West Nile Virus Mosquito Larvae Populations Assessment 2005 Annual Report

June 13, 2006

Prepared for

Seattle Public Utilities
Seattle, Washington

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EXECUTIVE SUMMARY

In 2005, Seattle Public Utilities (SPU) conducted research on stormwater catch basins and stormwater detention ponds to determine the extent of mosquito breeding in these drainage facilities. The purpose of the 2005 sampling effort was to identify specific areas of larvae development within the City of Seattle (City), as well as the time, duration, and number of larvae within the catch basins. The information was intended to guide SPU in its decisions regarding West Nile Virus response and treatment options. In the spring of 2005, the SPU West Nile Virus committee outlined the methods by which catch basins within the City were to be selected for sampling, how frequently they were to be sampled, and what equipment and data collection methods were to be used.

This sampling effort was completed in two phases. The first phase of sampling was conducted to collect a broad base of data from catch basins in a wide variety of geographic and land use areas to provide a basis for refining and focusing the second phase of sampling to areas where a repetitive sampling approach would be likely to identify areas of potential concern.

The initial 3-week sampling effort of 449 catch basins in single-family, multi-family, commercial, and industrial areas was conducted in June and early July. The initial study effort identified that mosquito larvae were concentrated in greater numbers within the single-family and multi-family land use areas, with average larvae counts of 6.9 per 3 dips in these areas as compared to an average count of 1.6 per 3 dips in commercial and industrial areas.

This information led to the selection of a more refined sampling group of 64 weekly catch basins and three revolving groups of 30 to 60 catch basins focused on multi-family and single-family land use areas for the second phase of sampling. Larvae counts were recorded at the 64 weekly catch basins and one of the revolving groups of catch basins once a week from July through early November. Results from the second phase of sampling, and data from those catch basins in the first phase that were retained during the second phase, were compiled to provide a statistical assessment of trends in larvae production.

Within the single- and multi-family land use areas, larvae counts were not concentrated in any one area (neighborhood) within the City limits. Overall, during the sampling season, 76 percent of all of the sampled basins contained mosquito larvae at some point. Of those catch basins in which larvae were observed, larvae counts throughout the sampling period ranged from 0 to 450 larvae per 3 dips, well exceeding the State's threshold for larvicide treatment of more than 1 larva per 3 dips. The median count during the sampling season was 15 larvae per 3 dips per basin. The highest larvae counts were recorded during July, August, and September with a median count of 35 larvae per 3 dips per basin during this sampling period.

The collected larvae data were also evaluated against precipitation data. The percentage of catch basins containing larvae were found to increase as the number of dry weather days also increased. Frequency of precipitation events in the week prior to sampling was evaluated, and it was determined that three or more rainfall events in the week prior to sampling significantly reduced mosquito larvae populations (75th percentile larvae counts of 0 to 1 per 3 dips, as compared to 15 to 50 per 3 dips for 0 to 2 rainfall events in the week prior to sampling). The relationship between larvae production and the duration of dry spells prior to sampling was also considered, and it was found that dry spells of 8 or more consecutive days lead to significantly greater mosquito larvae populations; the average 75th percentile larvae count for 0 to 6 rainless days is 10.5 per 3 dips, while the average 75th percentile count for 8 or more rainless days is 53.5 per 3 dips.

An apparent relationship between mosquito larvae production and ambient maximum temperature was also observed. When maximum daily temperatures ranged from 65° to 90°F, 75th percentile larvae counts ranged from 20 to 50 per 3 dips, as compared to 0 to 2 per 3 dips for maximum daily temperatures below 65°F.

This report provides background about the catch basin study, including the methodology, presentation and discussion of the data, general field observations, and conclusions. A description of the results of the pond sampling is also described briefly.

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1.0 INTRODUCTION

West Nile Virus (WNV) is a mosquito-borne disease that first appeared in the U.S. in 1999 on the East Coast. It has slowly made its way across the U.S. As of 2005, all states in the Lower 48 except Washington and Maine have had human infections. In 2002, a number of western Washington counties (but not King) reported cases of WNV in birds and horses. The disease moved up the Interstate 5 corridor in the summer of 2004, infecting people, animals, and birds in Oregon. In 2005, the State of Washington recorded two positive mosquito pools, one horse and one bird, in Yakima County in eastern Washington.

Public Health – Seattle and King County (Public Health) is the lead public agency for WNV response in Seattle. As a major property owner with thousands of employees, the City of Seattle (City) supports Public Health's WNV response efforts by controlling mosquito breeding habitat on City properties where feasible, and educating employees about disease prevention. In addition, the City assists Public Health in distributing prevention messages to the general public.

As part of their efforts to control mosquito breeding on City properties, Seattle Public Utilities (SPU) conducted research on drainage facilities in the City to determine whether they provide mosquito breeding habitat and to what extent mosquitoes are breeding in these facilities. Specifically, SPU studied stormwater detention ponds during the summers of 2003, 2004 and 2005, and examined catch basins in the summer of 2005.

This report describes the results of the 2005 catch basin research. A summary of the research regarding stormwater detention ponds is located in Appendix A.

2.0 METHODOLOGY

The following sections outline the methods by which catch basins within the City were selected for sampling during the 2005 season, how frequently they were sampled and why, and what equipment and data collection methods were used.

2.1 SAMPLE LOCATIONS

2.1.1 OVERVIEW OF DRAINAGE SYSTEM

Surface water (including stormwater and incidental water from such things as washing a car or watering a lawn) runoff usually enters the drainage collection system through grated street inlets and then travels from the street inlet to a catch basin through a drainage lateral pipe. Stormwater is then conveyed through the catch basin to a second drainage lateral pipe leading to a drainage or combined sewer mainline. Some catch basins are designed for stormwater to enter directly through a grated lid and not through a separate inlet. These catch basins then connect to the drainage or combined sewer mainline through a lateral pipe.

Catch basins are underground basins or chambers designed to hold stormwater and trap debris and sediment in order to keep this material from entering the drainage or combined system. The depth of the catch basin can range from a few feet to several feet below street level. Many catch basins in the City hold water year round.

2.1.2 INITIAL SAMPLING EFFORT

More than 46,000 catch basins are located in the City. SPU's statistician chose 600 representative catch basins around the City for the initial sampling effort. These catch basins spanned all land uses, neighborhoods, natural and built environments, and economic income distribution within the City limits. These initial catch basins were sampled within a 3-week period from June 20 to July 5, 2005. The results of this initial sampling effort indicated that catch basins are, indeed, mosquito breeding habitat and that multi-family and single-family land use zones have statistically higher percentages of mosquito larvae than other land use zones such as commercial or industrial zones. Following this broad sampling of catch basins throughout the City and the identification that single-family and multi-family land use areas contained higher larvae counts, a more refined sampling approach was selected for the summer-long sampling effort.

2.1.3 SUMMER SAMPLING LOCATIONS

Because of the findings outlined above, SPU staff selected catch basins from the multi-family and single-family land use areas within the City for further sampling. For electronic mapping purposes, the City was divided into a series of “tiles,” as shown on Figure 1. These tiles represent ¼-mile subsections of the City. A total of 64 catch basins were selected from different tiles within the City for weekly sampling within the remainder of the sampling period, again, selected from various neighborhoods, natural and built environments, and economic income distribution within the City limits. This group of catch basins is referred to as the Weekly Sample Group and is indicated by shading on Figure 1.

Because each neighborhood varies by topography, complexity of the City drainage network, and population of “at risk” residents (e.g., senior citizens), three Revolving Sample Groups were also selected in order to fully represent some of the differences throughout the City. These groups are identified as R1, R2, and R3. Each of these sample groups represents 30 to 60 catch basins. The tiles/areas sampled in the Revolving Sample Groups are also indicated by shading on Figure 1.

Each week, SPU sampled the Weekly Sample Group and one of the Revolving Sample Groups. The Revolving Sample Groups were rotated each week, so that each group was sampled at least once a month.

2.2 SCHEDULE

SPU established sampling protocols at the start of the sampling season. Crews sampled the weekly and revolving catch basin groups on Tuesday and Thursday of each week. For efficiency, sampling was completed by geographic location within the City. For example, the weekly and revolving group locations in the northern end of the City were sampled on Tuesdays, and southern end locations were sampled on Thursdays. The Tuesday/Thursday sampling schedule of the weekly catch basin group and one revolving catch basin group began the week of July 5, 2005 and continued through November 18, 2005.

SPU’s sampling plan was to remain consistent in sampling each week except in cases of strong rainstorms on the scheduled sampling day. In that case, the start of sampling was to be delayed for the day or was scheduled for another day. The rationale for delaying sampling following a rainstorm is that mosquito larvae tend to “dive” away from the water’s surface when it is disturbed, and sampling these basins as scheduled would have skewed the sampling results.

During the summer months, sampling was delayed to start later in the afternoon due to light rain events on two occasions. Later in the sampling season (November), sampling continued with or without the rain events due to the frequent occurrence of rain during this period. Although sampling was not originally planned to continue through November, data were collected through mid-November to help identify the latter end of the active mosquito breeding season in City catch basins.

Other surface water disturbing events, such as lawn watering and car washing, could not be predicted or avoided. Samplers were instructed to continue with their regular sampling scheduled regardless of whether water was observed to be flowing into catch basins from such sources. Samplers made field notes of these observations.

2.3 SAMPLING TECHNIQUES

SPU provided the field survey crew with Geographic Information System (GIS) maps of the City with the specific locations of the weekly and revolving catch basins identified. Each crew member recorded data collected at the catch basins following the methodology outlined below.

2.3.1 CATCH BASIN SAMPLING

Catch basin mosquito larvae sampling procedures were adapted from standardized sampling protocols outlined by O'Malley (1995). Generally, mosquito larvae were sampled (dipped) using a standard mosquito dipper. A mosquito dipper consists of a 1-pint cup attached to an extension handle.

During catch basin sampling, surveyors use a maintenance hole rod to remove the catch basin lid. Dirt and other debris will typically fall into the catch basin when opening, disturbing the water surface and causing mosquito larvae to dive from the water surface to depth. To adequately sample mosquito larvae, surveyors waited 20 to 30 seconds for mosquito larvae to rise back to the surface before sampling. When sampling catch basins, mosquito larvae will typically congregate along the sides of the catch basin resulting in higher densities of larvae along the side and fewer in the center of the catch basin. Taking this phenomenon into account, larvae sampled using standard mosquito dippers were taken along the sides of the catch basin.

Samples using the standard mosquito dipper were typically taken using the simple scoop method. However, depending on catch basin characteristics such as size and depth, surveyors occasionally employed the shallow skim or complete submersion methods. Surveyors collected three dips per catch basin and the total number of larvae was tallied. The Washington State Mosquito-borne Disease Response Plan (DOH 2003) has established a threshold of more than 1 mosquito larva per 3 dips when considering mosquito larvae control measures (see Photograph 3 in Appendix B).

3.0 RESULTS AND DISCUSSION

3.1 INITIAL SAMPLING PHASE

The initial phase of sampling spanned 3 weeks in June and early July, and consisted of the collection of 928 samples from 449 catch basins in single-family, multi-family, commercial, and industrial areas. Figure 3 shows box plots for mosquito larvae counts in two general land use categories: residential (single-family and multi-family), and industrial and commercial. Both data sets in the initial phase have relatively low frequencies of larvae presence because sampling occurred prior to the prime mosquito breeding season; therefore, there was relatively little variability in the residential and industrial/commercial median (both 0) and 75th percentile (2 and 0, respectively) larvae counts. However, it was noted that where larvae were observed, they were present in greater quantities in catch basins in residential areas. The average numbers of mosquito larvae observed were 6.9 in 3 dips for residential areas and 1.6 in 3 dips for industrial/commercial areas. Based on this observation, the second phase of sampling focused on catch basins in single-family and multi-family residential areas.

3.2 WEEKLY AND REVOLVING SAMPLE GROUPS

During the initial phase of sampling, no spatial trends were identified in mosquito larvae counts. In other words, there were no geographic areas of the City that appeared to have a significantly different tendency for mosquito larvae presence in catch basins. Therefore, the second phase of sampling was conducted in 16 ¼-mile by ¼-mile tiles representing various neighborhoods, natural and built environments, and economic income distribution. To balance the statistical benefits of consistent sampling over time (i.e., regular sampling at consistent locations throughout the sampling period), spatial coverage (i.e., sampling to characterize a wider, more representative geographic area), and cost, the sampling plan for the second sampling phase included catch basins that would be sampled on a weekly basis (identified as the “Weekly Sample Group”), and others that would be sampled on a regular rotating basis, once every 3 weeks (identified as “Revolving Sample Groups”).

Figure 4 presents box plots that compare data from the Weekly Sample Group and from the Revolving Sample Groups. The box plots show that data collected from the weekly and revolving groups of catch basins are statistically very similar. They have identical median and 75th percentile mosquito larvae counts (0 and 20 per 3 dips, respectively), and very similar maximum mosquito larvae counts: 450 per 3 dips for the Weekly Sample Group and 400 per 3 dips for the Revolving Sample Groups. Based on a comparison of these box plots, it appears that the combined use of data from weekly and revolving sample groups will not result in a biased data set. Furthermore, due to the similarity between weekly and revolving sample groups (i.e., the lack of significant geographic differences), it may be beneficial in future years to collect a higher proportion of samples from a consistent set of catch basins to provide a more robust data set for evaluating time-dependent factors (e.g., precipitation and temperature) at individual catch basins.

Overall, data collected show per basin larvae counts ranging from 0 to 450 larvae per 3 dips. Although some catch basins were found to contain a range of larvae throughout most of the sampling season (more than 6 weeks), many other catch basins were found to contain larvae for only short periods of time (0 to 3 weeks). Throughout the sampling season of June through November 2005, 294 catch basins were sampled as part of the weekly or revolving sample groups. Of these 294 catch basins, 76 percent contained mosquito larvae during at least one sampling event throughout the season. On average, individual catch basins contained mosquito larvae 45 percent of the time during the sampling season.

3.3 SEASONAL AND ATMOSPHERIC TRENDS

It is recognized that mosquito breeding season in the Puget Sound area generally peaks in the warm summer months. Figures 5 and 6 show box plots of mosquito larvae counts for discrete months and weeks, respectively, during the sampling period. As shown on Figures 5 and 6, the mosquito larvae counts are highest in August, with elevated levels in late July and throughout September. Median mosquito larvae counts (per 3 dips) are 0 in June and July, 8 in August, 2 in September, and 0 in October and November. The 75th percentile mosquito larvae counts (per 3 dips) are 0 in June, 20 in July, 55 in August, 30 in September, 1 in October, and 0 in November.

The seasonal frequency at which mosquito larvae were observed in catch basins is also noteworthy, as is the frequency of elevated counts of mosquito larvae. As shown on Figure 7, mosquito larvae were only observed in 7 to 26 percent of catch basins in the early summer and fall months of June, October, and November. And when mosquito larvae were identified in catch basins during June, October, and November, the populations were relatively low, with most of the larvae-bearing samples containing between 1 and 5 larvae per 3 dips. In the summer months of July, August, and September, the incidence of mosquito larvae presence increased to 48 to 62 percent. Greater proportions of the samples had significantly elevated larvae concentrations during these summer months, with as many as 9 percent of the samples containing more than 100 larvae per 3 dips.

Two seasonal atmospheric trends were monitored to observe potential impacts on mosquito larvae counts: precipitation and temperature. Figure 8 presents box plots of mosquito larvae counts, categorized by the frequency of rainfall events occurring in the week prior to the sampling event. This figure shows that an increase in recent rainfall events reduces the presence of mosquito larvae. The 75th percentile mosquito larvae counts for 0 to 2 rainfall events in the week prior to sampling were 50, 30, and 15 per 3 dips, respectively. When 3 or more rainfall events occurred in the week before sampling, the 75th percentile dropped to 0 or 1 mosquito larva per 3 dips.

Figure 9 presents box plots of mosquito larvae counts, categorized by the duration of the dry spell, in days, prior to the sampling event. Figure 9 shows that there is a significant increase in mosquito larvae counts when there are at least 8 rainless days prior to a sampling event. The average 75th percentile larvae count for 0 to 6 rainless days is 10.5 per 3 dips, while the average 75th percentile count for 8 or more rainless days is 53.5 per 3 dips. This notable increase in mosquito larvae counts with rainless periods of 8 or more days may be directly related to the mosquito life cycle schedule, which typically involves a 7- to 10-day existence in larva form, which begins 1 to 2 days after eggs are laid. Regular disruptions of standing water in catch basins at frequencies greater than or equal to 1 rainfall event every 6 days may result in lower potential for mosquito larvae population accumulations.

Figure 10 presents box plots of mosquito larvae counts, categorized by maximum daily temperatures. Mosquito larvae counts were observed to be very low (75th percentiles of up to 2 larvae per 3 dips) at temperatures less than 65°F. At temperatures above 65°F, the 75th percentiles of mosquito larvae counts ranged from 15.5 to 50 per 3 dips. Based on data collected during 2005, 65°F appears to be a critical temperature threshold for significant mosquito larvae production; however, it is recognized that larvae production are also dependent upon precipitation patterns.

In reviewing these seasonal trends, it is noted that during the summer months of generally elevated mosquito larvae counts, there were 2 weeks (the weeks beginning August 29, 2005 and September 19, 2005) in which lower larvae counts were observed. Precipitation events that were generally representative of other daily and weekly summer precipitation events occurred during both of these weeks. It is of note, though, that maximum daily temperatures decreased to 67°F during each of these weeks. With the current data set, there is insufficient data to predict the degree to which mosquito larvae populations are dependent on temperature and precipitation patterns alone; however, it is clear that each of these atmospheric conditions play a significant role in the larvae counts that were observed. Additional data collection in future years may help SPU assess more quantitatively the relationship between mosquito larvae production, precipitation, and ambient temperature.

4.0 GENERAL OBSERVATIONS

During the 5-month sampling period, field teams noted several observations that were not part of the original sampling methodology, but could provide additional insights. Some of these observations may be used for further consideration in planning future sampling events.

The teams noted a "high" number of larvae and adult mosquitoes in catch basins that contained organic material, such as leafs, pine needles, and fruit debris and also in basins surrounded by natural areas with features such as trees, grassy areas, or other vegetation components. Although these notations were made at catch basin sites that were found to contain a wide range of larvae values (40 to over 200), more than 70 percent of these catch basins with organic material, either within the basin or surrounding the catch basins, were found to have reoccurring larvae populations for more than 4 weeks of the sampling season.

Field samplers also noted the catch basins that contained non-organic debris, such as garbage, plastic, metal, and paper products. Data from these catch basins appear to show a trend of long-term (more than 4 weeks) support of larvae populations. In general, however, the recorded larval levels did not approach those catch basins with organic debris.

Field crews also noted a decline in water volume within the catch basins throughout the season. During prolonged dry periods from July to September, water levels within the majority of the catch basins declined, reducing the volume of water available for larvae development. Interestingly, catch basins with the lowest water volumes were often recorded with very high mosquito larvae counts (100 to over 400).

5.0 SUMMARY/CONCLUSIONS

Although only one season of catch basin sampling has occurred within the City, an evaluation of data collected during the first season provides some initial conclusions. First, the majority (76 percent) of City catch basins sampled contained mosquito larvae at some point during the sampling period. In general, larvae counts exceeded the State's per-basin threshold for treatment of more than 1 larva per 3 dips. In addition, catch basins in multi-family and single-family land use areas contained statistically higher mosquito larvae populations than commercial and industrial areas. Additionally, the weekly and revolving sampling groups provided a broad enough view to determine that larvae populations are not limited to or concentrated in any one neighborhood or location within the City. Lastly, the months of July, August and September were identified as the most active breeding times within the City.

This study also revealed some interesting observations that may warrant additional analysis. These include the impacts of rainfall, ambient temperature, water volume, organic and inorganic material, and natural features on mosquito larvae counts in City catch basins. An expanded sampling approach could further study the correlations of these factors with mosquito breeding in City catch basins.

6.0 USE OF THIS REPORT

This report has been prepared for the exclusive use of Seattle Public Utilities for specific application to the West Nile Virus Mosquito Larvae Populations Assessment. No other party is entitled to reproduce, disseminate, and/or rely on the information, conclusions, and recommendations included in this document without the express written consent of Seattle Public Utilities and Landau Associates. Further, the reuse of information, conclusions, and recommendations provided herein without review and authorization by Seattle Public Utilities and Landau Associates, shall be at the user's sole risk.

Landau Associates warrants that within the limitations of scope, schedule, and budget, its services have been provided in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions as this project. We make no other warranty, either express or implied.

This document has been prepared under the supervision and direction of the following key staff.

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7.0 REFERENCES

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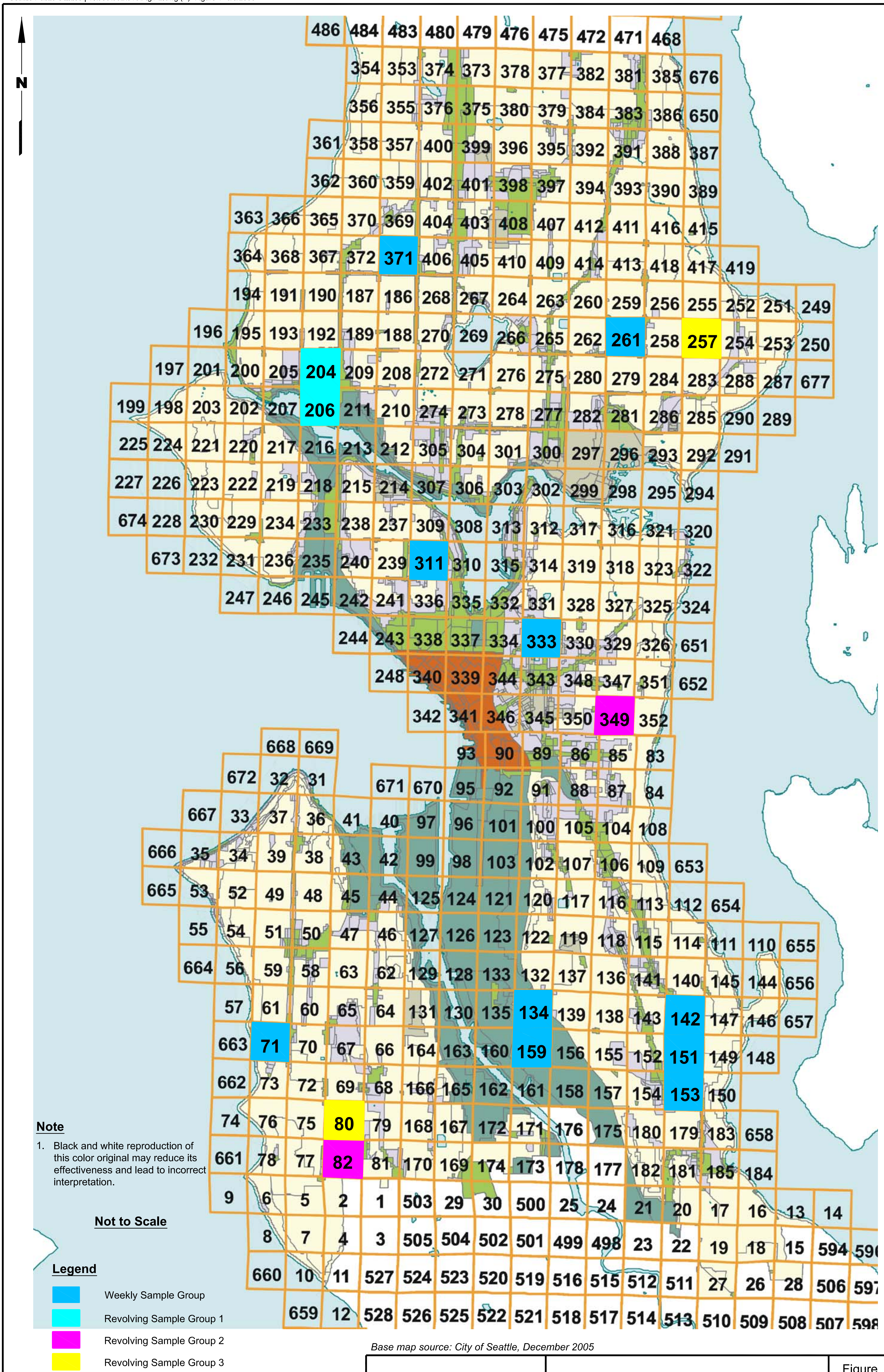
O'Malley, C. 1995. *Seven Ways to a Successful Dipping Career*. Wing Beats. Vol. 6(4): 23-24.



Base map source: City of Seattle, December 2005

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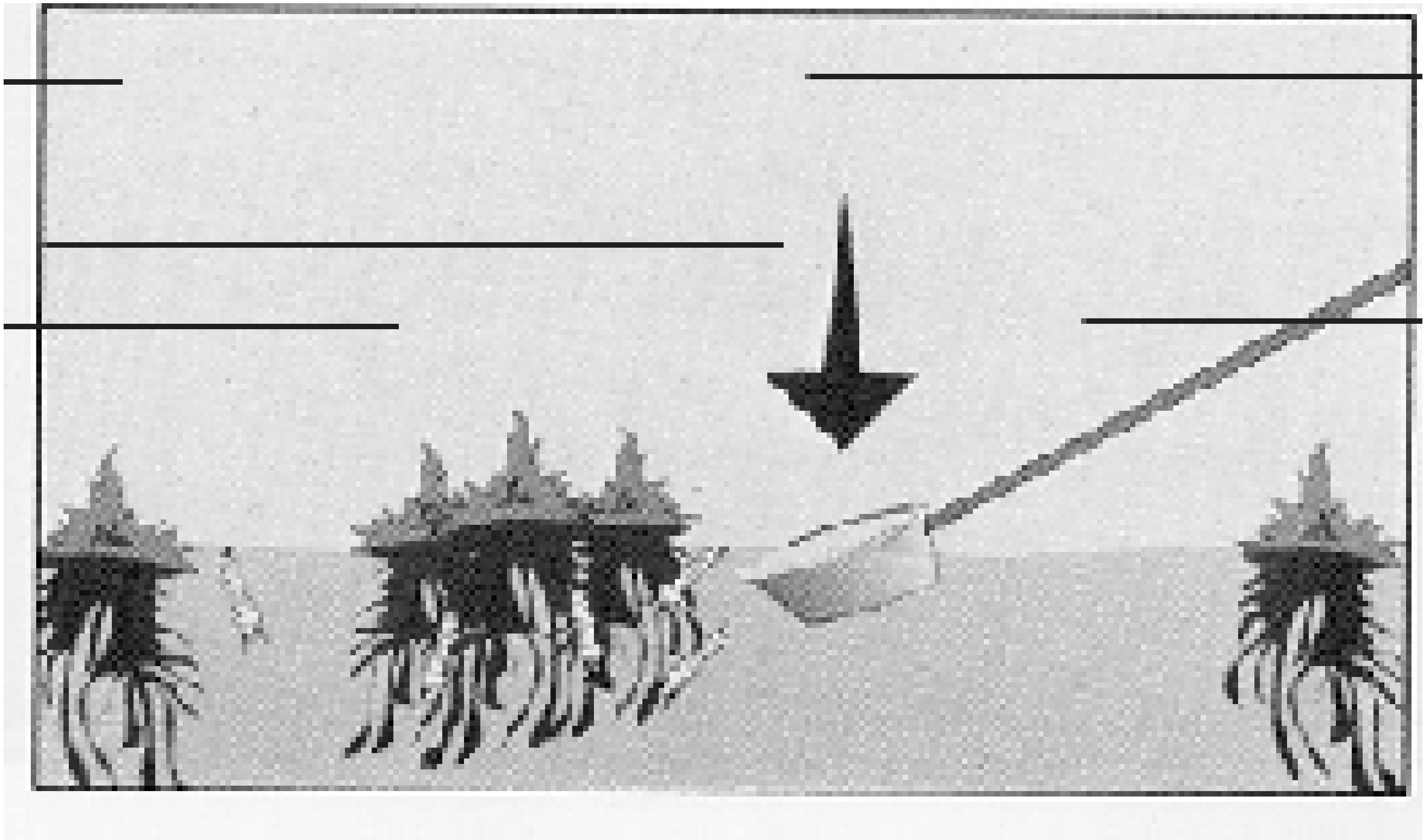
Seattle Public Utilities Seattle, Washington	**West Nile Virus Larvae Study** **Weekly & Revolving Sample Groups**	Figure 1



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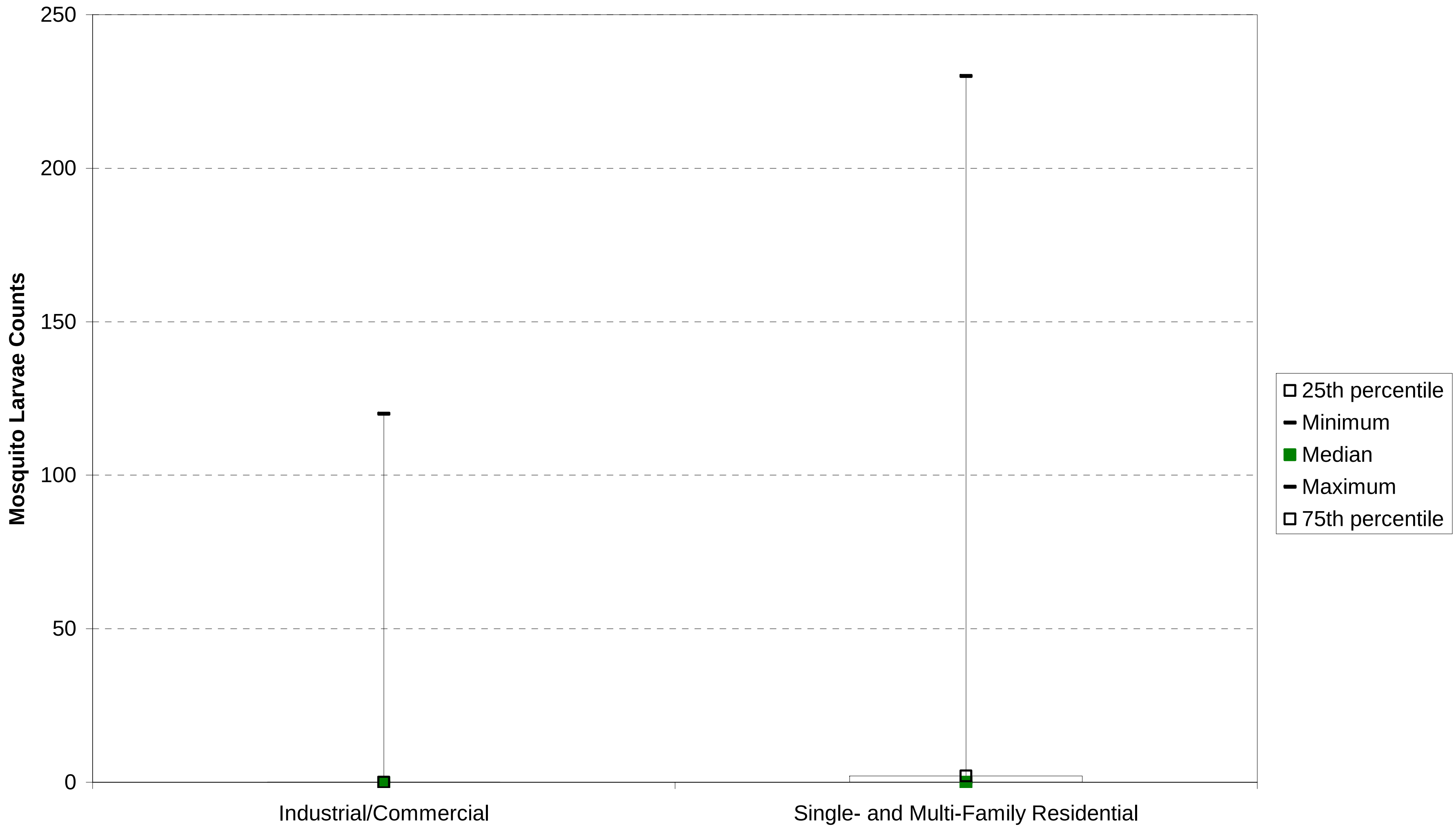
Seattle, Washington

Diagram of 'Partial Submersion' Sampling Technique

Figure 2



This figure presents the ranges of larvae counts observed in industrial/commercial area catch basins and residential (single- and multi-family) area catch basins during the initial phase of sampling. Catch basins in industrial/commercial areas had larvae counts ranging from 0 to 120 per 3 dips, with median and 75th percentiles of 0. Catch basins in residential areas had larvae counts ranging from 0 to 230 per 3 dips, with median and 75th percentiles of 0 and 2, respectively.

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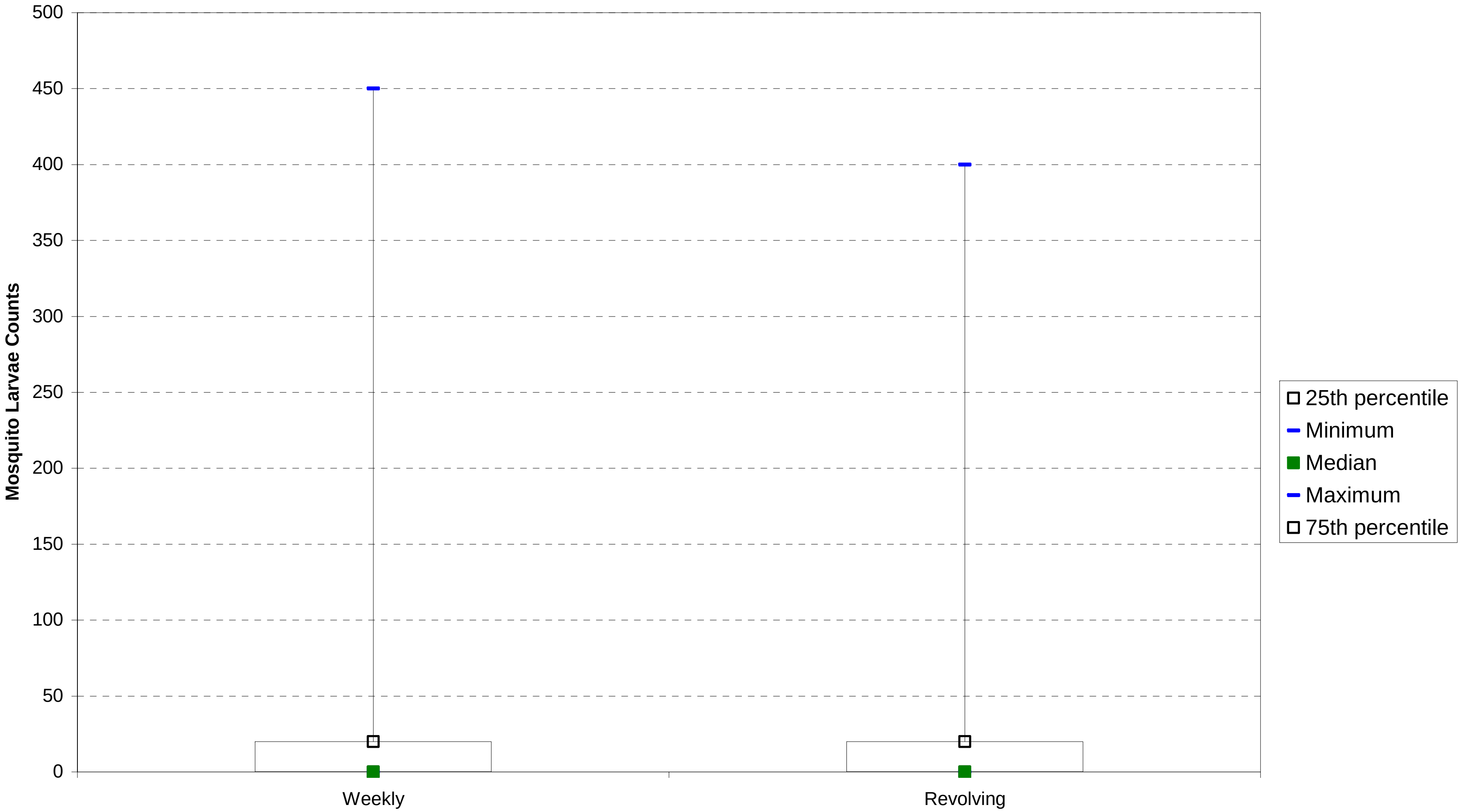
Initial Sampling
Land Use Comparison

Figure
3



This figure presents the range of larvae counts observed in weekly and revolving sample groups throughout the sampling period. Catch basins in the Weekly Sample Group had larvae counts ranging from 0 to 450 per 3 dips, with median and 75th percentiles of 0 and 20, respectively. Catch basins in the Revolving Sample Groups had larvae counts ranging from 0 to 400 per 3 dips, with median and 75th percentiles of 0 and 20, respectively.

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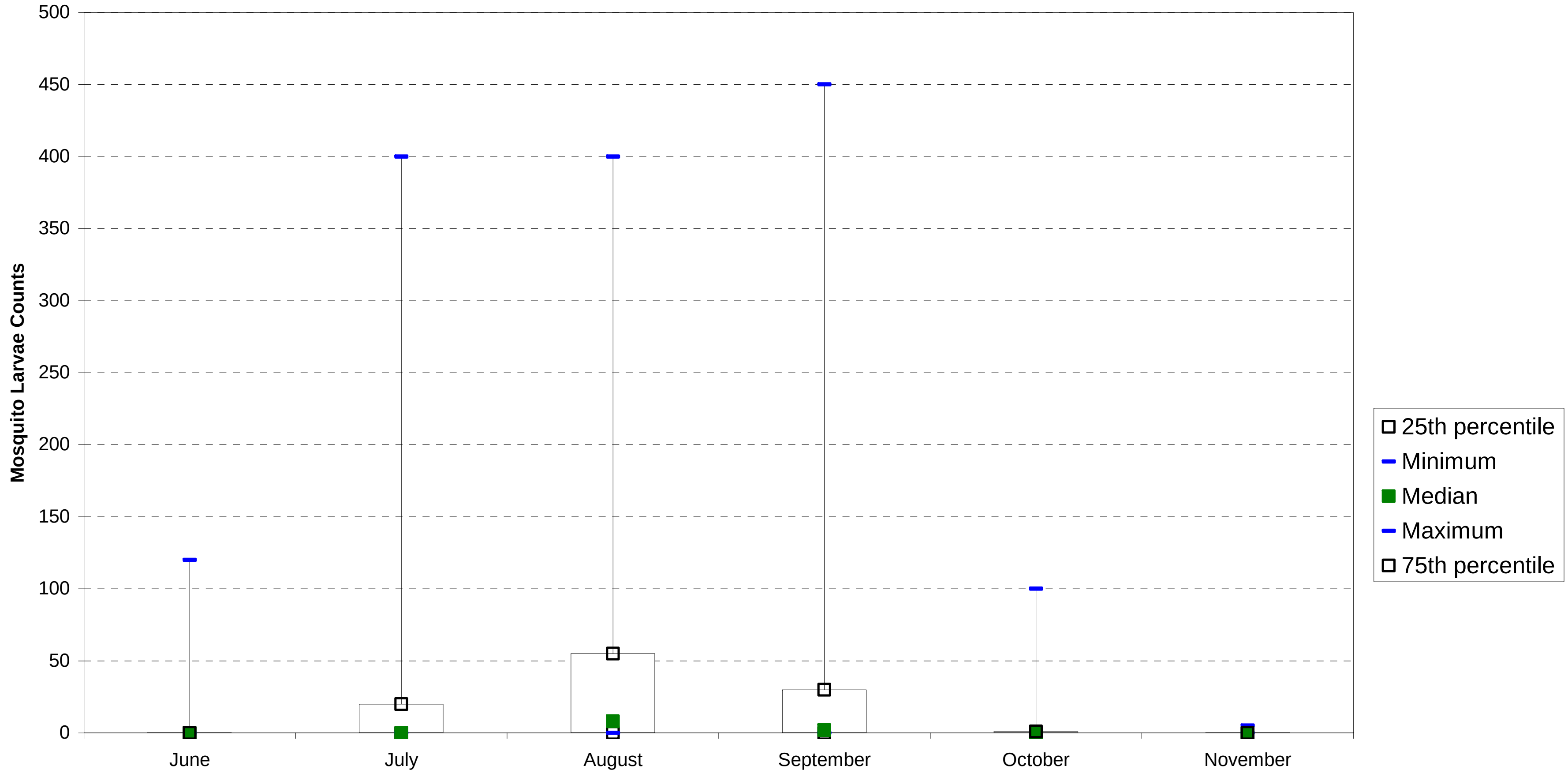
Weekly and Revolving Sample Groups Comparison

Figure 4



This figure presents the range of larvae counts observed during each month of the sampling period. Catch basins sampled in June had larvae counts ranging from 0 to 120 per 3 dips, with median and 75th percentiles of 0. Catch basins sampled in July had larvae counts ranging from 0 to 400 per 3 dips, with median and 75th percentiles of 0 and 20, respectively. Catch basins sampled in August had larvae counts ranging from 0 to 400 per 3 dips, with median and 75th percentiles of 8 and 55, respectively. Catch basins sampled in September had larvae counts ranging from 0 to 450 per 3 dips, with median and 75th percentiles of 2 and 30, respectively. Catch basins sampled in October had larvae counts ranging from 0 to 100 per 3 dips, with median and 75th percentiles of 0 and 1, respectively. Catch basins sampled in November had larvae counts ranging from 0 to 5 per 3 dips, with median and 75th percentiles of 0.

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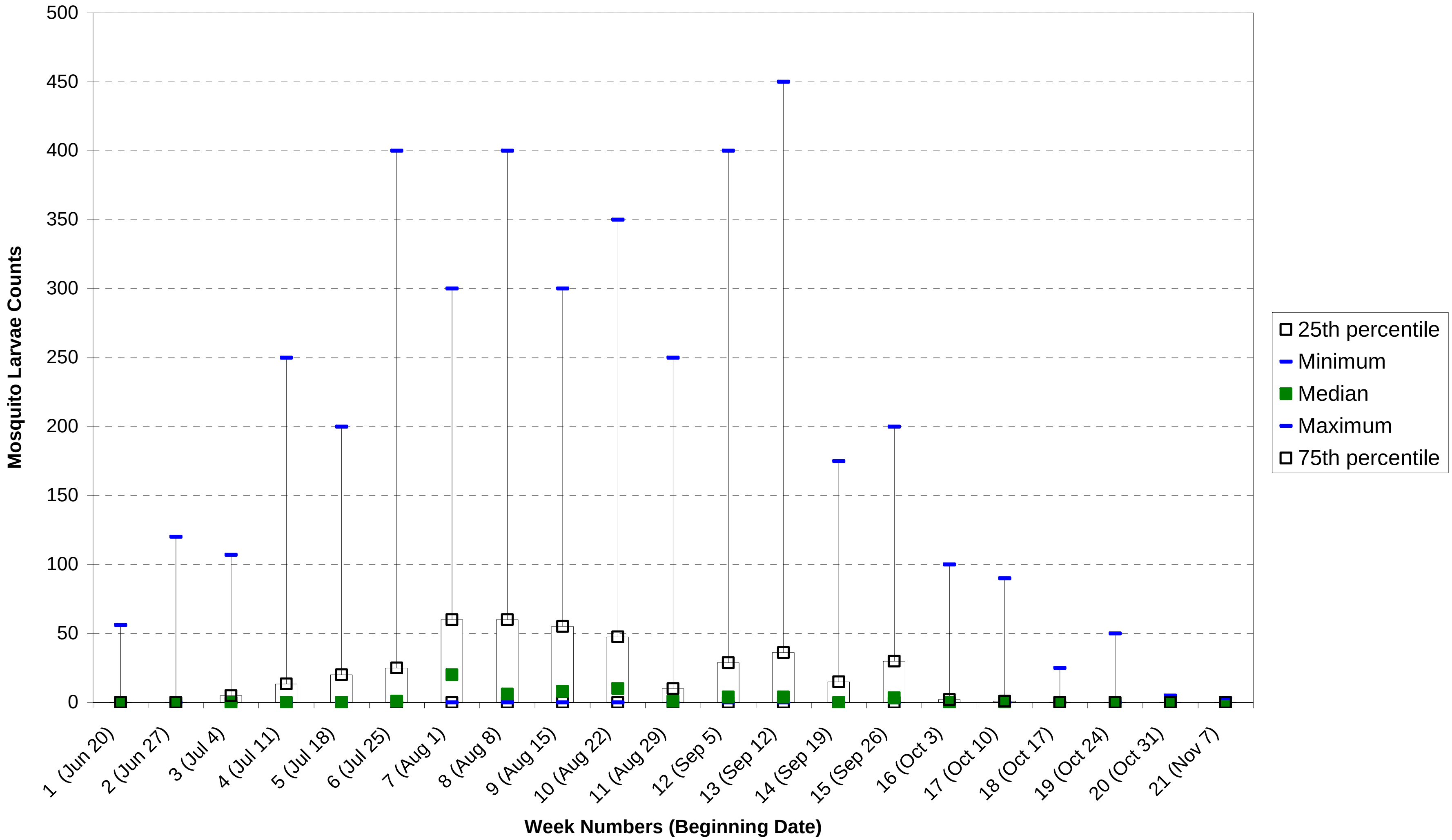
Distribution of Larvae Counts By Month

Figure 5



This figure presents the range of larvae counts observed during each week of the sampling period. Elevated maximum, median, and 75th percentile larvae counts are noted in July, August, and September. Lower larvae counts in Week 11 and Week 14 may be related to lower ambient daily temperature and/or precipitation events, as discussed in the text of the report.

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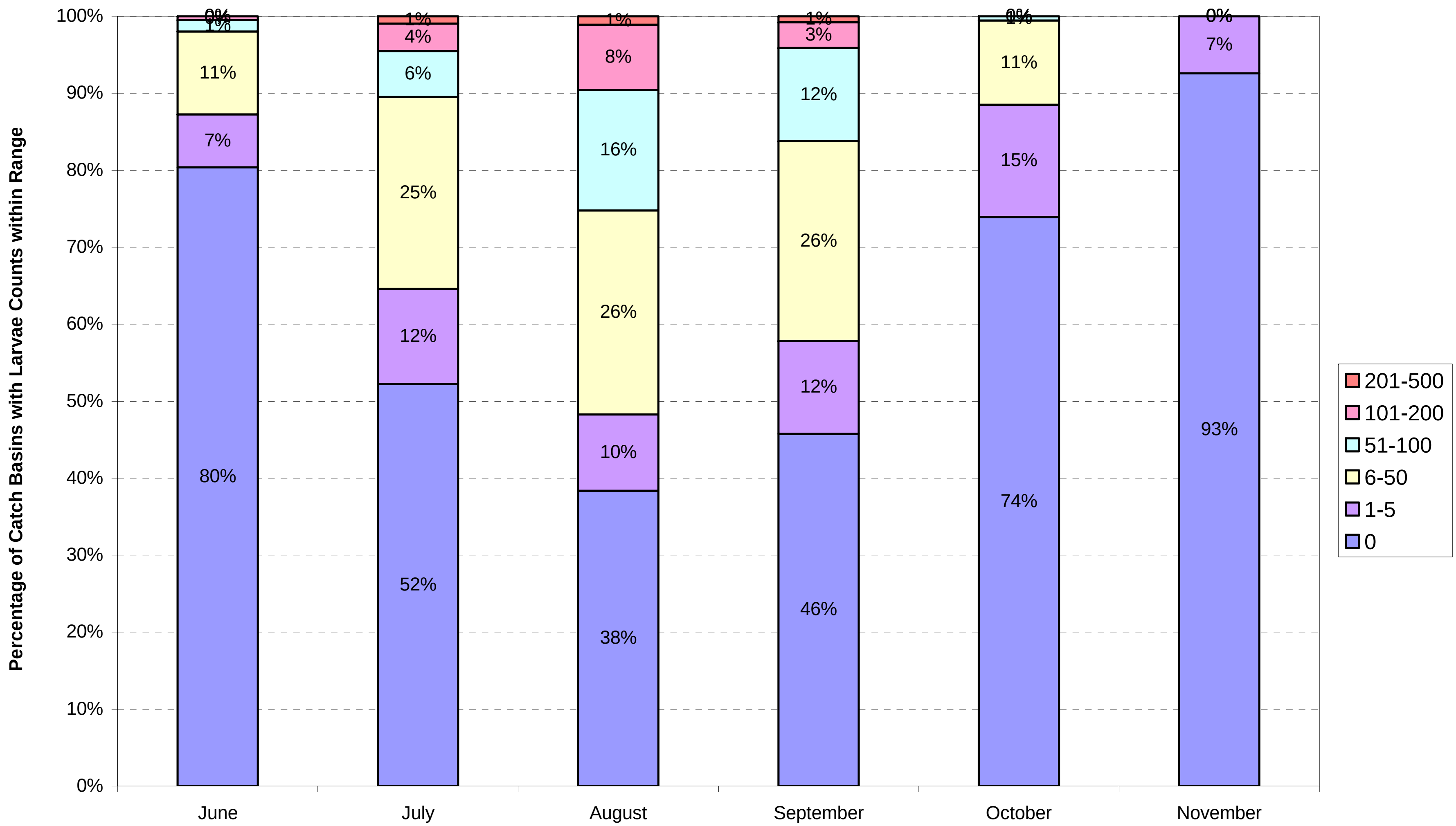
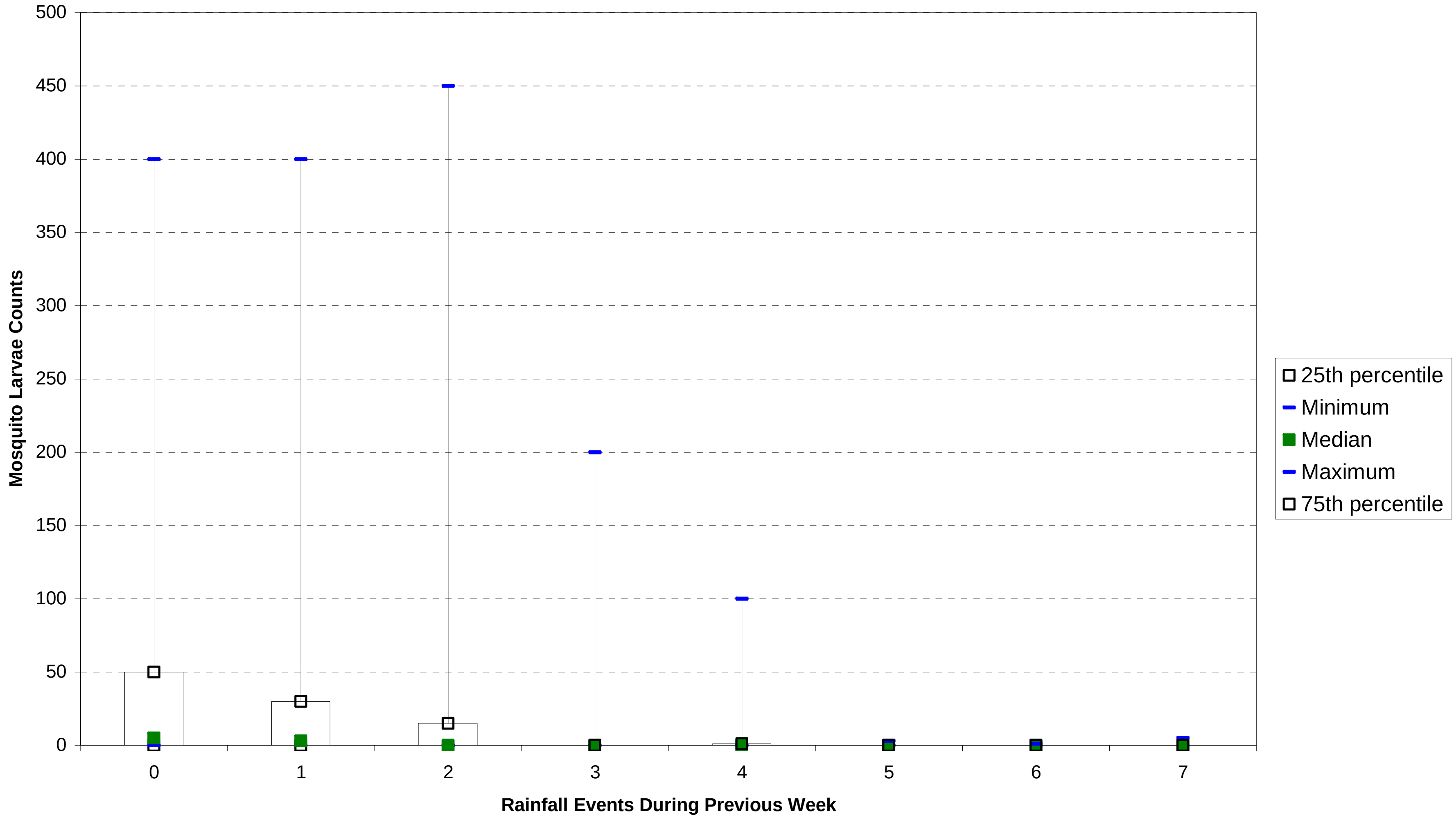
Seattle Public Utilities Seattle, Washington	**Distribution of Larvae Counts By Week**	Figure 6



This figure presents the magnitude distribution of larvae counts observed during each month of the sampling period. The frequency of larvae presence in catch basins increased from 20 percent in June to 62 percent in August, and then declined again to 7 percent in November. Furthermore, greater proportions of samples had higher larvae counts in August, with maximum larvae counts greater than 100 increasing from less than 1 percent in June to 9 percent in August, then decreasing again to 0 percent in November.

LANDAU ASSOCIATES	Seattle Public Utilities Seattle, Washington	**Larvae Count Magnitude Distribution by Month**	Figure 7



This figure presents data to consider the relationship between larvae counts and the frequency of recent rainfall events, expressed in days per week. The range of maximum larvae counts when there are 0 to 2 rainfall events in the week prior to sampling is 400 to 450 per 3 dips, with 75th percentile values ranging from 15 to 50. The range of maximum larvae counts when there are 3 or more rainfall events in the week prior to sampling is 1 to 200 per 3 dips, with 75th percentile values ranging from 0 to 1

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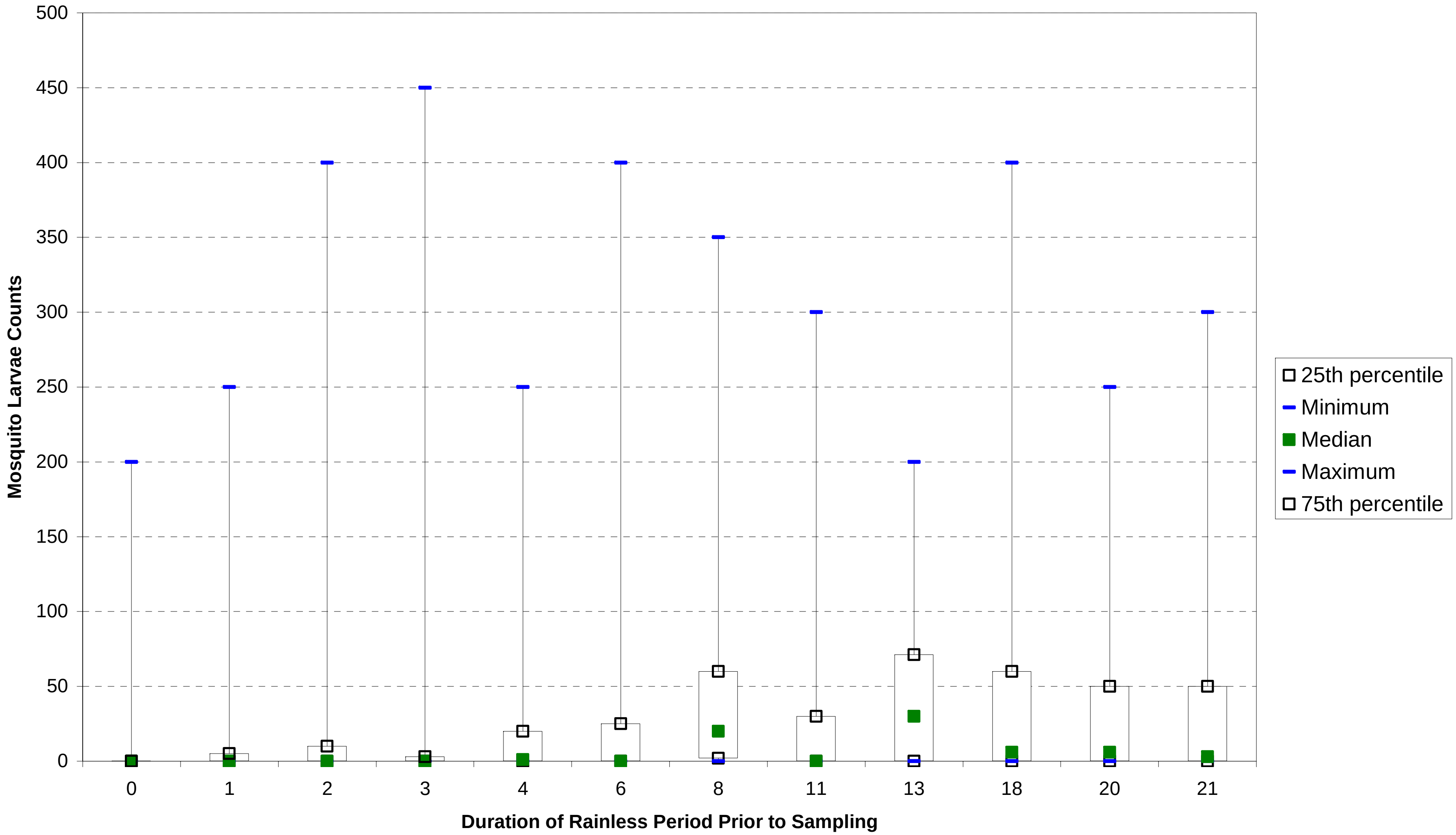
Effects of Recent Precipitation Frequency

Figure
8



This figure presents data to consider the relationship between larvae counts and the duration of rainless days prior to the sampling event. The average 75th percentile larvae count for 0 to 6 rainless days is 10.5 per 3 dips, while the average 75th percentile count for 8 or more rainless days is 53.5 per 3 dips.

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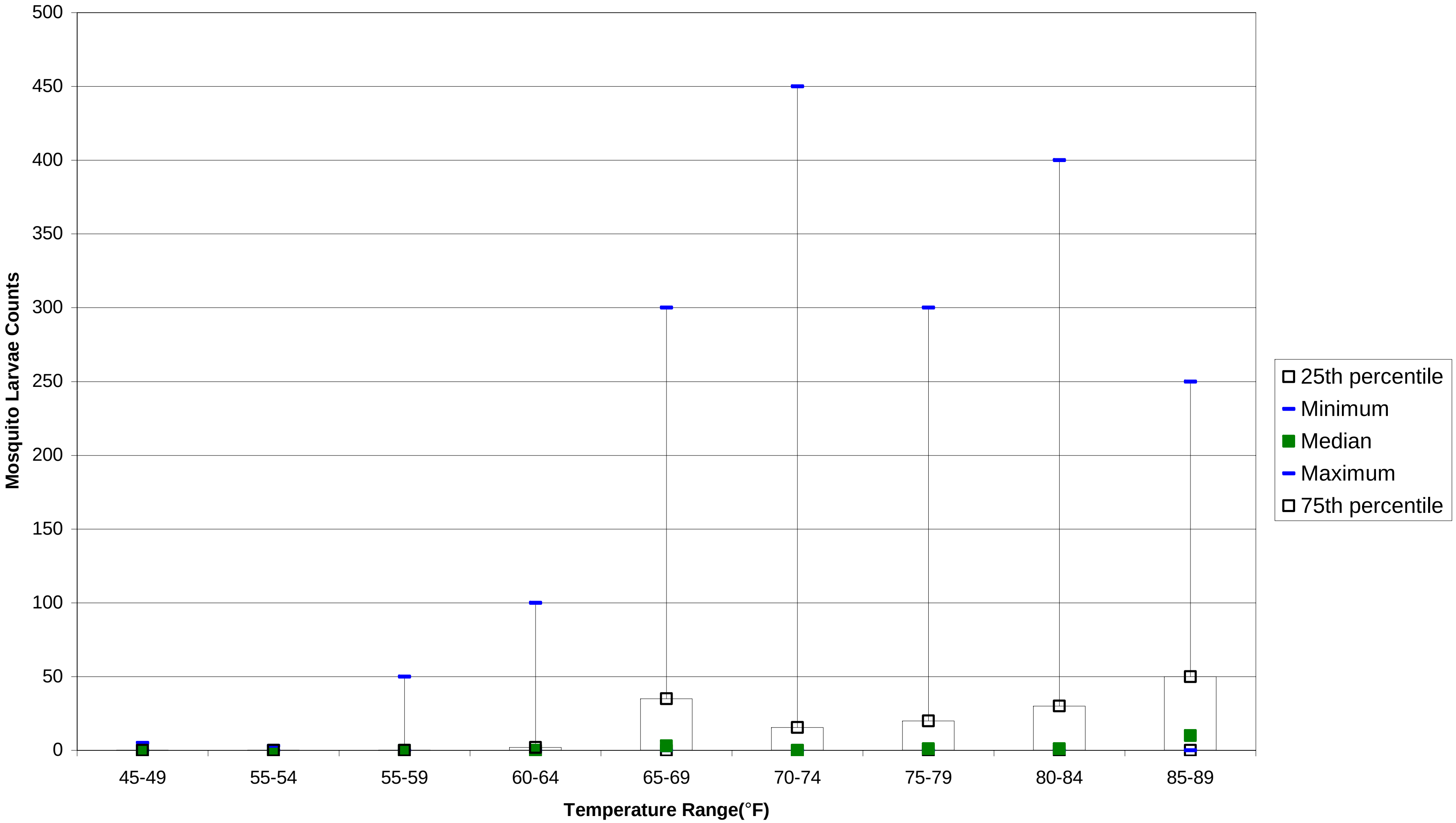
Seattle Public Utilities Seattle, Washington	**Effects of Dry Weather Duration**	Figure 9



This figure presents data to consider the relationship between larvae counts and the maximum daily temperature during the sampling event. When maximum daily temperatures ranged from 65 to 90 °F, 75th percentile larvae counts ranged from 20 to 50 per 3 dips, as compared to 0 to 2 per 3 dips for maximum daily temperatures below 65 °F.

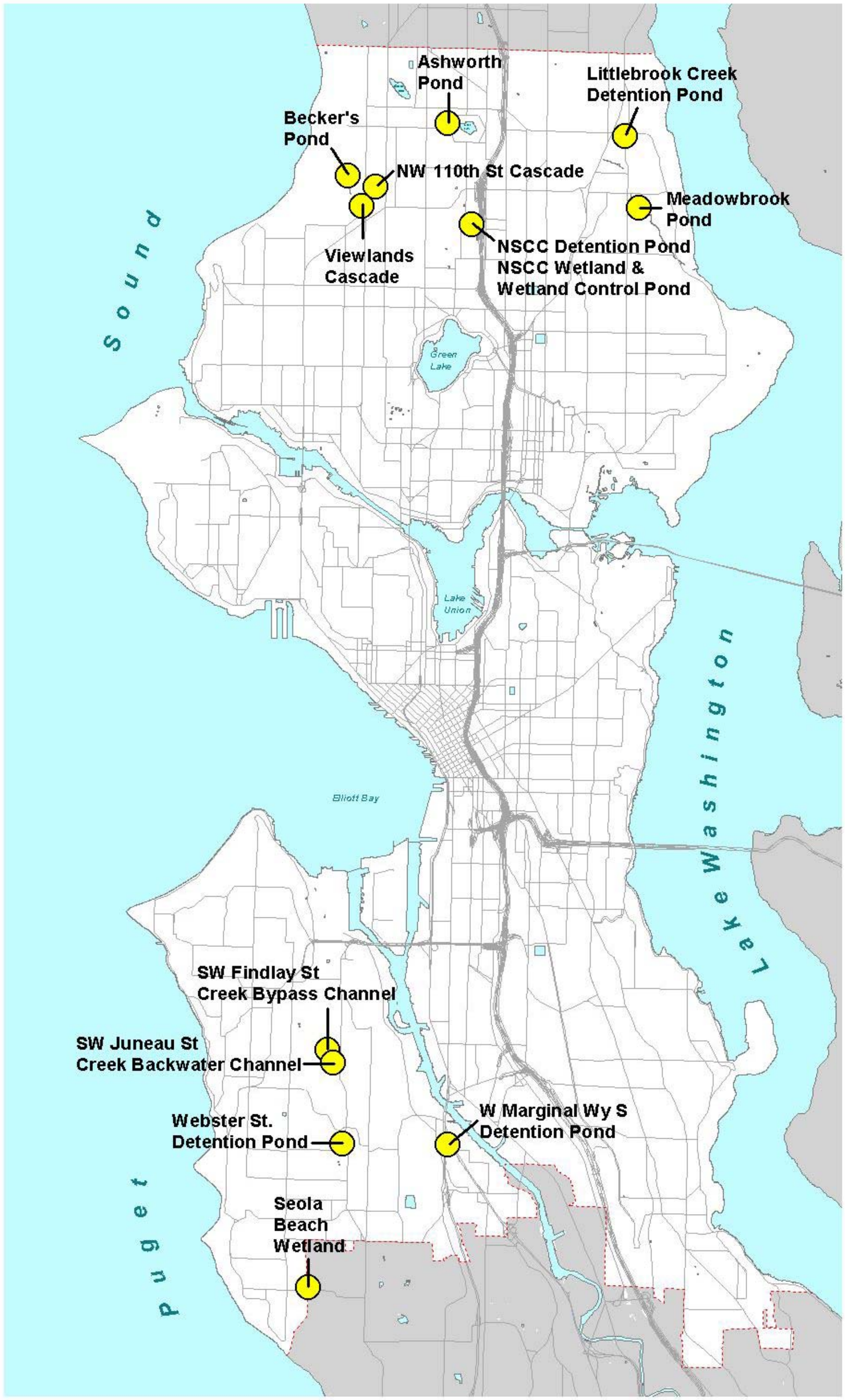
LANDAU ASSOCIATES	Seattle Public Utilities Seattle, Washington	**Effects of Temperature**	Figure 10

APPENDIX A

Detention Pond Sampling

APPENDIX A
DETENTION POND SAMPLING

A total of 13 sites were monitored in 2005 (Figure A-1). Of the 13 sites, 10 were stormwater detention ponds and constructed wetlands, two were stream backwater channels and one was a swale/ cascade located along NW 105th Street near Viewlands Elementary School. Fifteen sedimentation vaults located along NW 110th Street from 3rd Avenue NW to Greenwood Avenue North were also sampled. These sedimentation vaults are similar in design to standard catch basins and serve to trap and hold sediment within the basin. These basins contain standing water year round.



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Seattle Public Utilities
Seattle, Washington

2005 SPU Mosquito Larvae Monitoring Sites

Figure
A-1

Sampling was conducted from late May through mid-October. Seattle Public Utilities (SPU) attempted to sample detention ponds weekly; however, due to time constraints many ponds were sampled bimonthly.

Mosquito larvae were sampled at these sites using a standard mosquito dipper and according to the protocols outlined by O'Malley (1995). Samples (dips) were taken at various locations throughout each site. The number of samples collected at each site was dependent upon pond characteristics such as water depth and vegetation density. Various dipping techniques were employed based upon pond characteristics in order to adequately obtain a sample. Typical techniques included the shallow skim, complete submersion, partial submersion, simple scoop and scraping methods when floating vegetation was present (O'Malley 1995). Sampling at the NW 110th sedimentation vault sites were sampled following the catch basin sampling procedures.

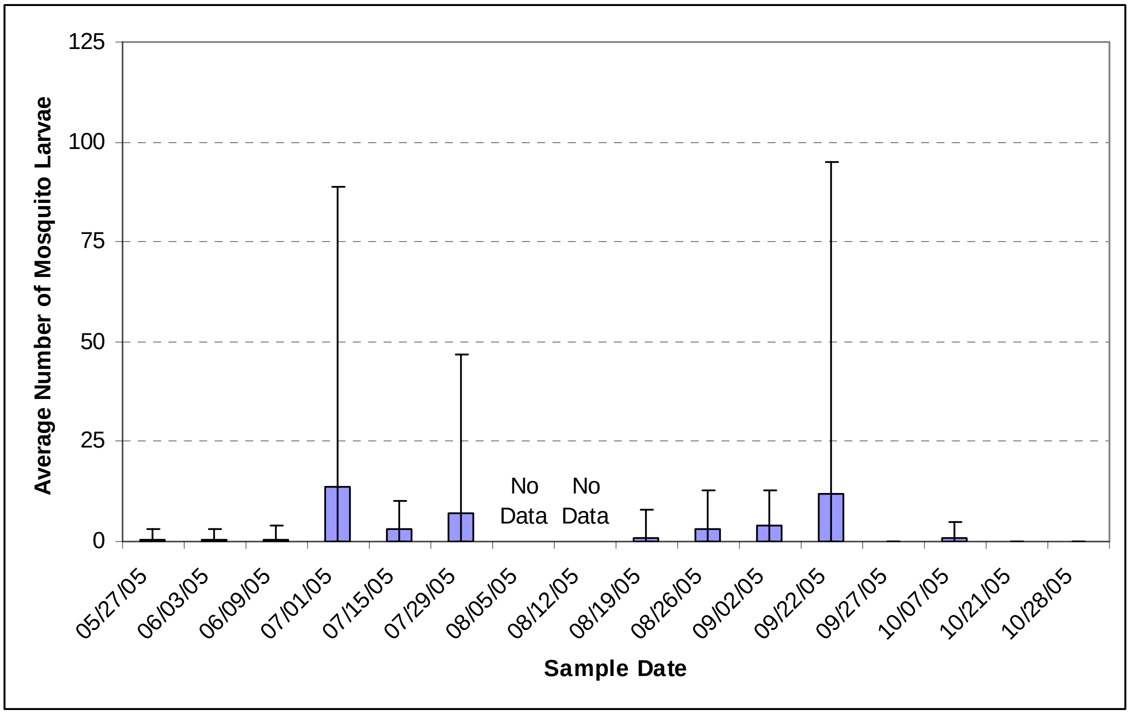
RESULTS

STORMWATER DETENTION POND SAMPLING RESULTS

In 2005, mosquito larvae were absent at four of the sites monitored as part of the detention pond monitoring effort: Ashworth Pond, Becker's Pond, the North Seattle Community College (NSCC) Wetland, and the NSCC Wetland control pond.

Ashworth Pond was dry between July 1, 2005 and September 22, 2005. Becker's Pond contained water during the entire sampling period; however, no mosquito larvae were found. The NSCC wetland was dry from July 1, 2005 to the end of the sampling period. The NSCC wetland control pond contained standing water throughout the entire sampling period, yet no mosquito larvae were found.

Results for the 2005 detention pond sampling effort are shown on Figure A-2. In general, mosquito larvae counts were found to fluctuate throughout the entire season. Counts peaked during both the early (June) and late (September) portions of the sampling effort. SPU speculates that the spikes were primarily due to high counts found at the Viewlands Elementary swale site. Higher counts of mosquito larvae were also found at the West Marginal Way detention pond on July 29, 2005. SPU believes that elevated mosquito larvae counts at this site were the result of a high concentration of larvae (up to 20 larvae per dip) in dense grassy vegetation at one area along the pond's edge.



Landau Associates

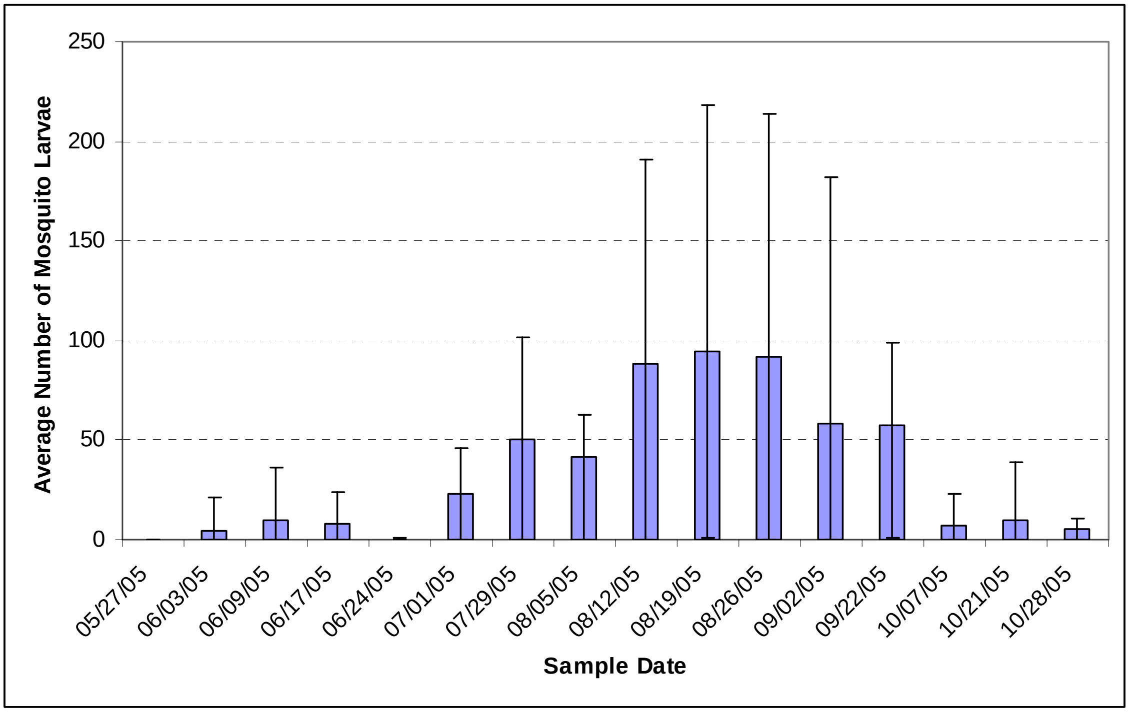
Seattle Public Utilities
Seattle, Washington

Results of 2005 Stormwater Detention Pond Sampling

Figure A-2

NW 110TH STREET SEDIMENTATION VAULT SAMPLING RESULTS

These sedimentation vaults are similar in structure and function to standard catch basins and appear to follow results observed during the citywide catch basin sampling effort. Mosquito larvae abundance shows a gradual increase through the sampling period, peaking around August 19 to August 26, 2005. Mosquito larvae abundance was observed to decrease from this peak period through the rest of the season until sampling was terminated. The date at which larvae were no longer found within the sedimentation vaults was not identified. Results for the 2005 NW 110th Street sedimentation vault sampling effort are shown on Figure A-3.



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Results of 2005 NW 110th Street Sedimentation Vault Sampling

Figure A-3

DISCUSSION

Differences in mosquito larvae counts observed between stormwater detention and constructed wetland sites, and the NW 110th Street sedimentation vaults may be the result of physical and functional differences. Most of the detention pond sites are in-line of stream systems with constant flow and few pockets of slow or backwater areas. In addition, some of these sites contain fish and aquatic insects, which prey upon mosquito larvae keeping larvae abundance in check.

In contrast, the NW 110th Street sedimentation vaults are uniform structures containing constant standing water. These structures offer a sheltered environment for mosquito larvae where larvae are typically the only aquatic organism observed in these structures.

REFERENCES

O'Malley, C. 1995. *Seven Ways to a Successful Dipping Career*. Wing Beats. Vol. 6(4): 23-24.

APPENDIX B

Selected Site Photographs

1. Standard dipper used for 2005 sampling season. One pint cup at the end of a retractable pole.

2. Dipper lowered into catch basin at an angle to draw water and larvae into cup.

3. Catch basins identified on GIS maps. Data recorded onto field data sheets.

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