitoes. The oils also kill other tube-breathing aquatic organisms, so we used these products only when use of other products was impractical or impossible. Approximately 11 % of the total 2004 acreage was treated with larviciding oil.

The mosquito hormone used in 2004 was Methoprene, in several forms under the trade names of "Altosid." Altosid products work by preventing larval mosquitoes from developing into adults. Altosid is not toxic to other animals, and allows the larval mosquitoes to play their normal role as a food source for fish and other aquatic organisms. Altosid products accounted for approximately 12% of the total acreage treated in 2004. **Note that the majority of this amount was applied by helicopter**. A helicopter was necessary because of the huge number of acres needing treatment in late summer. Vectolex was unfortunately not an option at the time because of the wide variation in larval stages at the helicopter sites.

The broad-spectrum chemical used in 2004 was Temephos, in a pellet form under the trade name "Abate Pellets." Temephos is a conventional organophosphate. It accounted for 0.004% of treated acreage in 2004. The few times Abate was used was in artificial containers such tire piles, or similar enclosed areas.

In 2004, 634.3 acres were treated with the bacteria Bti, 345.6 acres with the bacteria Bs; 146.6 acres were treated with larviciding oils, 154.2 acres with the mosquito hormone Methoprene (approximately 114 acres of this by helicopter), and 0.045 acres with the organophosphate product Abate. This totaled 1,280.7 acres in 2004, compared to approximately 500 acres in one treatment in 2003.

The following is a summary of larviciding efforts in 2004:

1) WNV Targeting - CMC field staff was trained to identify *Culex* larvae, enabling them to concentrate on sites that often produced these mosquitoes. In total, they killed approximately 3.2 Billion *Culex* larvae (the species that transmit WNV), and 4.6 larvae overall. **This works out to be approximately 20,300 Culex larvae per resident of Fort Collins.** Note that these estimates are likely low because in 2004, staff used large amounts of long-term products, thus only calculating the larvae killed at the initial treatment. The larvae killed by the long-term products as they circulated within the site in subsequent weeks (without a technician present to estimate population) were not calculated.

2) Long-Term Products – Just over one third of the acreage was treated with long-term larviciding products in 2004. (See Figure 3).

3) Site Inspections - The staff made 9,823 visits to mosquito larvae sites, compared to none in 2003 (prior to 2003 helicopter treatments). This large amount of visits was necessary because there is no history on any of the sites. Once sites have been visited for a few seasons, we can rank them based on their capacity to produce larvae, and reduce the number of visits significantly. Of course, some areas are highly erratic because of human behavior (e.g., irrigation sites, gravel pits) and must be visited weekly every year.

4) Size of Control Area -The larval surveillance area was approximately 109 square miles. Approximately 50 square miles were inside City limits, and 69 square miles were areas bordering the City. Unfortunately, it appears that a large proportion of

the adults within the City arose from sites outside of the City. A larviciding program within the City limits only would, frankly, be a waste of time and money.

5) Number of Larval Sites -The total number of potential larval sites increased from approximately 70 (for the one-time helicopter treatment) in 2003 to 867 by the end of the 2004 season. This type of dramatic increase is not unusual for a first year program. If the program is in place next season, another 200 to 300 sites are likely to be found, and a few hundred may be deleted due to inactivity.

6) Number of Treated Acres -The area treated in 2004 was 1,189 acres. This was approximately double the acreage treated by helicopter in 2003. However, it is *very* important to note that the number of mosquitoes killed in 2004 was many times higher because all 2004 treatments were made to the exact locations that larvae were present. This is the goal of an Integrated Pest Management program – treat only when and where larvae are present, thus reducing unnecessary pesticide use and, in the long run, saving money.

7) Inspection Efficiency – It is impossible to know if a given mosquito site will or will not be producing larvae on a given day unless it is physically inspected by a technician. However, using historical data, CMC technicians can prioritize which sites should be checked semi-weekly, weekly, or less often. This year, approximately 78% of sites were wet when inspected, and 25% were producing larvae when inspected. Of course, new sites have to be inspected every week for a few seasons, so efficiency is necessarily low for these sites until a pattern is established.

8) Helicopter Usage -a helicopter was used again this year to treat larval sites in Fort Collins. A total of 13 sites were treated by helicopter. One treatment was split between July 14th and16th, and a second treatment was done on August 6th. Total acreage for all treatments was 160 acres, using 278 lbs. of Vectolex CG and 618 lbs. of Altosid XRG.

9) Storm Drain Program - The storm drain program, now in its 2nd year, has increased again in 2004. It will level off from this point on because the entire City's stormwater system will be inspected annually. CMC staff located 3,636 storm drains (i.e., catch basins) in 2004, compared to approximately 1,000 in 2003. These 3,636 drains were inspected, and if necessary, treated, several times throughout the summer. In total, there were 6,246 wet/dry inspections done, with 821 drains treated with Altosid, 6 with larviciding oil (i.e., approx. 1 oz. per drain) and 9 with Vectolex. For quality control purposes, 379 larval dip inspections were done. Of the 379 dip inspections, larvae were only found in 21 drains. This is likely due to the regular rainfall in 2004. Based on Loveland storm drain data, storm drain infestation occurs more often in drought years.

The primary larval species found in storm drains was *Culex pipiens*, a known vector of WNV. *Culex tarsalis* was also found in a few drains.

10) Backyard Program –*Culex pipiens* is a known vector of WNV, and it usually is found in both residential settings and storm drains. In 2004 we standardized an inspection system to keep on top of residential properties which produce *Culex* mosquitoes. Approximately 40 residences were inspected approximately monthly to encourage them to remove larval habitat such as cans, clogged gutters, and garbage.

11) Owners of Mosquito Production Areas – Where do all of the Culex mosquitoes come from in Fort Collins? To find out, we plotted the number of Culex mosquitoes killed in the water in 2004 in the Fort Collins mosquito program by landowner. This is likely the most accurate measure because what we are concerned about is the number of mosquitoes produced, not the size of the water body from which they emerged. See Figure 5 for details.

What we found was that private landowners (e.g., residential homeowners, businesses, gravel pit operations, farmers, etc.) produce approximately 52% of the Culex mosquitoes. The second largest producer are Fort Collins Natural Areas at 36%, followed by Homeowner's Associations at 12%, and Other City Properties (e.g., parks and facilities) with 2%.

12) Culex Only Control Program – Some have suggested changing to a "Culex Only Control Program" similar to that attempted by the City of Boulder in 2004. CMC staff looked into this possibility for Fort Collins in terms of environmental preservation, time savings, and cost savings. Please refer to Figure 6.

Each of the 2,456 times CMC staff found mosquito larvae the technician attempted to identify the larvae in the site to genus (e.g., Culex, Culiseta, Aedes, or Ochleratattus). After examining the data, we found that often there would be a mix of different species swimming in the water together. We found that 33% of the time the technician found solely mosquitoes of the genus Culex, 28% of the time the technician found solely floodwater genera, 23% of the time he or she found a mixture of the two above groups, 11% of the time the larvae could not be identified (e.g., they were too small at the time), 1% of the time they were solely Culiseta mosquitoes, and the remainder were mixtures of all of the above.

If CMC had attempted a Culex Only Program in 2004, roughly 70% of the acreage would have had to be treated anyway because they contained some Culex mosquitoes in the mixture. The only possible exception was the unidentifiable 11% of larvae. Unfortunately, this would mean at least one additional trip to each questionable site to check on the mosquito's growth, and then a roughly 60% chance it would have to be treated anyway. This is certainly possible, but definitely not time efficient given the often long commutes between the office and sites.

The advantage to this type of program would be primarily environmental, assuming that floodwater species are a valuable food source for wildlife as larvae and/or adults. This is definitely true in some cases, floodwater species, having a strong "r" reproductive strategy, seek to hatch in and emerge, in massive numbers, from very temporary water sources before aquatic predators can colonize the area and feed on

Figure 5

Where *Culex* Mosquitoes are Produced
Fort Collins 2004

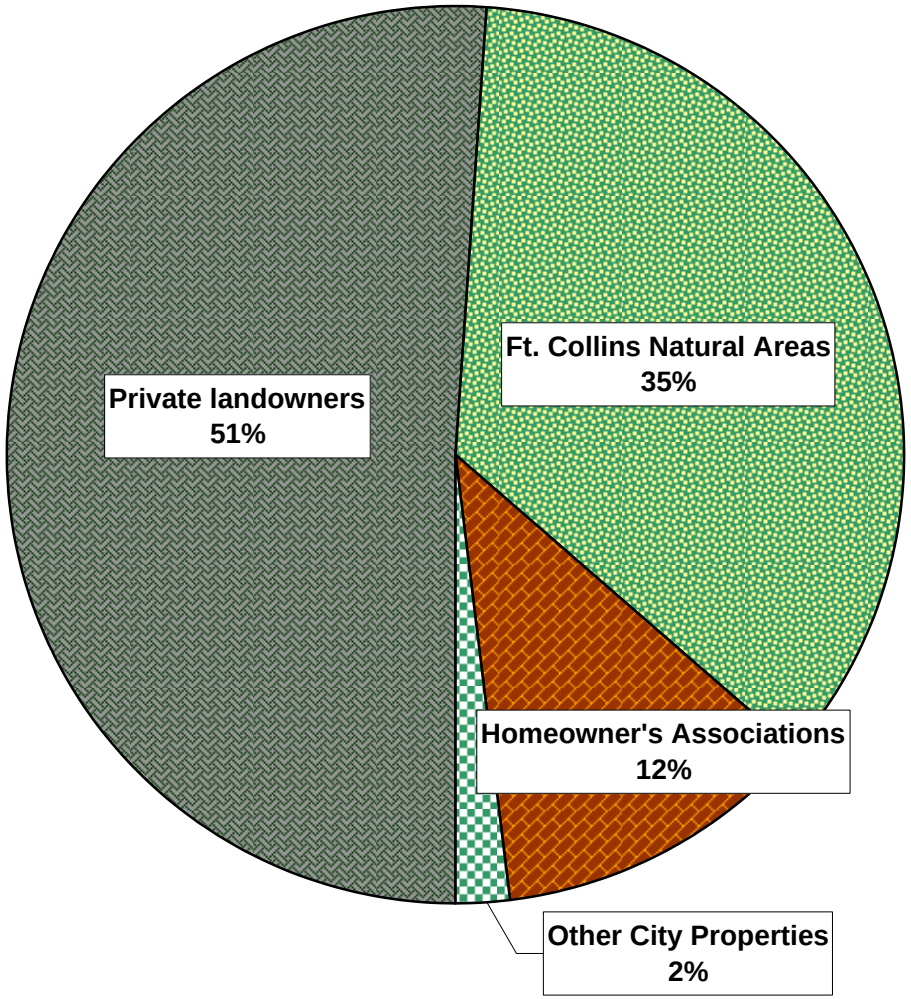
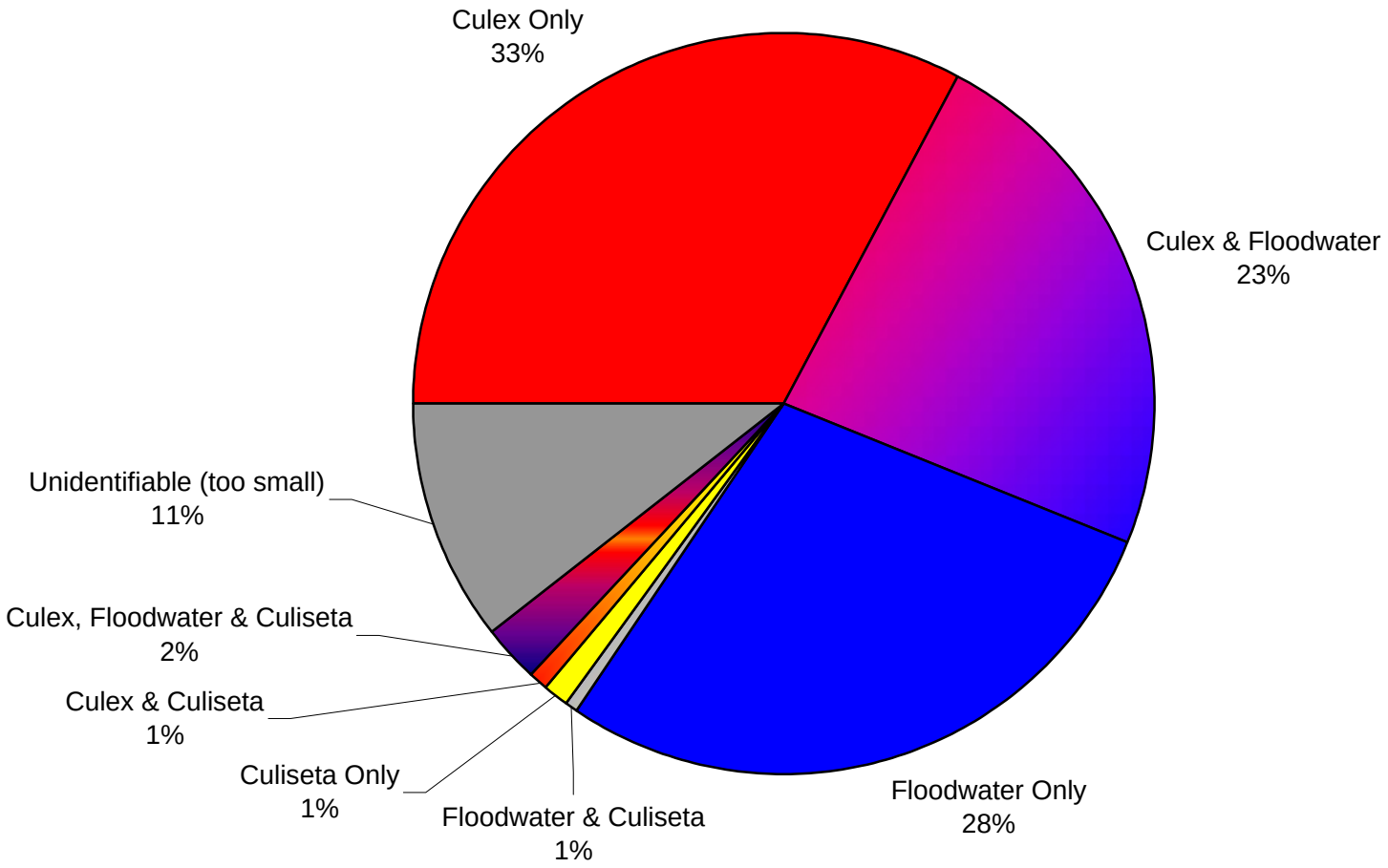


Figure 6

Types of Mosquito Larvae Found at Each Site
Fort Collins 2004



them. Unfortunately, Culex larvae tend to be better food sources for aquatic wildlife because they tend to colonize more permanent water bodies with established ecosystems.

The major disadvantage would be public perception that the mosquito program is failing, and unfortunately, would likely result in more requests to adulticide.

5. Adult Mosquito Control Efforts

A. Monitoring of Adult Mosquitoes

Adult mosquitoes are collected and identified for several reasons: 1) Quality control of existing larviciding efforts; 2) Assisting in finding new larval sites; 3) Targeting adulticiding efforts, and 4) collecting mosquito adults for WNV testing.

In 2004, mosquito populations in the City were monitored at 45 adult light trap locations. The battery-operated "light traps" and "gravid traps" were set in regular locations in most of the 65 "Adulticiding Zones" throughout the City. Light traps were set weekly, and gravid traps were set every 3 to 4 weeks, in each location. Several traps were also reserved each week for placement in the yards of residents who complained of excessive mosquitoes.

Results of the monitoring efforts are shown in Table 1. Note that the season average of 43 mosquitoes was 5.6 times lower than last year. Some would argue that this decrease was due in part (or mainly) to weather patterns and not to the mosquito program. Granted, weather naturally increases or decreases the number of mosquitoes hatching in the water any given year. *However*, note that the weather patterns are nearly identical in Fort Collins and Loveland. If weather was the main reason (i.e., mosquito control was not really having an effect) that mosquito populations decreased this year, then you would expect a very similar reduction from 2003 to 2004 in *both* cities. That is, in 2003 Loveland had a full mosquito program, and for all intents and purposes, Fort Collins did not. In 2004, both had similar mosquito programs and similar weather. If mosquito control was not having an effect, the weather should decrease the populations of both cities equally.

It did not. The mosquito population in Loveland (with similar mosquito programs both years) dropped by 3.2-fold in 2004, while Fort Collins populations (after starting a mosquito program) dropped nearly 5.7-fold during the same time period. Therefore, roughly a 2.5-fold drop in mosquito populations in Fort Collins was attributable to something other than weather. CMC submits that the only significant difference in 2004 was the start of an integrated mosquito control program.

This concept is illustrated graphically in Figure 7 and 8. Figure 7 shows the actual population trends of *Culex tarsalis* in Loveland and Fort Collins in 2003 and 2004. Note that in 2003 populations in both cities are high (dashed lines) but very different from each other. Now examine the 2004 populations (solid lines). Both are low, but this year they are nearly identical. If weather was the main force in reducing numbers, you would expect both to drop proportionally the same amount. Now turn to Figure 8. The solid, angular lines are again the actual populations of adult *Culex tarsalis*, with nearly identical population trends. Look at the red smoothed line. This is what you would expect the *Culex tarsalis* trend to be if Fort Collins populations dropped proportionally the same amount as Loveland (due to weather). They did not. They dropped farther due

Table 1
2004 Avg. Trap Count vs. Previous Years
City of Fort Collins
(June, July, & Aug. only)

Sector	2003*	2004
Old Town	329	62
Northeast of River	324	75
Warren Lake	263	61
City Park West	149	19
West Horsetooth	87	10
South of Harmony	303	30
Ft. Collins Season Avg.:	243	43

*2003 trapping season started on June 25, 2003

Table 2
2004 Fogging Miles
City of Fort Collins

Sector	2003*	2004
Old Town	n/a	194.0
Northeast of River	n/a	41.1
Warren Lake	n/a	214.4
City Park West	n/a	0.0
West Horsetooth	n/a	0.0
South of Harmony	n/a	47.5
Ft. Collins Season Total.:	271.2	497.0

*includes all Fort Collins Areas (HOA's, CSU, and City)

Figure 7

Culex tarsalis

Cities of Fort Collins and Loveland

2003 vs. 2004

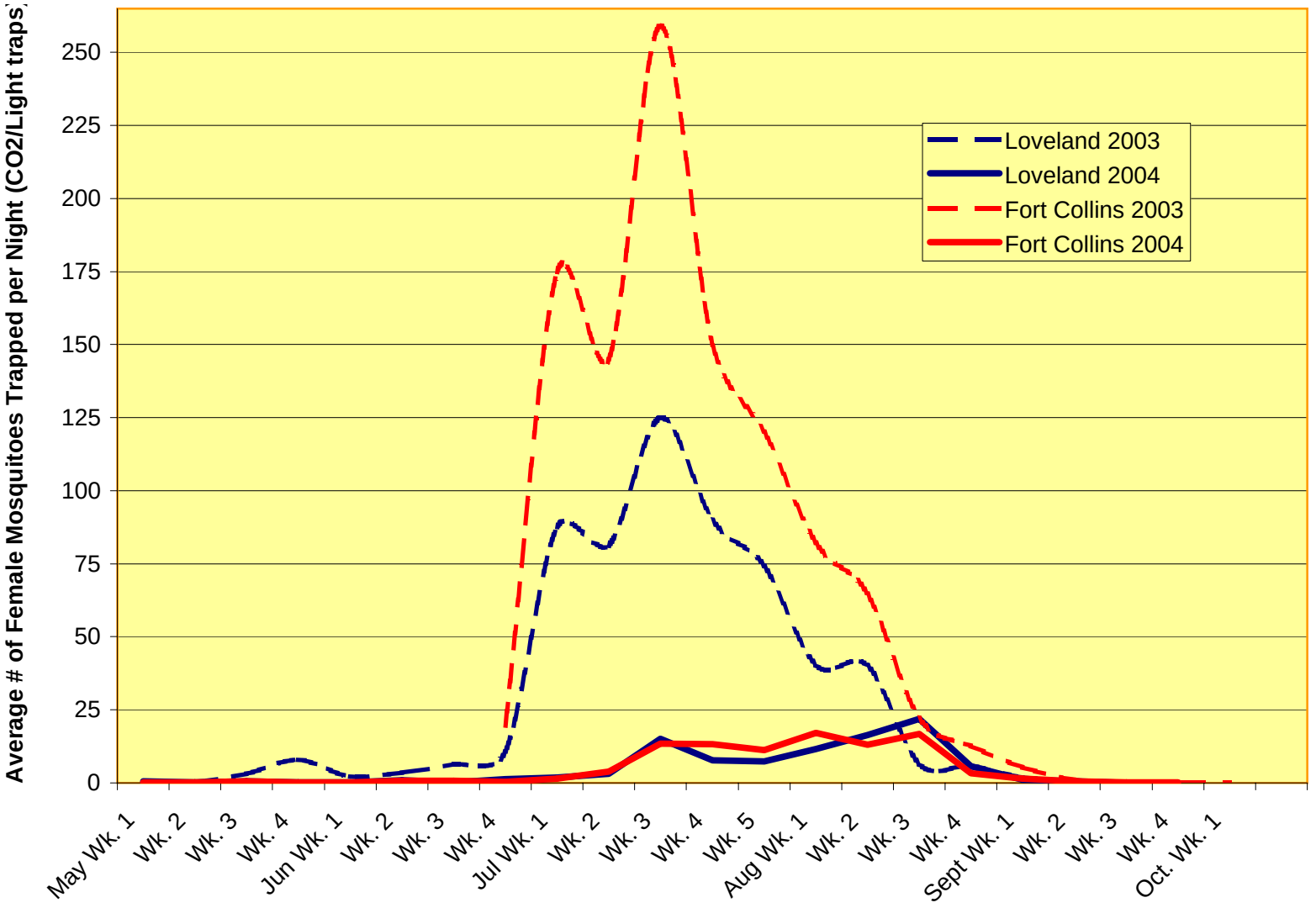
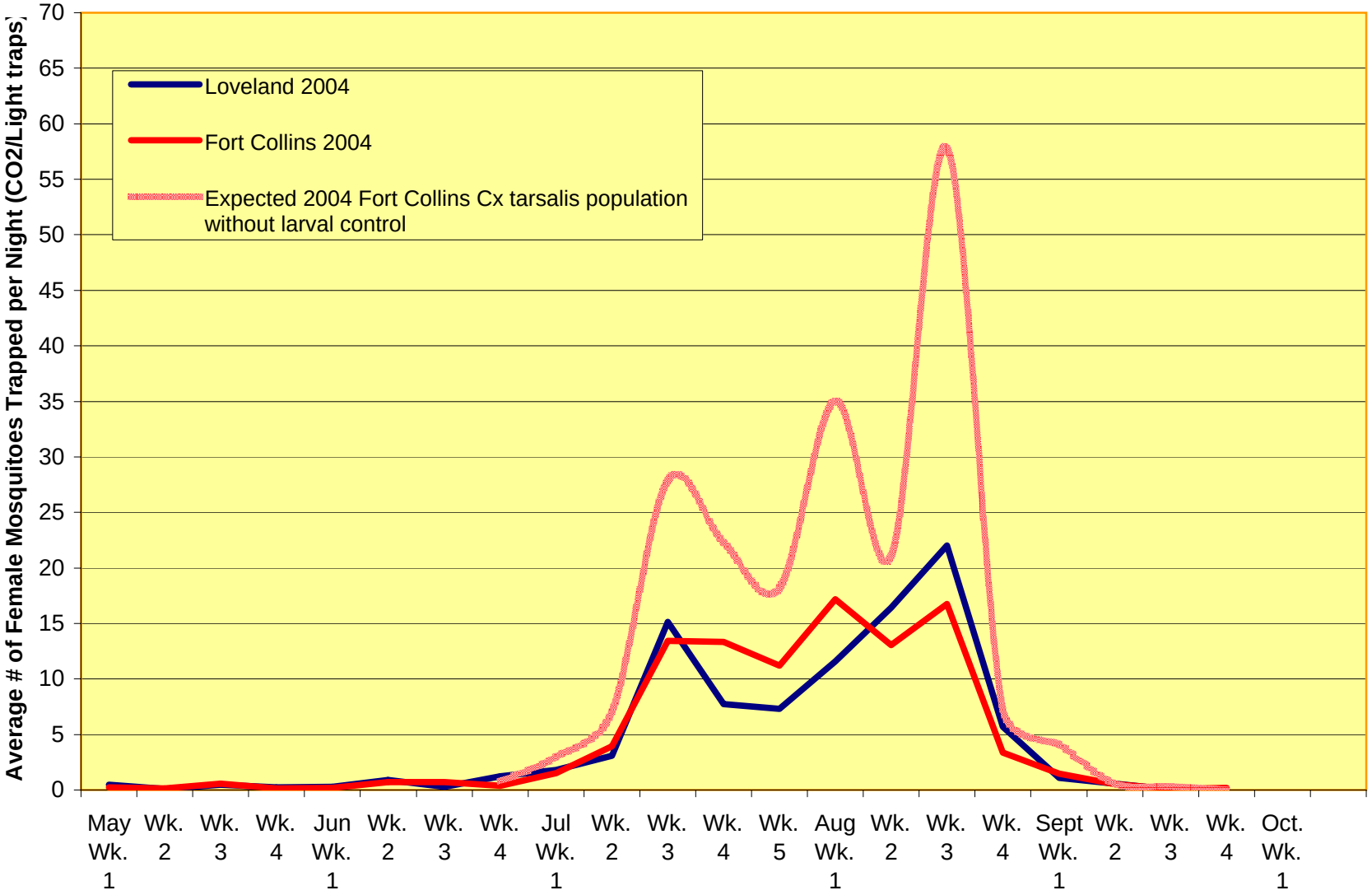


Figure 8
Culex tarsalis (Expected)
Cities of Fort Collins and Loveland
2004



to some other force. One possibility is CMC killing 3.2 billion Culex larvae in Fort Collins before they took flight.

The same idea is illustrated in Figures 9 and 10 using *Culex pipiens*, the other primary vector of WNV.

Because some species of mosquitoes can transmit West Nile Virus, Western Equine Encephalitis and St. Louis Encephalitis while others cannot, it is critical to know what species are present in Fort Collins, where they are, and when they are there. Figure 11 shows the relative abundance of these and other species in the Fort Collins area. The samples were taken in an area encompassed roughly from Terry Lake on the north to Carpenter Road on the south, and the foothills on the west to I-25 on the east.

Figure 11 shows both the total number of mosquitoes trapped each night (height of bars) and the population of each species (colored section of bars). Note that the populations of "floodwater" nuisance mosquitoes are indicated by blue tones, and the WNV vector species are indicated by red tones.

Note two important items: 1) the total population of mosquitoes has dropped dramatically from 2003 to 2004, and 2) the population of WNV vectors dropped 94% while the populations of nuisance mosquitoes dropped only 50%. This was an intentional goal of CMC's program – WNV vectors were the target in 2004.

Figure 12 shows the species breakdown for our new gravid traps. This trap is new to this area, and is designed to collect primarily WNV vectors. Please note that 78 % of the mosquitoes trapped were potential WNV vectors.

Figure 13 shows the population trends of all mosquitoes in Fort Collins and Loveland. Note the dramatic decrease in total populations for both cities.

B. Adult Mosquito Control

The primary emphasis of the Fort Collins program is to control mosquitoes in the larval stage, using safe biological control products. However, secondary measures must be taken when WNV vector populations rise due to movement from areas outside our control area, or from emergence from unknown larval sites.

The WNV Task Force worked hard to craft a threshold based on last year's data that would minimize the amount of fogging, should it become necessary, and maximize the mortality of WNV vectors.

The threshold is called a "WNV Risk Index" which mathematically combines the populations of WNV vector mosquitoes with the proportion of WNV-positive mosquitoes. For example, if one area of town has 10,000 WNV mosquitoes, but none are infected with WNV at the time (0% WNV-positive infection rate), then fogging would not be necessary. However, if a different area of town had only 100 WNV

Figure 9

Culex pipiens

Cities of Fort Collins & Loveland 2003 vs. 2004

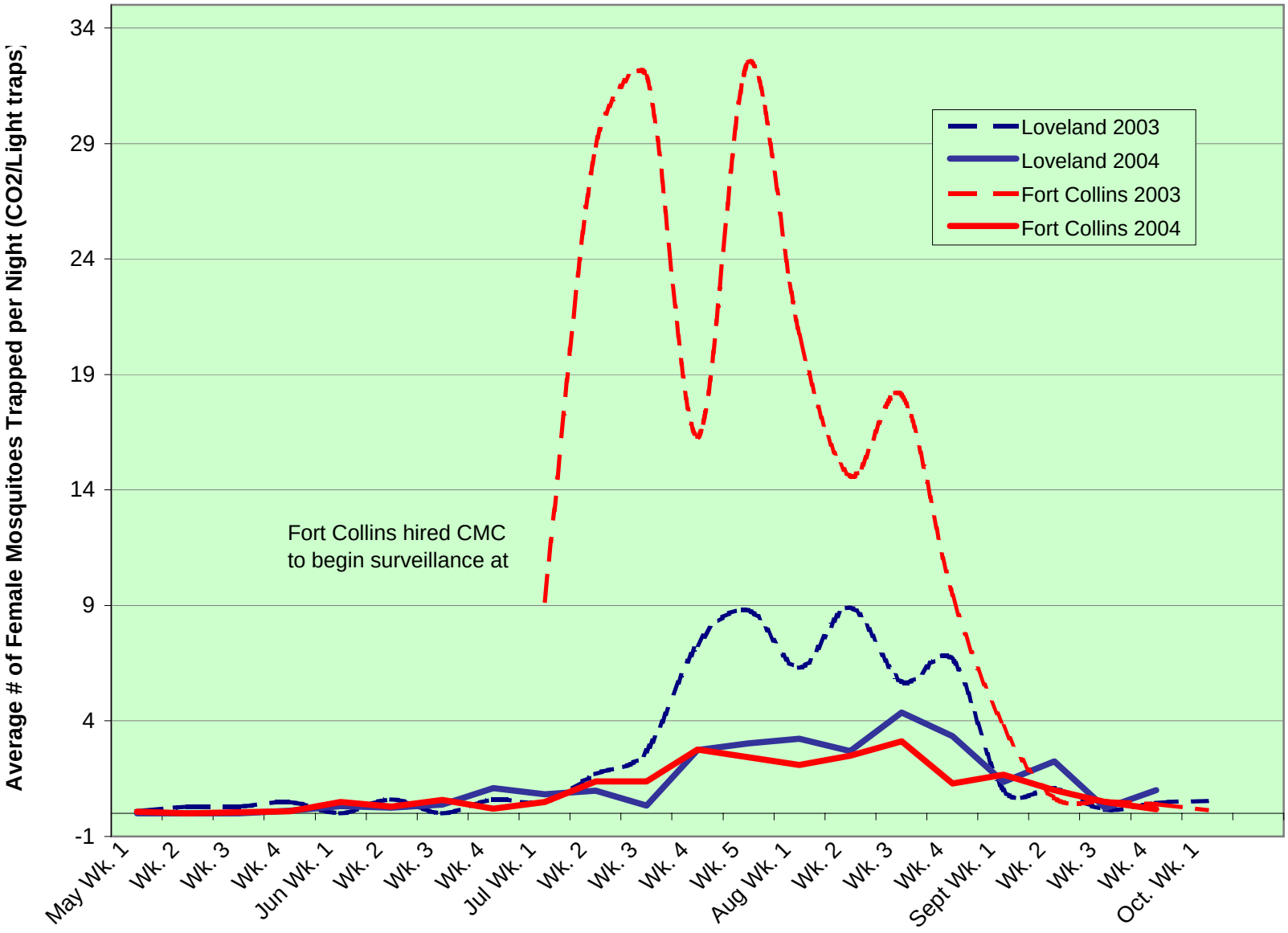


Figure 10

Culex pipiens (Expected)

Cities of Fort Collins and Loveland 2003 vs. 2004

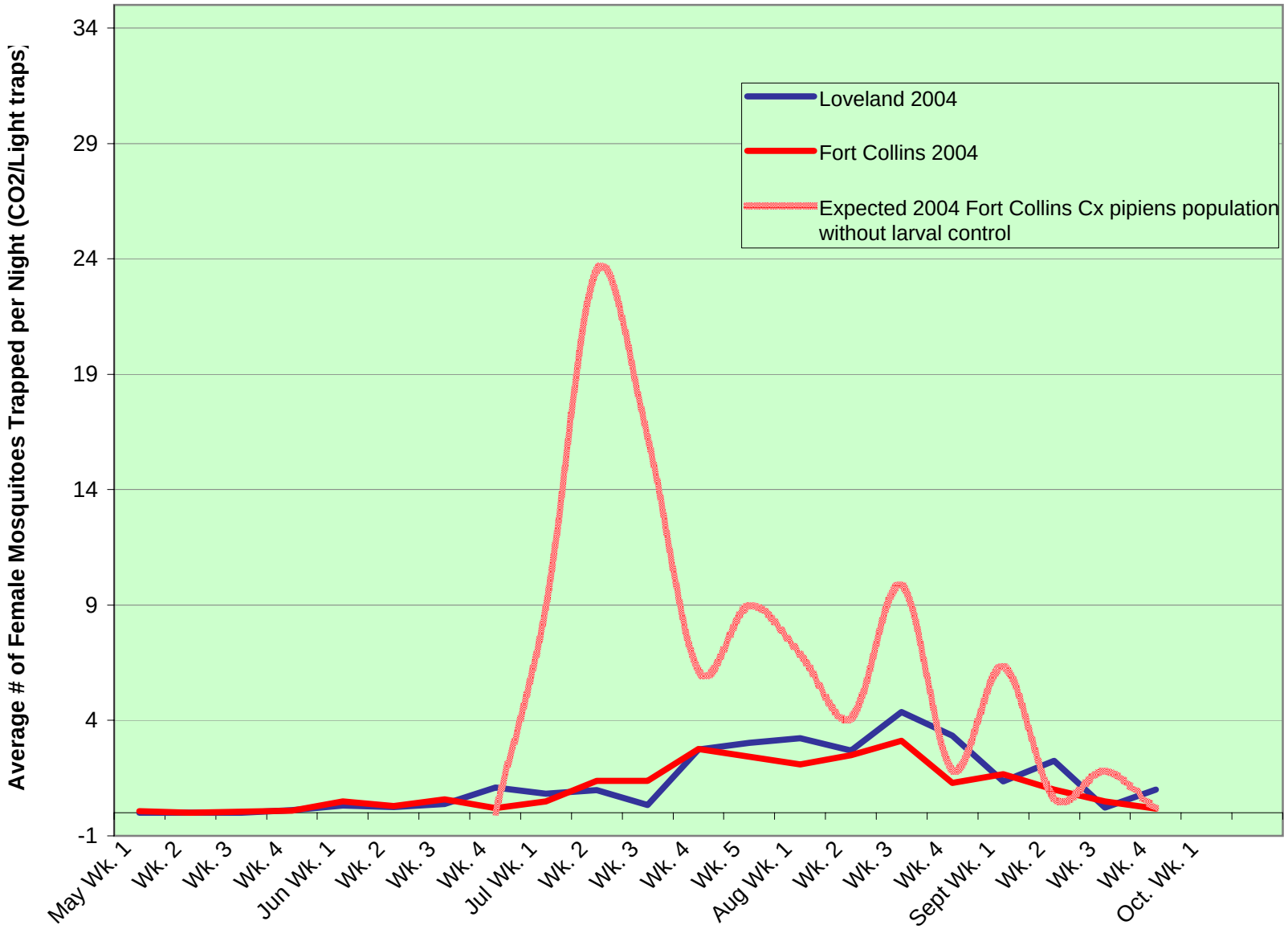
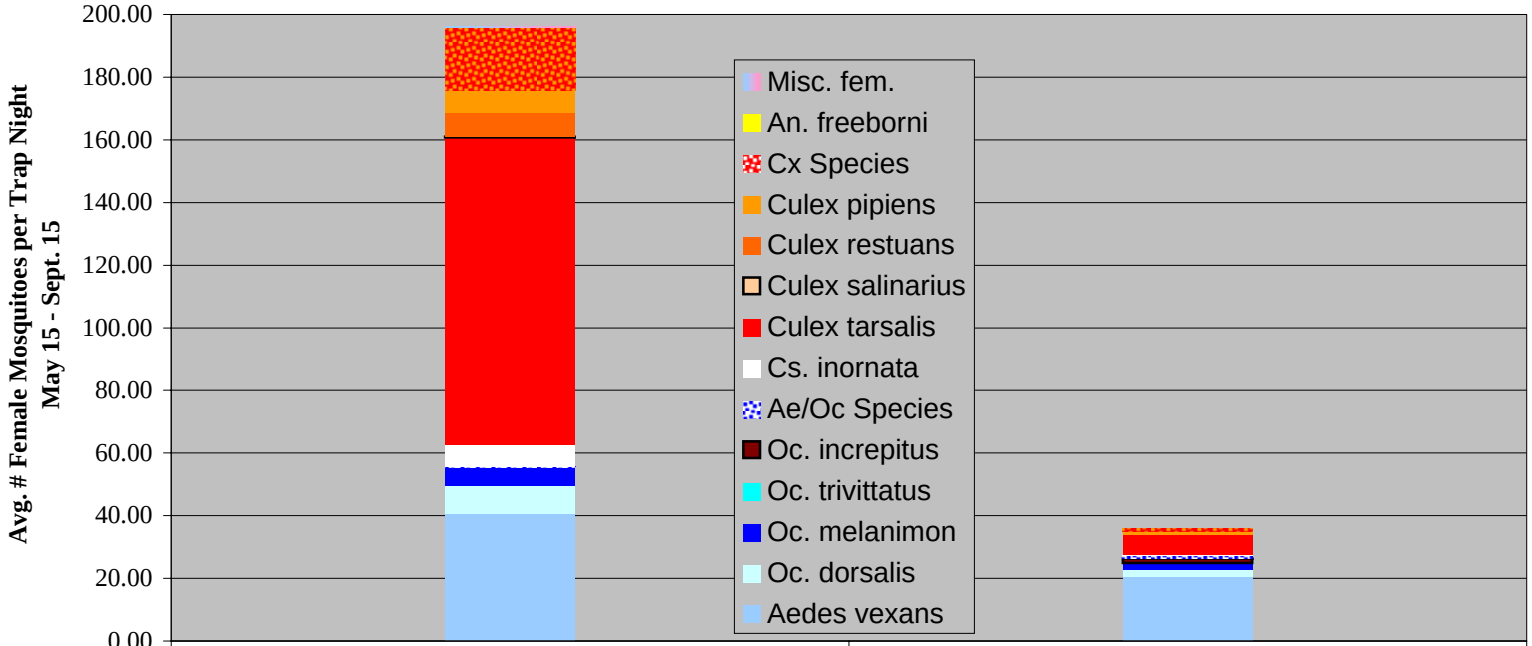


Figure 11
City of Fort Collins
Annual Variation in Mosquito Species
(CDC Light/CO2 traps)



	FC-2003	FC-2004
Misc. fem.	0.15	0.01
An. freeborni	0.00	0.04
Cx Species	20.33	0.89
Culex pipiens	6.88	1.19
Culex restuans	7.89	0.00
Culex salinarius	0.24	0.00
Culex tarsalis	98.06	6.20
Cs. inornata	7.15	0.46
Ae/Oc Species	0.17	0.78
Oc. increpitus	0.00	1.66
Oc. trivittatus	0.03	0.12
Oc. melanimon	5.70	1.71
Oc. dorsalis	8.85	2.24
Aedes vexans	40.71	20.66

Figure 12
City of Fort Collins
2004 Breakdown of Gravid Trap Species

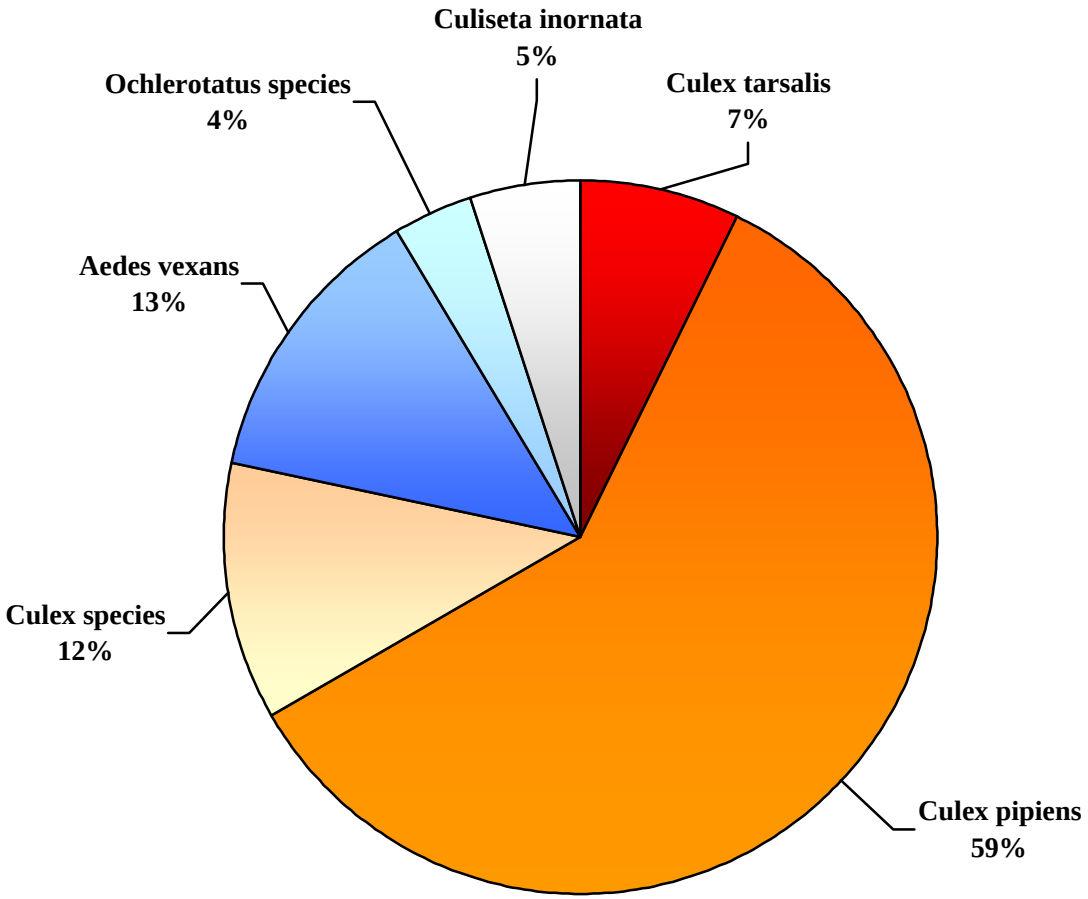
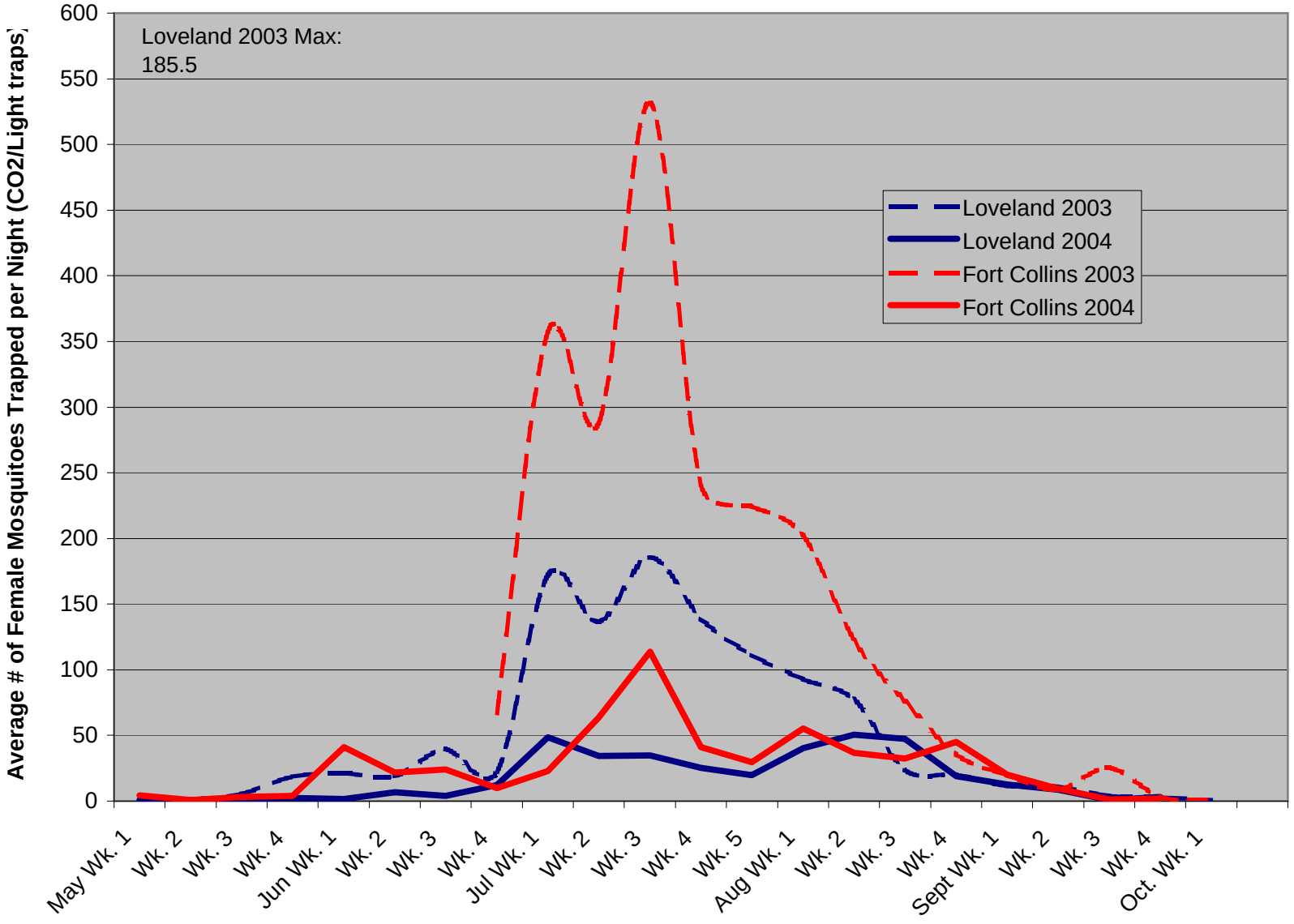


Figure 13
All Mosquito Species
Cities of Fort Collins and Loveland
2003 vs. 2004



mosquitoes, but 5% are WNV-positive, then fogging would be necessary. This method minimizes the number of times fogging would be necessary.

To minimize the size of the fogging area, Mike Doyle and the WNV Task Force split the City into 6 "Sectors" based on high, medium, or low populations of WNV mosquitoes in 2004. The mosquito traps in each Sector were to be combined to give a numerical "WNV Risk Index" for each Sector. In this way, only the areas with highest WNV risk would be fogged.

Fortunately, the Risk Index did not work as planned. There were only two WNV-positive mosquitoes in Fort Collins this year, so the index was not mathematically feasible. Also, the pattern of high and low mosquito populations was very different from 2003 – possibly due to effects of the new larval program – so the Sectors were also not as practical as we had hoped.

Instead, fogging decisions were based on the first half of the WNV Risk Index. That is, the populations of WNV mosquitoes. The first decision to fog was based on recommendations from the County Health Department. Here was the logic: **In 2003, by the time the very first human case was reported, nearly 20% of all people with WNV had already been infected**. When a person is bitten, it takes 3-14 days for symptoms to emerge, then usually a day or two to seek medical attention, then several days for the medical facility to get lab results, then several days to report these to the State Health Department, then several days for the State Health Department to confirm the findings and inform the County Health Department. **In the end, it can easily be 3 to 4 weeks between the mosquito bite and public notice of the case.** Therefore, when the first case was announced, it stood to reason that many more people in Fort Collins had already been infected. Secondly, Culex mosquito populations in 2003 jumped dramatically in less than a week (Figure 7). In mid-July 2004, Culex populations were starting to rise, a sharp spike was a real possibility, and the preparation time for adulticiding is nearly a week. Given these two factors, plus other indicators used by the Health Department, the WNV Task Force accepted the Health Department's recommendation and decided to commence fogging on July 20.

The 6 Sectors were split into 10 linear mile "Adulticiding Zones." In 2004 CMC fogged 53 zones for approximately 497 linear miles during 4 adulticiding events: July 20 and 26, August 5 and 9, August 13 and 16, and August 25. The second half of the August 25 treatment was cancelled due to inclement weather. Note that each successive treatment was for a smaller area.

A summary of this season's adulticiding miles, as compared to previous years, is shown on Table 2.

Were the treatments effective? Please refer to Figures 14 through 21. For all but the last event, *Culex tarsalis* populations decreased approximately 70% in the treated areas while populations of increased or stayed constant. A similar trend is seen with *Culex pipiens*, but less dramatically.

Please refer to Figure 14. Approximately 45 traps were set weekly throughout Fort Collins to monitor mosquito populations. We averaged the mosquito populations within the fogging area (13 traps) and compared them to the populations within the remainder of the City (approximately 30 traps). The first event shows a 70% decrease in Culex tarsalis populations after the first fogging event, while Culex tarsalis in the remainder of the City (which had much lower populations to begin with) nearly doubled in the same time period.

Please refer to Figure 15. Similar results were found after the second fogging event. Culex tarsalis populations dropped 72% (nearly the same as the first event) in the fogging area, while the Culex tarsalis populations remained unchanged throughout the rest of the City.

Please refer to Figure 16. Again, the Culex tarsalis population decreased by over three-fourths in the areas fogged, while populations in the untreated (unfogged) area increased by a third. Note that there were only 2 traps set within the fogged area, so the results, taken alone, are statistically weak. However, these results are very similar to the first two fogging events, which lends credence to the apparent success of the treatment.

Please refer to Figure 17. In the final treatment, Culex tarsalis populations decreased dramatically in the fogged areas, but unlike earlier treatments, the remainder of the City also strongly decreased. These decreases were as likely caused as much by the weather and the overwintering strategy of Culex mosquitoes as they were from the fogging. It is impossible to tell for certain.

Please refer to Figure 18. Culex pipiens is the other species which is known to transmit West Nile. In fact, it is the only major vector east of the Mississippi. Fogging is not normally as effective against Culex pipiens as compared to Culex tarsalis because Cx. pipiens tends to fly in more protected areas. However, the first treatments had a similar effect on Cx pipens as it did on Cx tarsalis (i.e., approx. 70% decrease), while the untreated mosquito populations increased three-fold. Keep in mind that Cx. pipiens are caught in small numbers in light traps, therefore making statistical comparisons from week to week not very reliable.

Please refer to Figure 19. After the second set of foggings, there was a measurable decrease in Culex pipiens populations in treated areas, and a slight increase in the untreated areas. However, the combination of small sample populations and relatively small changes in populations does not make these data very useful.

Please refer to Figure 20. The third set of fogging treatments again showed the same trend of decreased populations in the treated area. These data are more meaningful because (unfortunately) Cx pipiens populations were higher at the time.

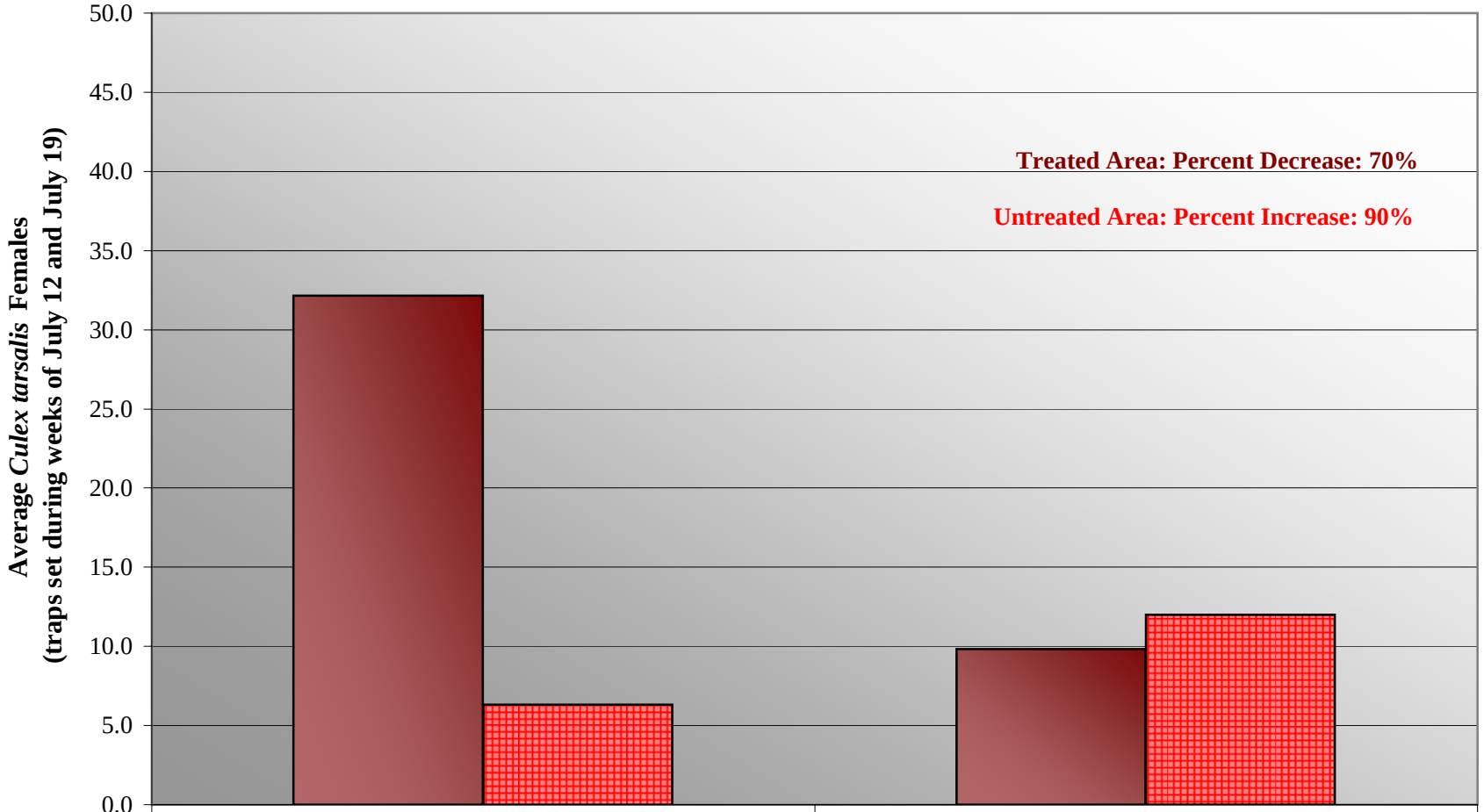
Please refer to Figure 21. The final fogging event was not repeated, so Culex pipiens reductions would be expected to be less than the earlier treatments. However, because weather hindered trap collections these data are not very useful. When you look at all treatments and collections, there is a definite pattern of approximately 70%

Figure 14

Fort Collins Fogging Event 1

Culex tarsalis July 20 and 26, 2004

13 traps in fogging area



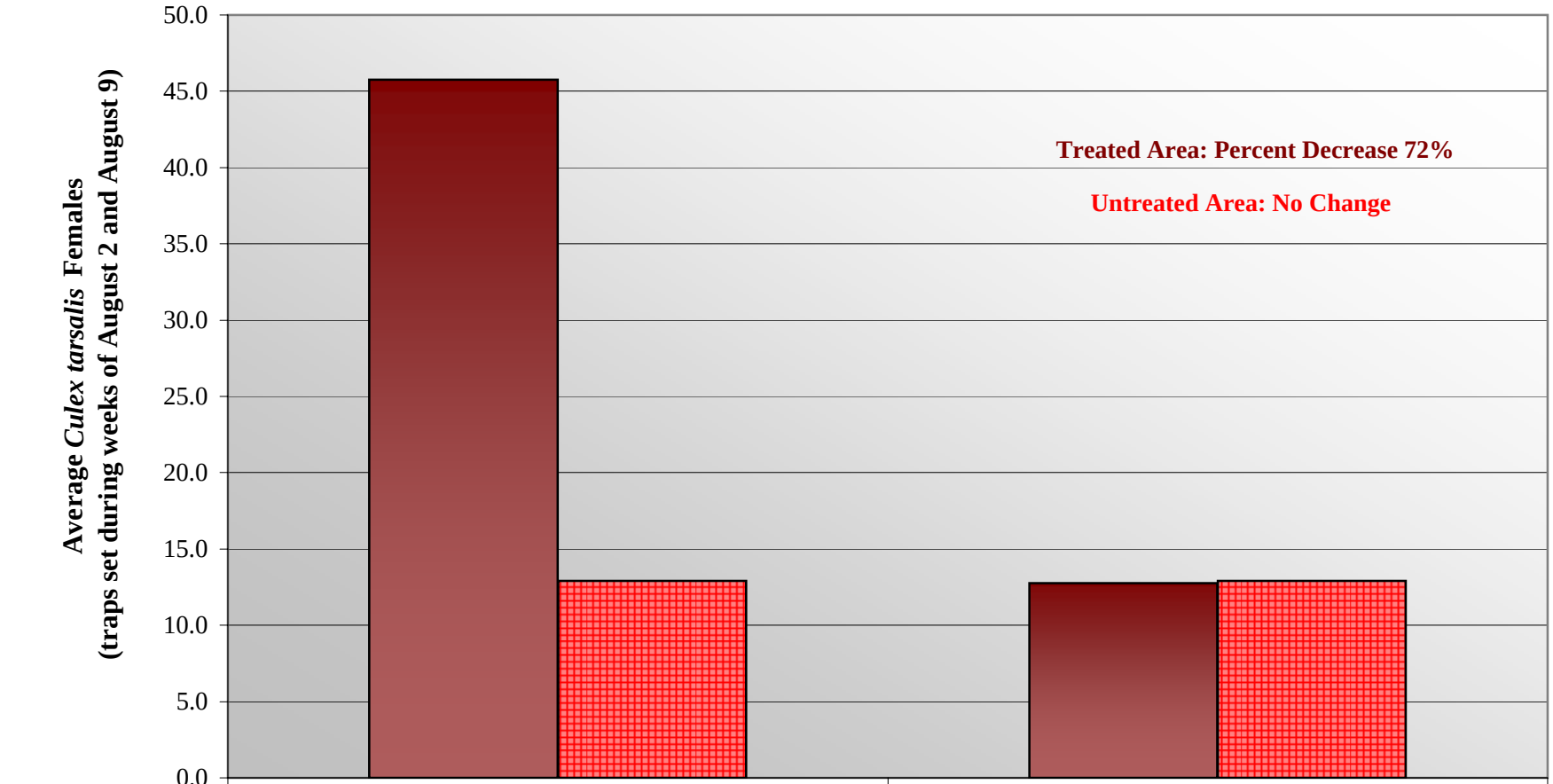
	Average Culex tarsalis Prior to Fogging	Average Culex tarsalis After Fogging
Event 1 Treated	32.2	9.8
Event 1 Untreated	6.3	12

Figure 15

Fort Collins Fogging Event 2

Culex tarsalis August 5 and 9, 2004

8 traps set in fogging area



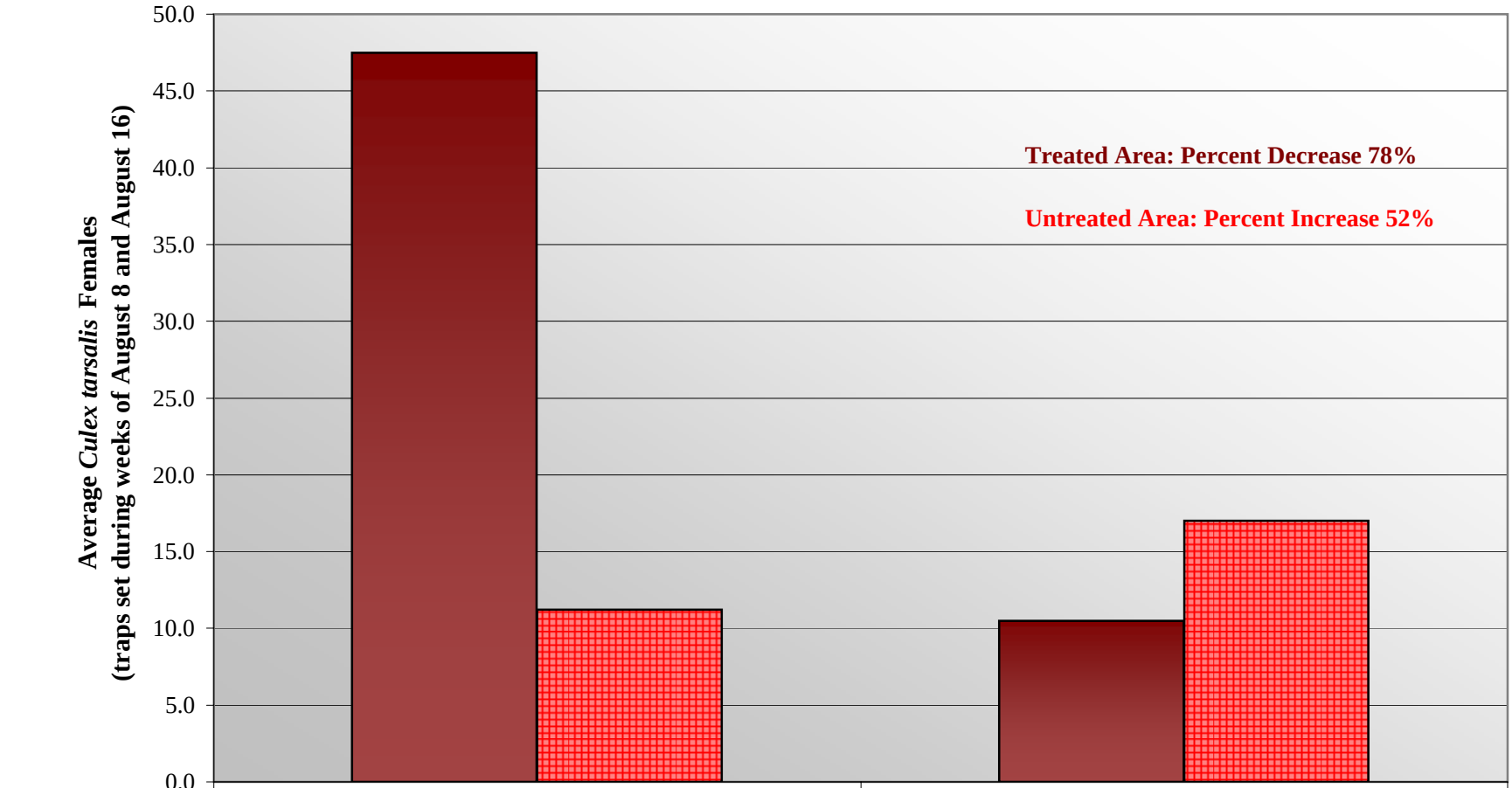
	Average Culex tarsalis Prior to Fogging	Average Culex tarsalis After Fogging
Event 2 Treated	45.8	12.8
Event 2 Untreated	12.9	12.9

Figure 16

Fort Collins Fogging Event 3

Culex tarsalis August 13 and 16, 2004

2 traps set in fogging area



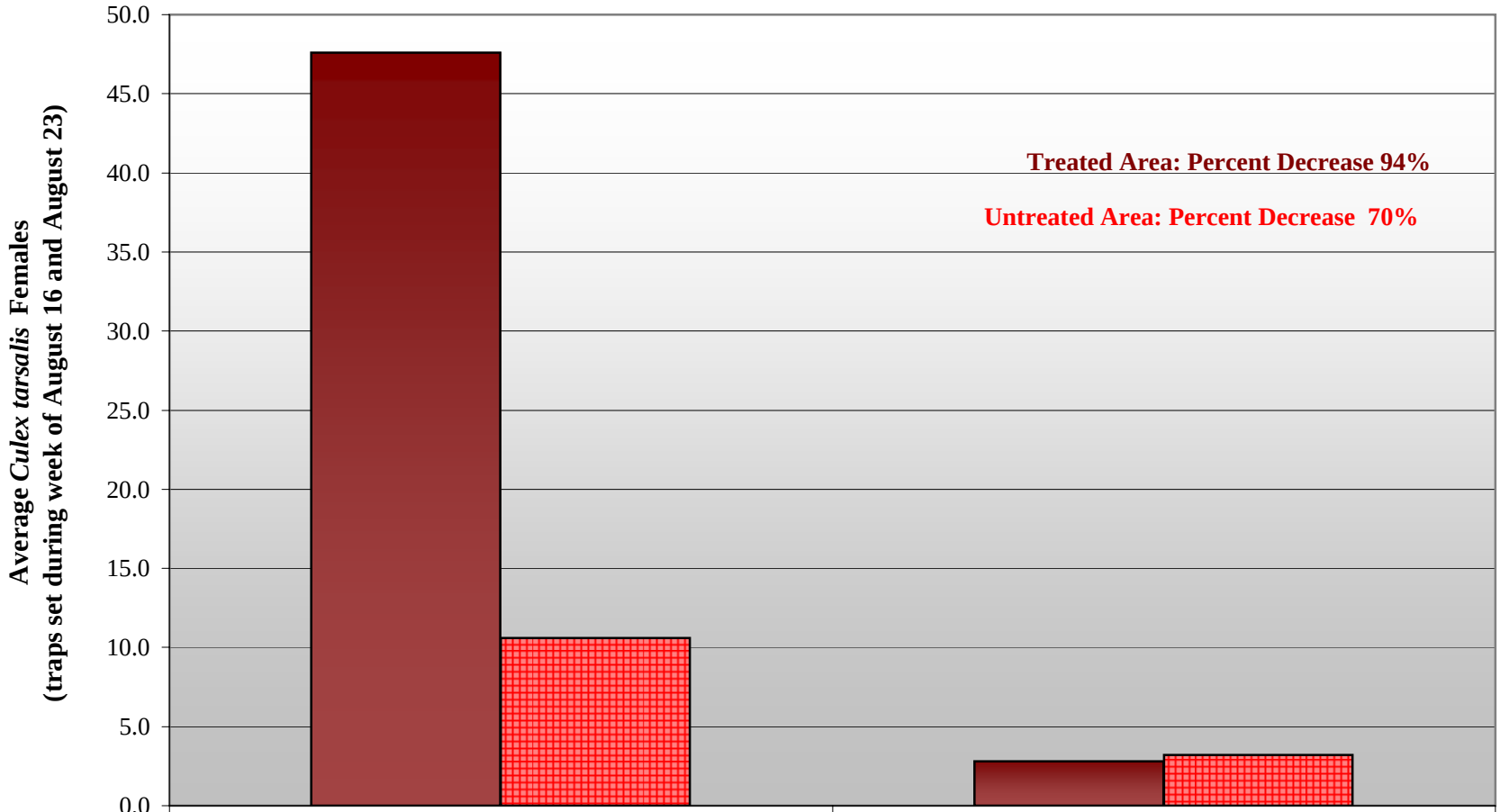
	Average Culex tarsalis Prior to Fogging	Average Culex tarsalis After Fogging
Event 3 Treated	47.5	10.5
Event 3 Untreated	11.2	17

Figure 17

Fort Collins Fogging Event 4

Culex tarsalis August 23, 2004

5 traps set in fogging area



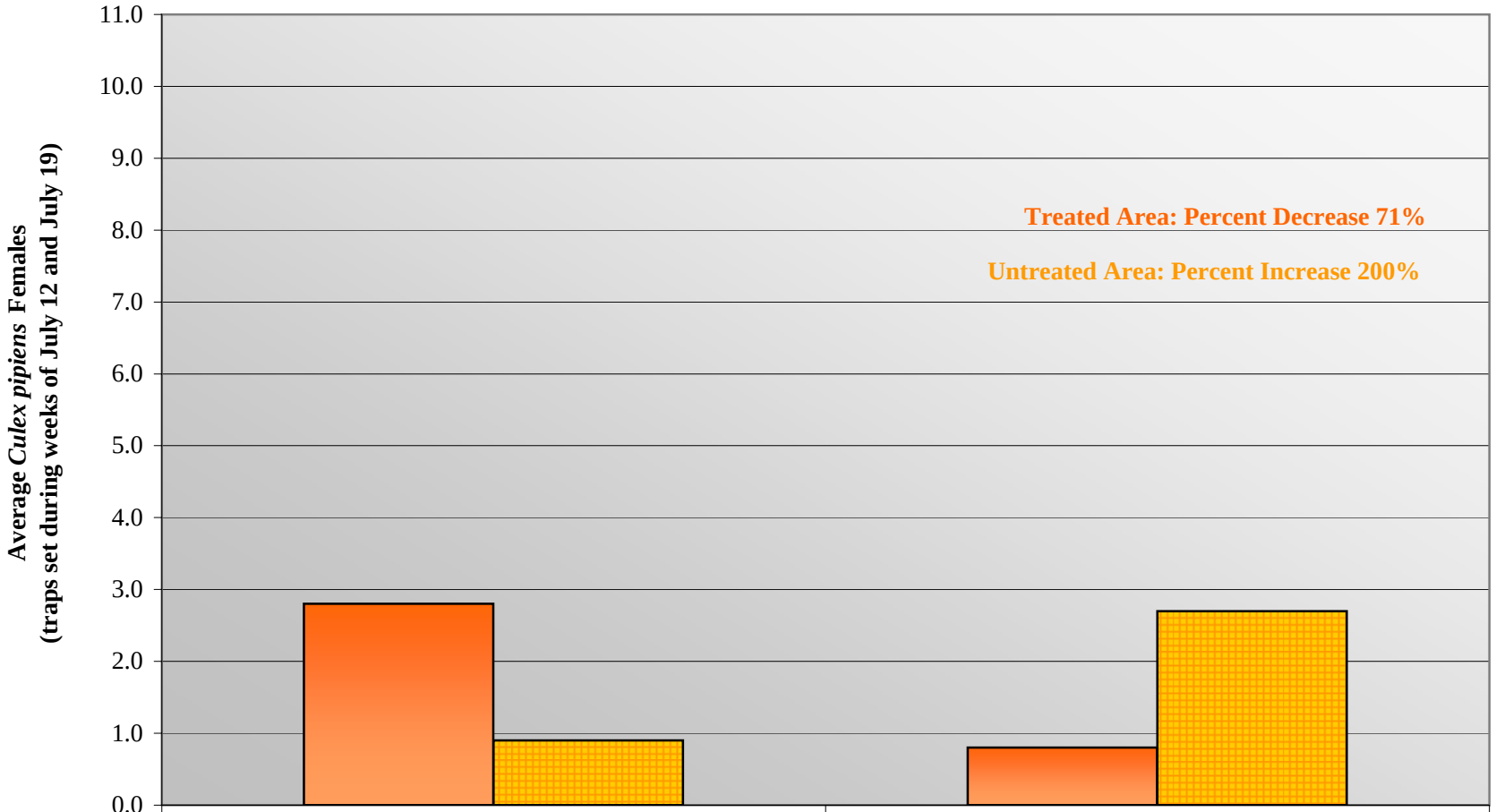
	Average Culex tarsalis Prior to Fogging	Average Culex tarsalis After Fogging
Event 4 Treated	47.6	2.8
Event 3 Untreated	10.6	3.2

Figure 18

Fort Collins Fogging Event 1

Culex pipiens July 20 and 26, 2004

13 traps in fogging area



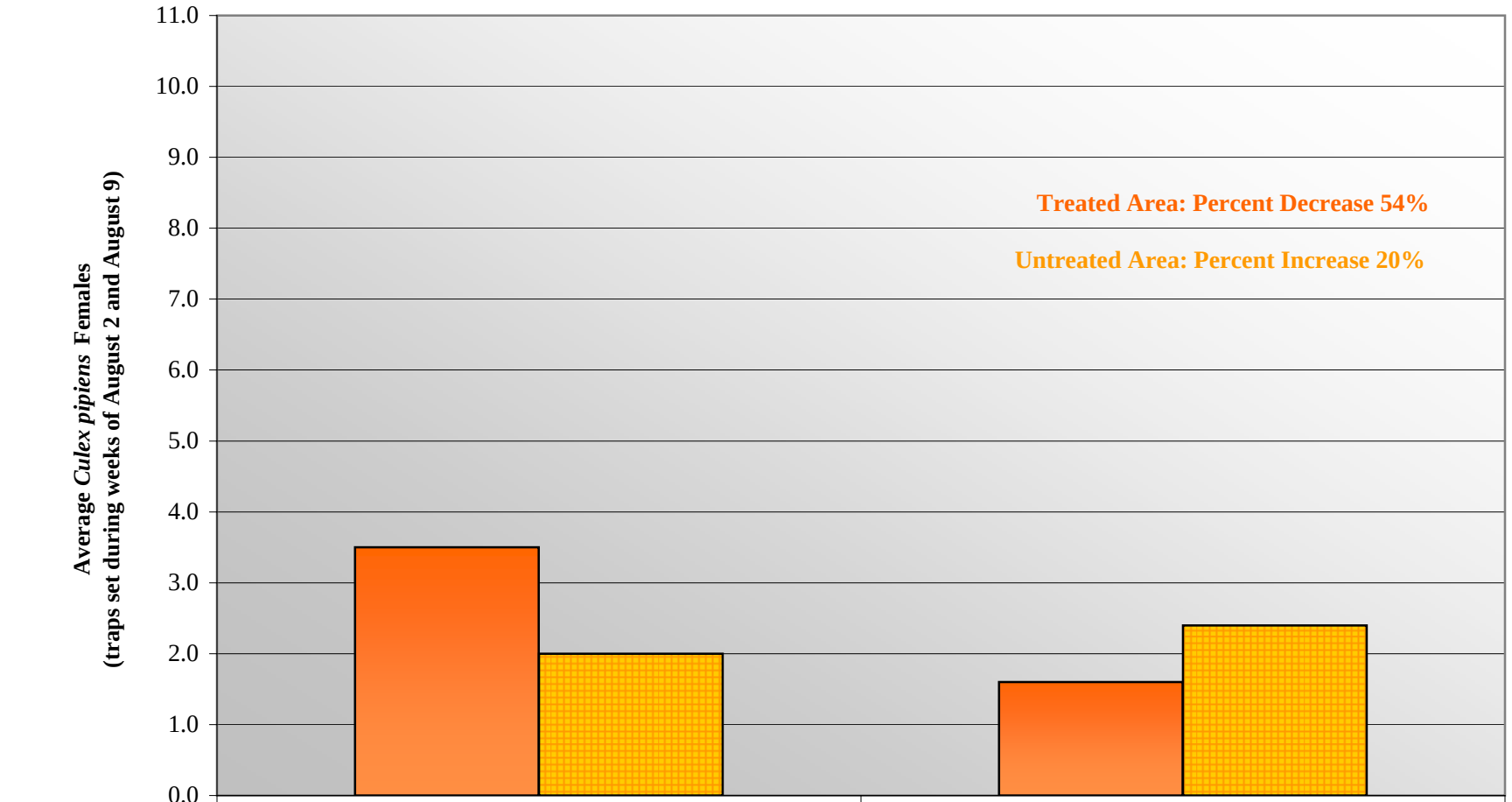
	Average Culex pipiens Prior to Fogging	Average Culex pipiens After Fogging
Event 1 Treated	2.8	0.8
Event 1 Untreated	0.9	2.7

Figure 19

Fort Collins Fogging Event 2

Culex pipiens August 5 and 9, 2004

8 traps in fogging area



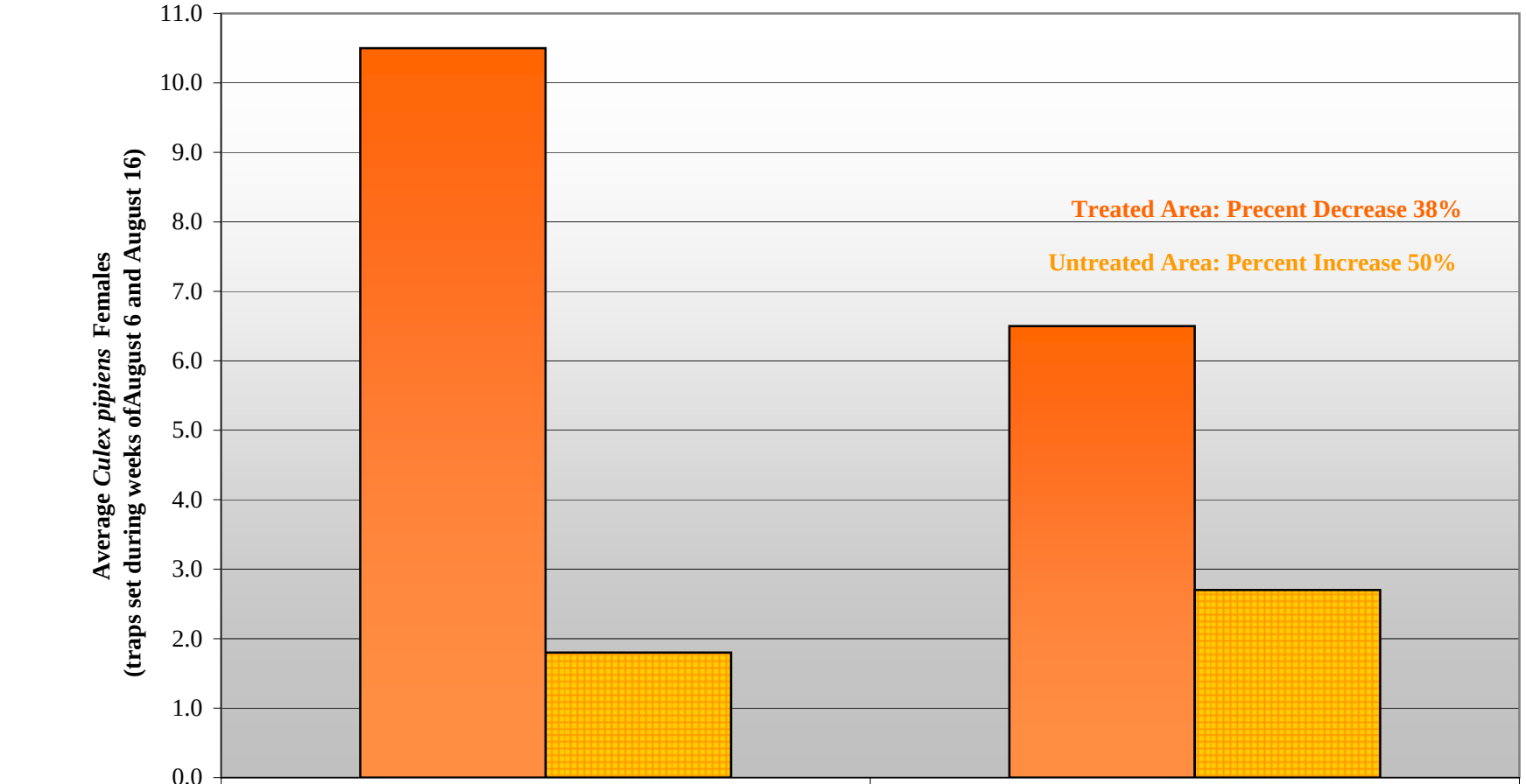
	Average Culex pipiens Prior to Fogging	Average Culex pipiens After Fogging
Event 2 Treated	3.5	1.6
Event 2 Untreated	2.0	2.4

Figure 20

Fort Collins Fogging Event 3

Culex pipiens August 13 and 16, 2004

2 traps in fogging area



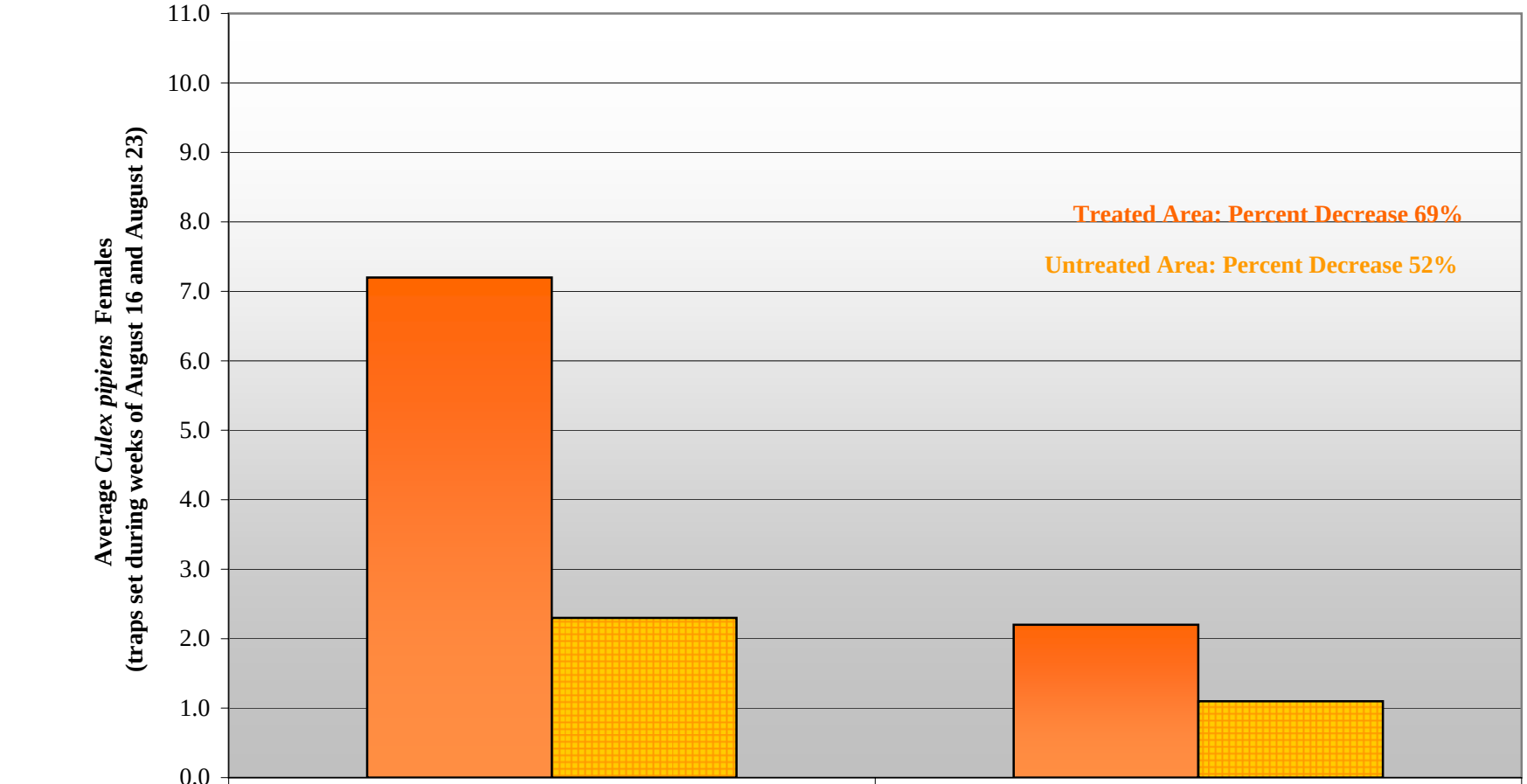
	Average Culex pipiens Prior to Fogging	Average Culex pipiens After Fogging
Event 3 Treated	10.5	6.5
Event 3 Untreated	1.8	2.7

Figure 21

Fort Collins Fogging Event 4

Culex pipiens August 23,2004

5 traps in fogging area



	Average Culex pipiens Prior to Fogging	Average Culex pipiens After Fogging
Event 4 Treated	7.2	2.2
Event 4 Untreated	2.3	1.1

reduction in the two West Nile Virus vectors, Culex tarsalis and Culex pipiens, after each spray event. At the same time, untreated mosquito populations either increased or remained the same.

The adulticiding products primarily used for truck-based adulticiding in Fort Collins were "Biomist 3+15," "Anvil 10 + 10" and "Aqua-Reslin". The active ingredient in these products is permethrin and sumethrin, synthetic versions of naturally occurring pyrethroids found in plants.

The application equipment used in Fort Collins was one of two types of Ultra Low Volume (ULV) truck or ATV-mounted foggers. Both types of foggers utilized a low volume of product (0.7 ounces per acre). Because mosquitoes are the targets, the foggers break the liquid into extremely small droplets (approximately 17 microns, or 0.000001 meter). Higher doses or greater droplet sizes would be needed to control larger insects. One type of fogger utilized forced air, which created a loud roar when the engine was running. The other utilized a spinning ceramic disc, which was nearly silent.

The time of application is always in the early evening hours, after sundown but before temperatures drop below our minimum of 60 degrees Fahrenheit. The wind must be less than 10 mph, and it cannot be raining. These conditions are necessary because the adulticiding chemical must physically contact the adult mosquitoes as they fly. The product breaks down in a very short time, so has little or no effect on insects, pets, or people the following day.

C. Resident Notification

Because of the controversial nature of fogging, the WNV Task Force had the forethought to design a simple, easy to use method of informing interested residents of fogging events should they become necessary. This "Fogging Notification List" gave residents the option to either register directly on the City's website, or call CMC to have our staff get on the web and register them. In the end, 2,108 entities asked to be registered. Keep in mind that a small percentage of these were multiple listings by the same person with multiple phone numbers or addresses.

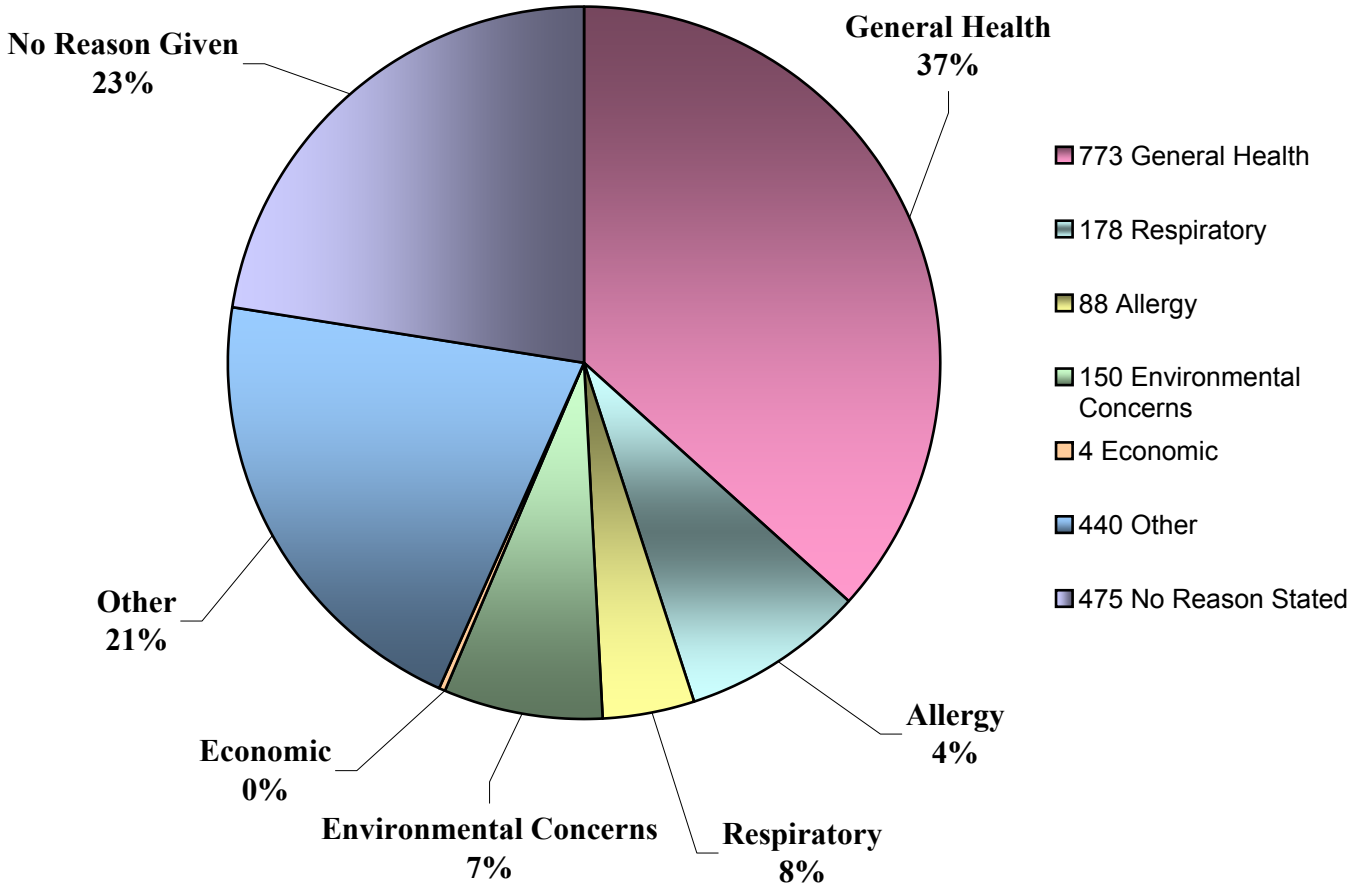
Residents were given the option to register why they wished to be on the Notification List. Note on Figure 22 that health issues made up the majority of the stated reasons (49%), followed by environmental reasons (7%). A full 45% had other reasons, or did not state their reasons. I

Approximately 24 hours prior to fogging events, all residents near the proposed fogging area were sent an email and an automated phone message with details about the event.

The response to the Notification List was very encouraging. Over 500 residents called the CMC office to sign up immediately prior to the first fogging event on July 20. See Figure 23. Note that the number of calls spiked on each day fogging was planned, but also that the number of calls decreased with each fogging event. This was likely because the Notification Program was working effectively. Fewer people were calling

Figure 22

2004 Fort Collins Fogging Notification List:
Reason Why Citizens Signed-up
2,108 Requests Total



with questions and concerns with each event. This also may have been partly because the size of the fogging area also decreased over the summer.

One big difference between the fogging done in 2003 and 2004 was the issue of "Shut offs." That is, was the City able to accommodate residents who desired that the flow of insecticide be shut off at their property boundary. In 2003, the City decided to give all residents the option to shut off. Partly because residents did not have the option to be notified, and partly because of concerns about the fogging itself, literally thousands of residents requested to be shut off. This nearly crippled the fogging effort because of the amount of time the fog was shut off in any given area. Also, because the fog is designed to drift which ever direction the wind is blowing; many residents complained that the fog was reaching their properties despite the truck shutting off at their property boundaries.

This problem was remedied in two ways in 2004. As described above, residents were given a "notification" option, and secondly, the Task Force decided to only allow shut offs for those who had serious health issues as demonstrated by their registration on Colorado's Statewide Pesticide Sensitivity Registry. This solution worked logistically quite well, but was not without its drawbacks. Namely, a large number of people attempted to get onto the list, flooding the State Department of Agriculture office with phone calls and questions. The State argued that the Registry is designed to act as a notification list for use by turf and ornamental pesticide applicators, not as an assurance that public health pesticides will not enter a given property.

6. Encephalitis Surveillance Program

West Nile Virus (WNV) is a form of encephalitis. The purpose of a surveillance program is to be an early warning system. In other words, the system is intended to alert mosquito personnel of an impending health crisis. The key is that the system gives enough advance warning that the personnel can take effective steps to minimize the number of human cases.

In 2003, carbon dioxide-baited "light traps" were placed throughout the City weekly, and many of the mosquitoes collected were tested for WNV.

The Fort Collins surveillance program had several changes in 2004. Several traps were added to the trapping network to increase sensitivity to changes in mosquito populations. A second type of adult mosquito trap, called a "gravid trap" was added to the normal light trapping program. Finally, all *Culex* mosquitoes were sent to either the Centers for Disease Control, the Weld County Health Department, or the State Health Department for WNV testing.

The gravid traps were set at the same locations and on the same night as light traps. Because they are still in the experimental stage, gravid traps were set at most locations approximately every 3 to 4 weeks. Once we establish the most productive locations, we plan to set them weekly at these locations. See Figure 12 for a breakdown of the species found in these traps.

All of the mosquitoes collected were identified to species. Those of the genus *Culex* were separated, placed in vials, and sent in for WNV testing. Most of the *Culex* samples were sent weekly to the Centers of Disease Control. The purpose was two-fold, first, because the CDC was conducting a study on WNV, and secondly it provided us with a weekly picture of WNV threats for our use in planning emergency adulticiding.

A few *Culex* mosquitoes were sent to Weld County Health Department for daily testing with "VecTests" in an attempt to establish a near "real time" evaluation of WNV infection rates. These rates were intended to fuel part of a "WNV Risk Index" discussed above. As it turns out, only 2 mosquitoes were found to be infected by mid-season, so the VecTests were stored for possible use next summer.

CMC did not collect any dead birds this year because there were none reported to our office which were of the correct bird family. This is likely because a large portion of these species (i.e. crows, ravens, magpies, and jays) succumbed to WNV last season. Also, the birds that survived last year were likely immune.

7. Public Education

CMC worked with the City of Fort Collins and the County Health Department on educating the public on mosquito biology, effectiveness of repellents, and other logistical issues. However, educating the public on what they can do to help reduce mosquito populations is CMC's major goal.

To this end, CMC started a "Backyard Inspection Day" to encourage awareness of larval habitats in residential areas. The program was designed to randomly inspect residential properties, giving gift certificates to residents whose properties were free of mosquito "breeding" habitat.

The first event drew interviews from a local TV news station, and follow-up articles in the Coloradoan newspaper. In all, approximately 50 homes were inspected. Of these, nearly 80% had some types of standing water, and several had *Culex pipiens* mosquitoes. Clogged gutters appeared to be the most overlooked source for mosquitoes.

This event spurred the start of a permanent "Backyard Inspection Program," where problematic properties are followed up weekly or monthly by CMC staff.

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