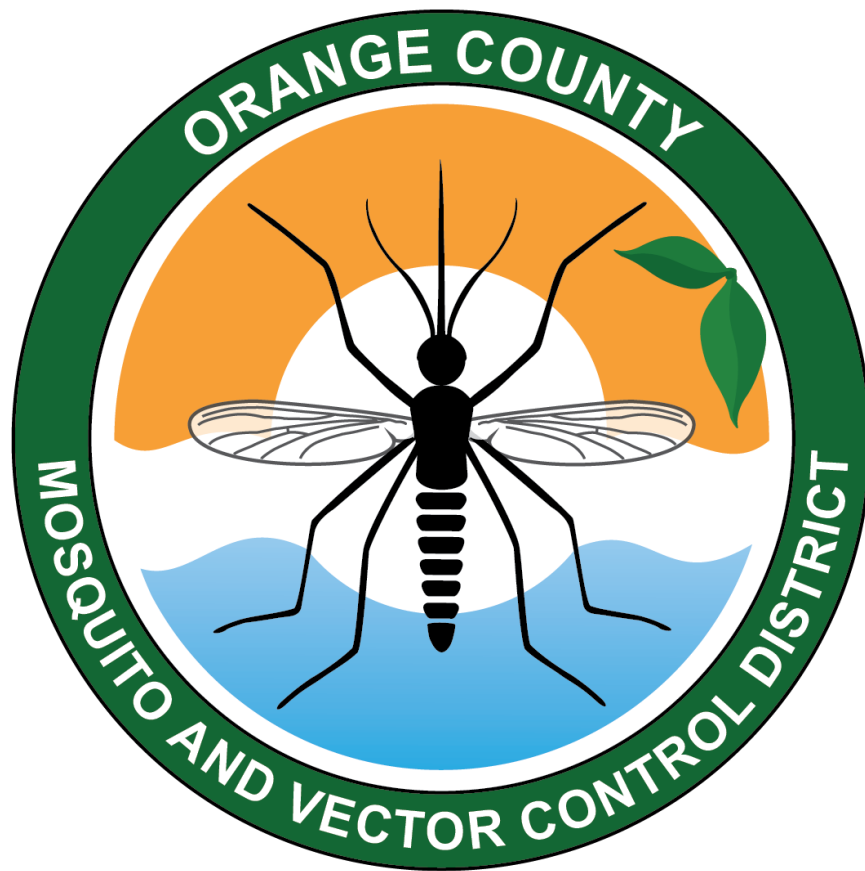


ORANGE COUNTY MOSQUITO AND VECTOR CONTROL DISTRICT
INTEGRATED VECTOR MANAGEMENT AND RESPONSE PLAN
*SUPPLEMENTAL CHANGES TO THE 2010 INTEGRATED VECTOR MANAGEMENT
AND RESPONSE PLAN AS IT RELATES TO
WEST NILE VIRUS EMERGENCY MOSQUITO RESPONSE*



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WEST NILE VIRUS EMERGENCY MOSQUITO RESPONSE PLAN

Introduction

The Orange County Mosquito and Vector Control District (OCMVCD), previously known as the Orange County Vector Control District (OCVCD), was originally formed in 1947 as a mosquito abatement district. Over time, the OCMVCD's mosquito surveillance plan has changed following the introduction of West Nile virus (WNV) in 2003, and because of the on-going threat from invasive mosquitoes and other vector-borne diseases. The present program has been in place since 2008 when in-house real-time reverse transcription PCR (PCR) testing was added to the surveillance program. This plan was initially adopted by the OCMVCD Board of Trustees in May, 2010. Changes were made to the plan following the 2014 WNV super epidemic that resulted in 280 human infections and nine deaths. Since its introduction to Orange County, a total of 532 people have been confirmed infected with WNV and 18 have died.

This document describes an enhanced surveillance and response program for Orange County, which is dependent on the risk level of mosquito-borne virus transmission to humans. The Mosquito-borne Virus Surveillance & Response Plan, 2015 (Appendix A), was generated by the California Department of Public Health (CDPH), Mosquito & Vector Control Association of California and the University of California. This plan constitutes the core of the OCMVCD's WNV Risk Assessment (Table 1). The California Plan's WNV Risk Assessment assigns values to various benchmarks within multiple Surveillance Factor categories. In the OCMVCD's West Nile Virus Risk Assessment worksheet, adjustments were made to the WNV Surveillance Factors to make categories relative to the conditions specific to Orange County.

The risk ratings generated from this assessment can be used to communicate levels of WNV activity to the Local Health Officer to determine whether a declaration of a local public health emergency should be considered. The risk ratings can be used as a basis to communicate risk to the Orange County Emergency Operation Center (EOC). Additionally, the risk rating can be used as justification to request Federal public health exemptions from FIFRA (40 CFR 166) and emergency pesticide tolerance exemptions (40 CFR 176).

In conjunction with the Orange County Health Care Agency (OCHCA) Emergency Operations Plan (EOP), and the OCMVCD Integrated Vector Management (IVM) & Response Plan (Appendix B), the following operational procedure for the OCMVCD has been developed. This follows the recommendations of the California Public Health and Medical Emergency Operations Manual, and the procedure is in coordination with the Orange County Medical Health Operational Area Coordinator (MHOAC) Annex to the OCHCA EOP.

In the event of a local, state, or federal declaration of emergency, the OCMVCD shall assist the MHOAC with investigation and control of vector-borne diseases. The OCMVCD will notify the County Epidemiology Program of any unusual event or finding related to vector-borne diseases. Examples of an unusual event include surveillance data indicating an increased risk of vector-borne disease transmission to residents of Orange County, OCMVCD's intention to implement

area-wide adult mosquito control to target vector-borne diseases in high risk areas, or the presence of a recently introduced vector or disease agent of concern. Epidemiology will notify the MHOAC as needed of any situations affecting human health. The OCMVCD will update the MHOAC, as necessary and if requested, of current vector surveillance, testing volumes and capacity, intended applications of area-wide adult mosquito control, and of any needs for supplies, equipment or personnel due to the emergency or unusual event. OCMVCD may request assistance through the MHOAC to minimize and respond to vector-borne disease events.

WEST NILE VIRUS RISK ASSESSMENT

Response Levels

The OCMVCD's IVM & Response Plan is based on conditions that exist at three response levels: 1) Normal Season, 2) Elevated Risk, and 3) High Risk. Six WNV surveillance factors are analyzed to determine the appropriate response level and include:

1. Environmental conditions (temperature)
2. Adult mosquito abundance
3. WNV infection rate in mosquitoes
4. Number of WNV-positive dead birds
5. WNV antibody seroprevalence in free-ranging birds
6. Human infections of WNV

The majority of the factors listed above are rated on a scale of 1 to 5 with 5 representing conditions indicative of a high risk of human infection with WNV. Factors 5 (seroprevalence) and 6 (human infections) are weighted differently than the other four factors and are rated on adjusted scales of 2 to 5 and 3 to 5, respectively. An overall rating is determined by computing the mean of the six risk factors and is correlated with the response level as follows:

Level 1: Normal Season (Rating – 1.0 to 2.5)

Level 2: Elevated Risk (Rating – 2.6 to 4.0)

Level 3: High Risk (Rating – 4.1 to 5.0)

The West Nile Virus Risk Assessment worksheet (Table 1) is designed to determine the appropriate rating for each of the risk factors for the entire County. These ratings are used to trigger the response levels listed above. Supporting reference documentation can be found in Tables 2 through 9 and Figures 1 through 5. In the event that WNV surveillance factors values are elevated in the historically high WNV risk area of Orange County, additional risk assessment ratings will be calculated for that specific area to generate an appropriate response level (Figure 5). Roles and responsibilities of key agencies involved in implementing the surveillance and response plan are outlined in OCMVCD Response Levels to Risk Ratings. The appropriate

response implemented at each level shall be determined based on the degree and magnitude of risk factors presenting. The WNV surveillance factors used to determine the response level are described below.

Guidelines for adult mosquito surveillance, processing mosquitoes for arbovirus detection, testing of dead birds, as well as information regarding human case definitions and public health pesticides approved for mosquito control in California are part of the State of California Mosquito-Borne Virus Surveillance & Response Plan, 2015 (Appendix A). Specific triggers for mosquito operational decisions can be found in the IVM & Response Plan (Appendix B).

West Nile Virus Surveillance Factors

Environmental Conditions

OCMVCD reviews weather reports from local, state, and federal agencies biweekly to assess current conditions and analyze the potential influence on mosquito breeding and virus replication. The average high, low, and mean temperatures by month from 2010 through 2014 are found in Table 2 (UCIPM Online, 2015). Total precipitation is also considered but has not been found to be a critical factor in mosquito-borne disease outbreaks in southern California.

Additional websites related to weather conditions can be found in the California State Mosquito-Borne Virus Surveillance & Response Plan, 2015 (Appendix A).

Adult *Culex quinquefasciatus* and *Culex tarsalis* Mosquito Abundance

Adult mosquito surveillance in Orange County is conducted by setting 63 carbon dioxide (CO₂) baited traps and 33 gravid traps on a weekly basis during the warm months of March through November and by setting 21 carbon dioxide (CO₂) baited traps and 15 gravid traps on a biweekly basis during cooler weather from December – March (Table 3 and Table 4). Additional adult mosquito surveillance is conducted after the detection of WNV-positive dead birds, human infections, and in response to nuisance biting complaints from the public. Only routinely trapped locations using CO₂ and gravid traps are used to generate a five-year average for abundance, which is then used as a baseline to compare current mosquito abundance. Mosquito trap locations (Tables 3 and 4; Figures 1 and 2) and average monthly *Cx. quinquefasciatus* abundance can be found in Table 5 (*Cx. tarsalis* averages not shown). *Cx. tarsalis* and *Cx. quinquefasciatus* abundance is scored separately when calculating the WNV Risk Assessment ratings and response level.

Guidelines for mosquito surveillance are summarized in the California State Mosquito-Borne Virus Surveillance & Response Plan, 2015 (Appendix A).

Infection Rates in *Culex quinquefasciatus* and *Culex tarsalis* Mosquitoes

Adult mosquito abundance and their WNV infection rates are the key factors used to evaluate the risk of disease transmission to humans. Once collected in CO₂-baited and gravid traps, mosquitoes are pooled into variable sized samples containing five (5) to 50 mosquitoes. Pooled

samples are then tested at OCMVCD using real time PCR. Results are generated up to two times per week during the months of high mosquito activity. Infection rates [calculated using the Maximum Likelihood Estimator (MLE), Biggerstaff, 2003] are determined biweekly and represent the number of WNV-positive mosquito pools found in collections of a particular mosquito species over a defined time period. The OCMVCD's current system is designed to detect WNV in real time, with retrospective testing of samples for other arboviruses, such as St. Louis encephalitis (SLE) and western equine encephalomyelitis (WEE).

Procedures for processing mosquitoes for virus infection are summarized in the California State Mosquito-Borne Virus Surveillance & Response Plan, 2015 (Appendix A).

Dead Bird WNV Infection

The OCMVCD began testing dead birds for WNV in 2003. Currently, dead birds are reported to OCMVCD for collection and tested in-house by PCR. The OCMVCD works with the public, local animal control agencies, and wildlife rehabilitators to coordinate collection of dead birds. Dead birds are necropsied at OCMVCD and the kidney is removed for WNV testing. The number of dead birds tested and positive for WNV is updated weekly on the OCMVCD website. The number of WNV-positive dead birds collected in Orange County summarized biweekly over the last five years can be found in Table 6.

Guidelines for Procedures for Testing Dead Birds are found in California State Mosquito-Borne Virus Surveillance & Response Plan, 2015 (Appendix A).

WNV Antibody Seroprevalence in Free-Ranging Birds

Detection of WNV transmission in avian populations can be achieved by collecting, and testing the samples obtained from free-ranging birds to detect anti-WNV antibodies and circulating viral RNA. Currently, the OCMVCD operates multiple bird traps within historically defined areas of moderate-to-high WNV activity (Table 8). Traps are baited with bird seed on a biweekly basis and birds are captured, held overnight, bled and released. This activity is permitted by the United States Geological Survey (Permit #23547) and the California Department of Fish and Wildlife Scientific Collecting Permit (Permit ID Number 009202). Protocols for bleeding and testing of free-ranging birds can be found in Fair et al. 2010, Hall 1995, and Lanciotti et al. 2000. Patterns observed in avian herd immunity to WNV (i.e., seroprevalence) show that in some years when seroprevalence is less than 10 percent in late winter and spring, outbreaks of West Nile virus neuroinvasive disease occurred in the ensuing summer (Kwan et al. 2012). Based on the analysis of eleven years of serological data (2004-2014), similar patterns of "herd" immunity are observed in avian populations in Orange County. Thus, free-ranging bird seroprevalence has been incorporated as a surveillance factor in the OCMVCD's West Nile Virus Risk Assessment worksheet. Seroprevalence data from 2008 to 2014 are included in Table 7. Locations of bird traps are listed in Table 8 and shown in Figure 3.

Human Infections

In general, human infections are not a sensitive surveillance indicator of neurotropic arbovirus activity, such as WNV, SLE, WEE, because most human infections (> 80%) have no, or only mild, symptoms. Communication with key hospitals and local health officials has been enhanced following the super epidemic of WNV in 2014. Rapid detection and reporting of confirmed human cases of WNV and of other arboviral diseases is crucial to local mosquito control agencies in planning and expending emergency control activities to prevent additional human infections. Human infections by year of onset are listed in Table 9 for 2004 - 2014. Human infections by week of onset for 2004 – 2014 are depicted in Figure 4.

More information about human case reporting and testing are found in the California State Mosquito-Borne Virus Surveillance and Response Plan, 2015 (Appendix A).

Historical Risk Area Consideration

Spatial and Temporal Predictors of High WNV Risk in Orange County

Orange County has been recognized as a hotspot of WNV activity since 2004. An analysis of WNV surveillance factors throughout Orange County from 2004 to 2013 produced a spatial model (Figure 5) that captured 84.4% of all WNV human cases (Liao et al. 2014). When comparing years with high WNV activity (2004, 2008, 2012, and 2014) to years with low WNV activity (2005 to 2007; 2009 to 2011; and 2013), several indicators have emerged as reliable predictors of an impending WNV epidemic:

- Low (< 10%) winter/spring WNV antibody seroprevalence rates in wild birds;
- Early season (May/June) detection of WNV-positive dead birds at infection rates > 20%;
- Early season (May/June) detection WNV-positive mosquito pools at MLE infection rates > 2.1;
- Early season (March - June) detection of WNV human infections.

In the event that WNV surveillance factors are occurring in the historically high WNV risk area of Orange County, especially from May through June, additional Risk Assessment ratings for that area will be calculated and presented to determine an appropriate OCMVCD response (Figure 5).

OCMVCD Response Levels to Risk Ratings

Normal Risk Rating: 1.0 – 2.5

General Conditions
<ul style="list-style-type: none"> • Cool to moderate seasonal temperatures (< 65°F) • Mosquito abundance at or below five year average (key indicator = adults of vector species) • Mosquito infection rates (0 – 1.0 MLE) • None or 1 (or more) WNV positive dead bird(s) in neighboring county • Approximately 20-30% antibody seroprevalence in free-ranging birds • No human cases
Response Activities by Role
<p>District Manager</p> <ul style="list-style-type: none"> • Ensure adequate emergency funding • Establish and maintain routine communication with the Emergency Operations Center personnel
<p>Director of Communications</p> <ul style="list-style-type: none"> • Conduct routine public education (eliminate standing water around homes, use personal protection measures) • Release routine press notices • Inform the public about adult mosquito control pesticide applications, if appropriate • Notify OCHCA of the need to alert physicians and/or veterinarians of the surveillance activity
<p>Director of Scientific and Technical Services</p> <ul style="list-style-type: none"> • Compile data for West Nile Virus Risk Assessment worksheet • Conduct routine mosquito and virus surveillance activities • Evaluate pesticide resistance in vector species
<p>Director of Operations</p> <ul style="list-style-type: none"> • Coordinate routine mosquito larval control activities • Define target area for potential adult mosquito control activities • Inventory pesticides and equipment • Ensure aerial adulticide contract is current • Contact OC Agricultural Commissioner to obtain current list of registered organic growers • Establish communication chain between OCHCA and OCMVCD for potential distribution of ecologic investigations of human exposure sites

Elevated Risk Rating 2.6-4.0

General Conditions
<ul style="list-style-type: none"> • Temperatures above average (66-79° F) • Adult mosquito abundance average within 91 – 150 % of 5-year average • One or more WNV positive mosquito collections (MLE < 5) • Multiple WNV positive dead birds distributed broadly throughout the County • Late winter and early spring avian WNV seroprevalence ranging from 10 to 20% or evidence of recent infection in wild birds including WNV isolation, multiple seroconversions in hatch-years, or notable seroprevalence increase in the wild bird population • One human case in Orange County • Viral activity (mosquito pools and dead birds) occurring in historical high risk area
Response Activities by Role
<p>District Manager</p> <ul style="list-style-type: none"> • Review epidemic response plan • Notify Board of Trustees of increased WNV risk • Prepare to coordinate epidemic response in consultation with management team • Consider suspending other District programs as needed or necessary
<p>Director of Communications</p> <ul style="list-style-type: none"> • Review epidemic response plan • Enhance public education, coordinate with OCHCA to distribute messages on signs and symptoms of encephalitis and recommend medical care if needed • Inform public about adult mosquito control pesticide applications, if appropriate • Enhance information to public health providers • Notify key agencies and impacted cities of presence of viral activity, including the EOC
<p>Director of Scientific and Technical Services</p> <ul style="list-style-type: none"> • Compile data for West Nile Virus Risk Assessment • Review epidemic response plan • Increase adult mosquito surveillance • Increase number of mosquito pools tested for virus • Review candidate pesticides for availability and susceptibility of vector mosquito species • Identify any special environmental compliance concerns in affected area and communicate with Lead District staff
<p>Director of Operations</p> <ul style="list-style-type: none"> • Coordinate routine ecologic investigations of human exposure sites and report to OCHCA • Review epidemic response plan • Increase surveillance and control of mosquito larvae by decreasing cycle times • Coordinate localized chemical control of adult mosquitoes • Brief aerial adulticide contractor about the current status of WNV surveillance factors

High Risk Rating 4.1-5.0

General Conditions
<ul style="list-style-type: none">• Temperatures well above average (>79° F)• Adult vector population above 5-year average (>150%)• Multiple WNV positive mosquito collections (MLE > 5.0)• Multiple clusters of WNV positive dead birds throughout the County• One or more WNV positive human cases within the County• Late winter and early spring avian WNV seroprevalence below 10% or evidence of recent infection in wild birds including WNV isolation, multiple seroconversions in hatch-years, or notable seroprevalence increase in the wild bird population• Temporal and spatial clustering of viral activity (mosquito pools and dead birds) occurring in historical high risk area
Response Activities by Role
<p>District Manager</p> <ul style="list-style-type: none">• Ensure adequate emergency funding• Coordinate epidemic response and communicate plan with Board of Trustees• Discuss with OCHCA anticipated need for area-wide adult mosquito control and request notification of the MHOAC• Notify Orange County Agricultural Commissioner of area-wide adult mosquito control• Schedule adult mosquito control as appropriate by ground-based equipment or aircraft• Contact aerial mosquito control contractor; schedule aerial application, if appropriate• Discuss with local Health Officer whether declaration of a local public health emergency should be considered• Coordinate the response with the Emergency Operations Center• Provide situational status updates to MHOAC if requested• Request public health exemptions from FIFRA (40 CFR 166) and emergency tolerance exemptions (40 CFR 176)
<p>Director of Administrative Services</p> <ul style="list-style-type: none">• Secure state funds and resources, if available, to assist epidemic control efforts• Work with aerial mosquito control contractor to schedule payment for control efforts
<p>Director of Communications</p> <ul style="list-style-type: none">• Conduct full scale media campaign• Implement campaign to notify residents of area-wide adult mosquito control pesticide application• Continue mosquito education and control programs until mosquito abundance or mosquito infection rates are substantially reduced and no additional human cases are detected
<p>Director of Scientific and Technical Services</p> <ul style="list-style-type: none">• Determine flight plan for aerial pesticide application, if appropriate• Continue to compile data for WNV Risk Assessment• Ensure remaining environmental compliance requirements are met• Deploy surveillance equipment for evaluation of pesticide applications

- Notify registered organic growers of area-wide application of public health pesticides

Director of Operations

- Coordinate ecologic investigations of human exposure sites and reporting to OCHCA
- Continue enhanced larval surveillance/ control and reduce larviciding cycle times
- Coordinate adult mosquito control efforts in high risk areas
- Determine target area for ground-based public health pesticide application, if appropriate.
- Determine flight plan for aerial public health pesticide application, if appropriate

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Table 1 – Orange County Mosquito and Vector Control District West Nile Virus Risk Assessment

Table 1. WNV Surveillance Factor	Assessment Value	Benchmark	Value	
1. Environmental Conditions Favorable environmental conditions in Orange County for WNV multiplication/transmission. Considers temperature for prior 2 week period.	1	Average daily temperature ≤ 56°F		
	2	Average daily temperature 57 - 65°F		
	3	Average daily temperature 66 - 72°F		
	4	Average daily temperature 73 - 79°F		
	5	Average daily temperature > 79°F		
			<i>Cx.</i>	<i>Cx.</i>
			<i>quinq.</i>	<i>tarsalis</i>
2. Abundance of adult <i>Culex quinquefasciatus</i> and/or <i>Culex tarsalis</i> Area wide average of adult mosquitoes the last 5 years = mosquitoes/trap night by month.	1	Vector abundance well below average (≤ 50%)		
	2	Vector abundance below average (51 - 90%)		
	3	Vector abundance average (91 - 150%)		
	4	Vector abundance above average (151 - 300%)		
	5	Vector abundance well above average (> 300%)		
3. WNV Infection rate (MLE) in variable pool sizes of <i>Culex quinquefasciatus</i> and <i>Culex tarsalis</i> mosquitoes. Considers pooled data for prior 1 or 2 week period.	1	MLE = 0		
	2	MLE ≥ 0.001 – 1.0		
	3	MLE = 1.1 – 2.0		
	4	MLE = 2.1 - 5.0		
	5	MLE > 5.0		
4. Dead Bird WNV Infection Number of birds that have tested positive (recent infections only) for WNV during the prior 30 days.	1	No WNV-positive dead birds in Southern California		
	2	One or more WNV-positive dead birds in neighboring county		
	3	One WNV-positive dead bird in Orange County		
	4	Multiple WNV-positive dead birds in broad region of Orange County		
	5	Multiple WNV-positive dead birds in specific region of Orange County		
5. Seroprevalence of WNV in free-ranging birds WNV antibody-positive/total sampled biweekly.	2	> 30% seroprevalence		
	3	21 - 30% seroprevalence		
	4	11 - 20% seroprevalence		
	5	< 10% seroprevalence		
6. Human WNV Infections This factor is not included in calculations if no cases are detected in region	3	One or more human WNV infections in neighboring county		
	4	One or more human WNV infections in Orange County		
	5	Multiple human WNV infections in specific region of Orange County		
			<i>Cx.</i>	<i>Cx.</i>
			<i>quinq.</i>	<i>tarsalis</i>
WNV Response Level/Average Rating Normal Season (1.0 to 2.5) Elevated Risk (2.6 to 4.0) High Risk (4.1 to 5.0)	TOTAL			
	AVERAGE			

Table 2 – Average Minimum and Maximum Temperatures (°F) in Orange County, California.

Time Period (biweekly)	2010			2011			2012			2013			2014			5-Year Average		
	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min
Jan 1-15	76	63	49	65	54	43	73	58	42	61	49	37	72	59	45	70	56	43
Jan 16-31	65	56	46	73	59	45	68	56	43	71	58	45	72	59	47	70	58	45
Feb 1-14	66	57	47	69	55	41	69	57	44	62	52	41	67	57	46	67	55	44
Feb 15-28	70	59	48	60	50	41	65	54	42	67	54	40	72	60	48	67	55	44
Mar 1-15	64	54	45	70	57	45	71	57	44	71	58	45	74	62	51	70	58	46
Mar 16-31	74	61	48	66	55	45	64	55	45	69	58	47	71	61	51	69	58	47
Apr 1-15	67	57	47	68	58	47	69	56	43	69	59	49	75	62	49	70	58	47
Apr 16-30	67	58	48	72	62	51	73	62	51	73	61	49	75	64	53	72	61	50
May 1-15	72	61	51	74	61	49	71	61	51	77	65	54	82	69	55	75	64	52
May 16-30	70	61	52	70	60	50	74	64	53	74	65	55	77	67	57	73	63	53
Jun 1-15	74	66	58	73	65	56	73	64	55	74	66	57	78	68	58	75	66	57
Jun 16-31	74	65	56	76	66	56	77	66	54	80	69	57	79	69	59	77	67	56
Jul 1-15	76	67	58	81	71	60	79	68	58	82	72	61	84	73	63	80	70	60
Jul 16-31	78	68	59	79	68	58	79	68	57	78	68	59	84	73	62	80	69	59
Aug 1-15	77	66	55	80	69	57	86	74	62	83	69	55	84	73	63	82	70	58
Aug 16-31	85	71	58	84	70	57	86	75	63	87	74	61	85	73	61	85	73	60
Sep 1-15	79	67	54	82	69	56	88	74	61	88	75	62	90	76	63	85	72	59
Sep 16-30	84	70	55	77	67	57	86	72	58	81	68	56	84	73	61	82	70	57
Oct 1-15	76	67	57	79	65	51	80	68	56	78	66	53	86	72	58	80	67	55
Oct 16-31	70	62	55	74	62	50	77	65	53	75	63	51	79	68	56	75	64	53
Nov 1-15	79	64	50	68	57	45	73	60	47	78	64	50	77	65	53	75	62	49
Nov 16-30	63	52	42	69	58	46	69	59	48	67	58	49	76	63	50	69	58	47
Dec 1-15	71	57	44	63	52	41	66	57	49	65	54	42	69	61	53	67	56	46
Dec 16-30	61	53	46	68	54	41	60	51	41	70	58	45	66	56	46	65	54	44

Table 3 – List of Gravid Trap Locations in Orange County, 2015.

Site Name	City	LATITUDE	LONGITUDE
39 Marsh	Huntington Beach	33.652188	-117.987509
Central Park	Huntington Beach	33.70633	-118.001806
Seal Beach - Hellman	Seal Beach	33.749845	-118.099752
Seal Beach - Leisure World	Seal Beach	33.773958	-118.095089
Pett's Residence	Huntington Beach	33.681454	-117.991867
Fairview Park	Costa Mesa	33.666769	-117.940251
Seal Beach NWS - Nature Center	Seal Beach	33.744892	-118.080668
Westminster Cemetery	Westminster	33.74818	-117.994807
Fairhaven Cemetery	Santa Ana	33.769162	-117.841918
Centennial Park	Santa Ana	33.72119	-117.910417
Grijalva Park	Orange	33.792321	-117.819961
Holy Sepulcher Cemetery	Orange	33.81407	-117.766031
W MAIN STREET	TUSTIN	33.741344	-117.827109
OCMVCD	Garden Grove	33.775497	-117.903915
SJWS	Irvine	33.660505	-117.841037
Aliso Creek	Laguna Hills	33.595058	-117.710332
IVC, Irvine Valley College	Irvine	33.676322	-117.77922
Modjeska Park	Anaheim	33.815466	-117.954318
La Habra (Osornio Park Creek)	La Habra	33.944906	-117.966635
Los Alamitos Race Track	Los Alamitos	33.806482	-118.046184
Anaheim Cemetery	Anaheim	33.843172	-117.900118
Craig Park	Fullerton	33.894518	-117.885981
Forest Lawn Cemetery	Cypress	33.834147	-118.059148
Memory Gardens Cemetery	Brea	33.934612	-117.902757
Miller Basin	Anaheim	33.866413	-117.856114
Ralph B. Clark Regional Park	Fullerton	33.89256	-117.975951
Muckenthaler Cultural Center	Fullerton	33.875414	-117.944426
Oso Creek	Mission Viejo	33.575091	-117.672476
Ortega Equestrian Center	San Juan Capistrano	33.49953	-117.655236
Saddleback College	Mission Viejo	33.547222	-117.661944
San Clemente Skeet Club	San Clemente	33.409465	-117.592236
Vista Terrace	Lake Forest	33.667811	-117.663571
Michelson Dr.	Irvine	33.673654	-117.843569

Table 4 – List of CO2 Trap Locations, Orange County 2015.

Site Name	City	LATITUDE	LONGITUDE
39 Marsh	Huntington Beach	33.652188	-117.987509
(BC) South	Huntington Beach	33.684587	-118.025231
(BC) Harriet Wieder Park	Huntington Beach	33.68896	-118.019877
(BC) North	Huntington Beach	33.708072	-118.040666
Central Park	Huntington Beach	33.70633	-118.001806
Kadane Marsh-LC	Costa Mesa	33.643377	-117.945098
Kadane Marsh-Central	Costa Mesa	33.643377	-117.945098
Pett's Residence	Huntington Beach	33.681454	-117.991867
Fairview Park	Costa Mesa	33.666769	-117.940251
Seal Beach NWS - Torpedo 88	Seal Beach	33.745951	-118.072744
Seal Beach NWS - Gun Range	Seal Beach	33.743059	-118.085266
Seal Beach NWS - Nature Center	Seal Beach	33.744892	-118.080668
Centennial Park	Santa Ana	33.72119	-117.910417
W MAIN STREET	TUSTIN	33.741344	-117.827109
OCMVCD	Garden Grove	33.775497	-117.903915
Peter's Canyon	Orange	33.784894	-117.758989
Villa Park	Orange	33.81407	-117.766031
SJWS	Irvine	33.660505	-117.841037
Bayview Park	Newport Beach	33.653122	-117.868002
Big Canyon – Back Bay	Newport Beach	33.631582	-117.884634
Moulton Res	Laguna Hills	33.621102	-117.73149
Carlson Marsh	Irvine	33.662975	-117.848811
Harvard X University	Irvine	33.657253	-117.838397
Laguna Lakes	Laguna Beach	33.610764	-117.755176
Mason Park	Irvine	33.653493	-117.828902
UCIM #13	Irvine	33.66228	-117.850016
UCIM #14	Irvine	33.663	-117.852
UCIM #20	Irvine	33.655323	-117.85342
UCIM #5	Irvine	33.660195	-117.854598
University at La Vida	Newport Beach	33.647924	-117.864769
Modjeska Park	Anaheim	33.815466	-117.954318
La Habra (Osornio Park Creek)	La Habra	33.944906	-117.966635
Los Alamitos Race Track	Los Alamitos	33.806482	-118.046184
Muckenthaler Cultural Center	Fullerton	33.875414	-117.944426
Arroyo Trabuco G.C., Trabuco Creek	Mission Viejo	33.545719	-117.659839
Coto de Caza - South	Rancho Santa Margarita	33.563714	-117.58829
Coto de Caza North	Rancho Santa Margarita	33.564936	-117.587779

Table 4 Cont. – List of CO2 Trap Locations, Orange County 2015.

Site Name	City	LATITUDE	LONGITUDE
Horno Creek	San Juan Capistrano	33.526194	-117.648425
Ladera Ranch - Arroyo Trabuco Marsh	Ladera Ranch	33.569793	-117.644967
Nichols Institute	Unincorporated OC	33.564205	-117.545294
Oso Creek	Mission Viejo	33.575091	-117.672476
San Clemente Skeet Club	San Clemente	33.409465	-117.592236
Trestles	San Clemente	33.387137	-117.594023
Arroyo Trabuco G.C., Trabuco Creek	Mission Viejo	33.545719	-117.659839
Vista Terrace	Lake Forest	33.667811	-117.663571
Shadow Rock Marsh	Rancho Santa Margarita	33.661392	-117.564722
Serrano Creek	Lake Forest	33.649256	-117.689534
Kite Hill	Laguna Niguel	33.543176	-117.71591
Oso Res	Mission Viejo	33.65987	-117.627349
Severyns Rd	Tustin	33.717077	-117.825311
Robinson Ranch, Plano Trabuco	Rancho Santa Margarita	33.651982	-117.597164
21st and Alona	Santa Ana	33.763257	-117.89359
Romneya Dr. and N West St	Anaheim	33.850771	-117.932236
N. Bristol St & W Park Ln	Santa Ana	33.771996	-117.884815
Townley St & Marty Ln	Santa Ana	33.769379	-117.90684
W. Civic Center Dr. & English St	Santa Ana	33.751474	-117.89665
Monarch St & Blades Av	Garden Grove	33.791689	-118.006764
Burning Tree Rd & Moore Av	Fullerton	33.875828	-117.973553
S Manchester Av & City Bl W	Orange	33.787531	-117.8932
Markon Dr & Patterson Dr	Garden Grove	33.798364	-118.008114
W Chapman Av & N Basque Av	Fullerton	33.873761	-117.950633
Walnut St	La Habra	33.939778	-117.950458
N Schaffer St & E Cumberland Rd	Orange	33.825314	-117.849045

Table 5 – Average Number of *Culex quinquefasciatus* Mosquitoes in Gravid Traps by Month, 2010-2014.

Month	2010	2011	2012	2013	2014	5 Year Average
Jan	9.33	1.17	5.25	7.63	18.56	8.76
Feb	4.98	1.50	6.66	2.25	2.60	4.75
Mar	18.01	0.30	6.02	17.13	2.20	10.82
Apr	19.63	4.13	19.31	18.36	40.56	19.85
May	35.27	6.77	21.24	22.62	18.56	22.12
Jun	42.30	17.53	24.60	21.56	31.21	27.50
Jul	39.55	34.94	22.15	15.93	27.28	27.39
Aug	12.05	34.50	22.25	22.77	43.18	28.54
Sep	5.65	20.33	17.70	16.13	32.15	18.39
Oct	5.00	18.45	14.60	23.76	39.62	22.50
Nov	6.13	17.19	16.67	22.47	33.23	21.59
Dec	3.69	7.58	13.67	16.88	22.83	11.78

Table 6 – West Nile Virus Positive Dead Bird Collections, 2010-2014.

	2010	2011	2012	2013	2014	5 YEAR AVG
Jan 1-15	0	0	0	0	1	0.2
Jan 16-31	0	0	0	0	0	0
Feb 1-14	0	0	0	0	0	0
Feb 15-28	0	0	0	0	0	0
Mar 1-15	0	0	0	0	0	0
Mar 16-31	0	0	0	0	0	0
Apr 1-15	0	0	0	0	0	0
Apr 16-30	0	0	0	0	0	0
May 1-15	0	1	0	0	0	0.2
May 16-31	1	1	0	0	0	0.4
Jun 1-15	0	0	0	1	6	1.4
Jun 16-31	0	2	0	0	3	1
Jun 1-15	1	0	1	1	9	2.4
Jun 16-30	1	0	0	1	12	2.8
Jul 1-15	1	6	3	1	30	8.2
Jul 16-31	2	2	5	10	77	19.2
Aug 1-15	2	3	13	6	82	21.2
Aug 15-31	5	6	31	2	45	17.8
Sep 1-15	0	13	25	6	53	19.4
Sep 16-30	0	9	15	3	68	19
Oct 1-15	3	2	13	3	24	9
Oct 15-30	0	2	2	4	14	4.4
Nov 1-15	1	1	2	1	11	3.2
Nov 15-30	0	0	0	0	4	0.8
Dec 1-15	0	0	0	0	0	0
Dec 16-31	0	0	0	0	4	0.8

Table 7 – Herd Immunity (% seropositive) for House Finches by Quarter and Number of Human Infections (2008-2014), Orange County.

Year	Quarter	% WNV-Seropositive	Number of Human Cases with Known Onset Date
2008	Jan-Mar	9.91	0
	Apr-Jun	2.39	2
	Jul-Sep	8.12	68
	Oct-Dec	18.90	1
2009	Jan-Mar	13.02	0
	Apr-Jun	5.18	1
	Jul-Sep	3.30	2
	Oct-Dec	3.16	1
2010	Jan-Mar	2.42	0
	Apr-Jun	4.49	0
	Jul-Sep	0.00	1
	Oct-Dec	3.23	0
2011	Jan-Mar	11.90	0
	Apr-Jun	6.28	0
	Jul-Sep	11.84	8
	Oct-Dec	22.46	2
2012	Jan-Mar	16.00	0
	Apr-Jun	7.78	0
	Jul-Sep	9.75	36
	Oct-Dec	28.21	7
2013	Jan-Mar	20.21	0
	Apr-Jun	14.95	0
	Jul-Sep	8.43	6
	Oct-Dec	12.50	4
2014	Jan-Mar	7.38	1
	Apr-Jun	9.09	2
	Jul-Sep	45.19	232
	Oct-Dec	60.78	14

Table 8 – Location of Free-Ranging Bird Traps, Orange County 2010-1015.

Location	City	Latitude	Longitude
OCMVCD	Garden Grove	33.775497	-117.903915
Modjeska Park	Anaheim	33.815466	-117.954318
Anaheim Cemetery	Anaheim	33.843172	-117.900118
Blooms	Tustin	33.765149	-117.806015

Table 9 – Human West Nile Virus Infections, Orange County, 2004-2014.

Year	Total Human Infections (Deaths)
2004	64 (4)
2005	17 (0)
2006	7 (0)
2007	10 (0)
2008	79 (3)
2009	4 (0)
2010	1 (0)
2011	10 (0)
2012	48 (2)
2013	12 (0)
2014	280 (9)
Grand Total	532 (18)

Figure 2 – Map of CO2 Trap Locations in Orange County, 2014.

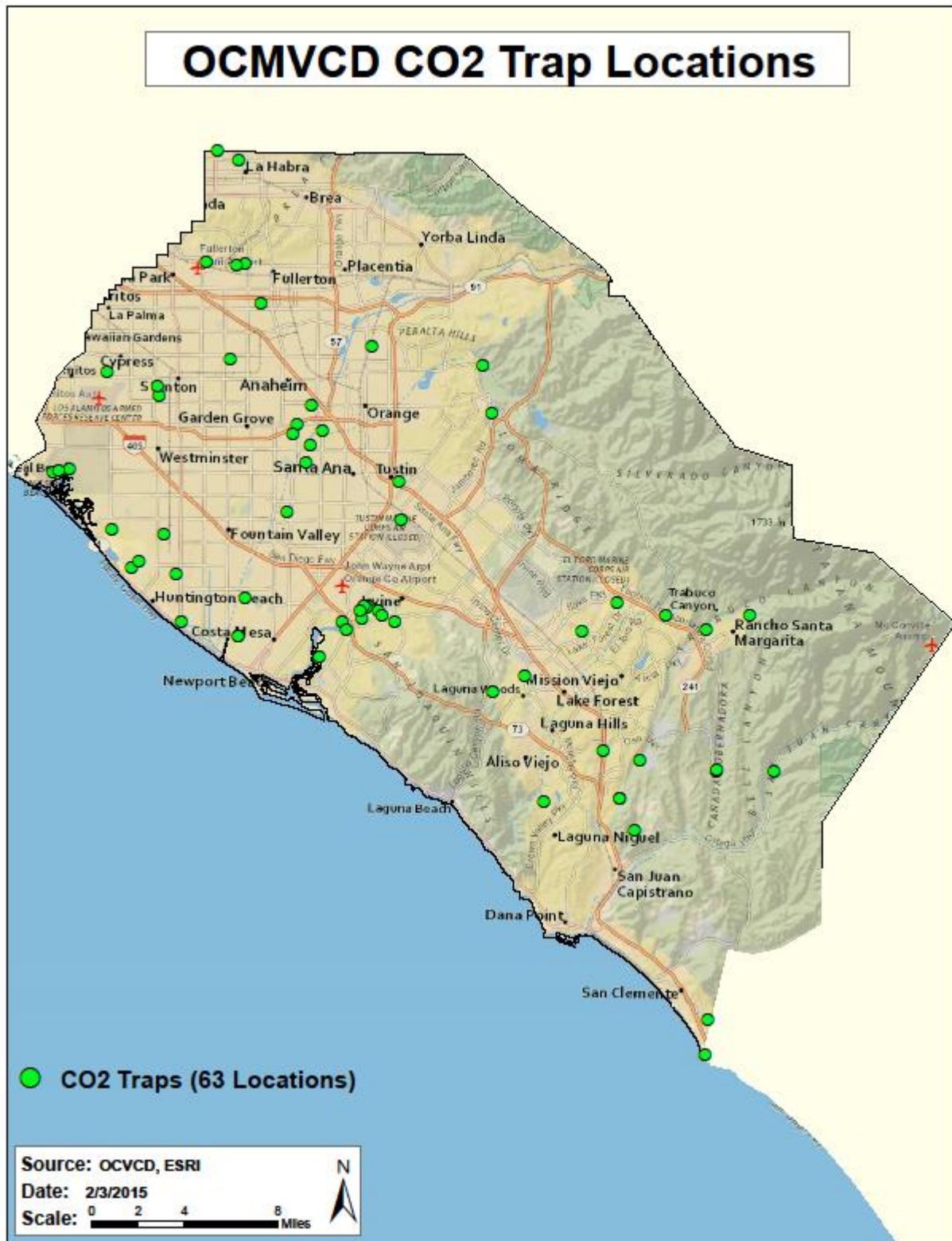


Figure 3 – Map of Free-Ranging Bird Traps, Orange County, 2014.



Figure 4 – Historical Human WNV Infections by Disease Onset Week, Orange County, 2004 – 2014.

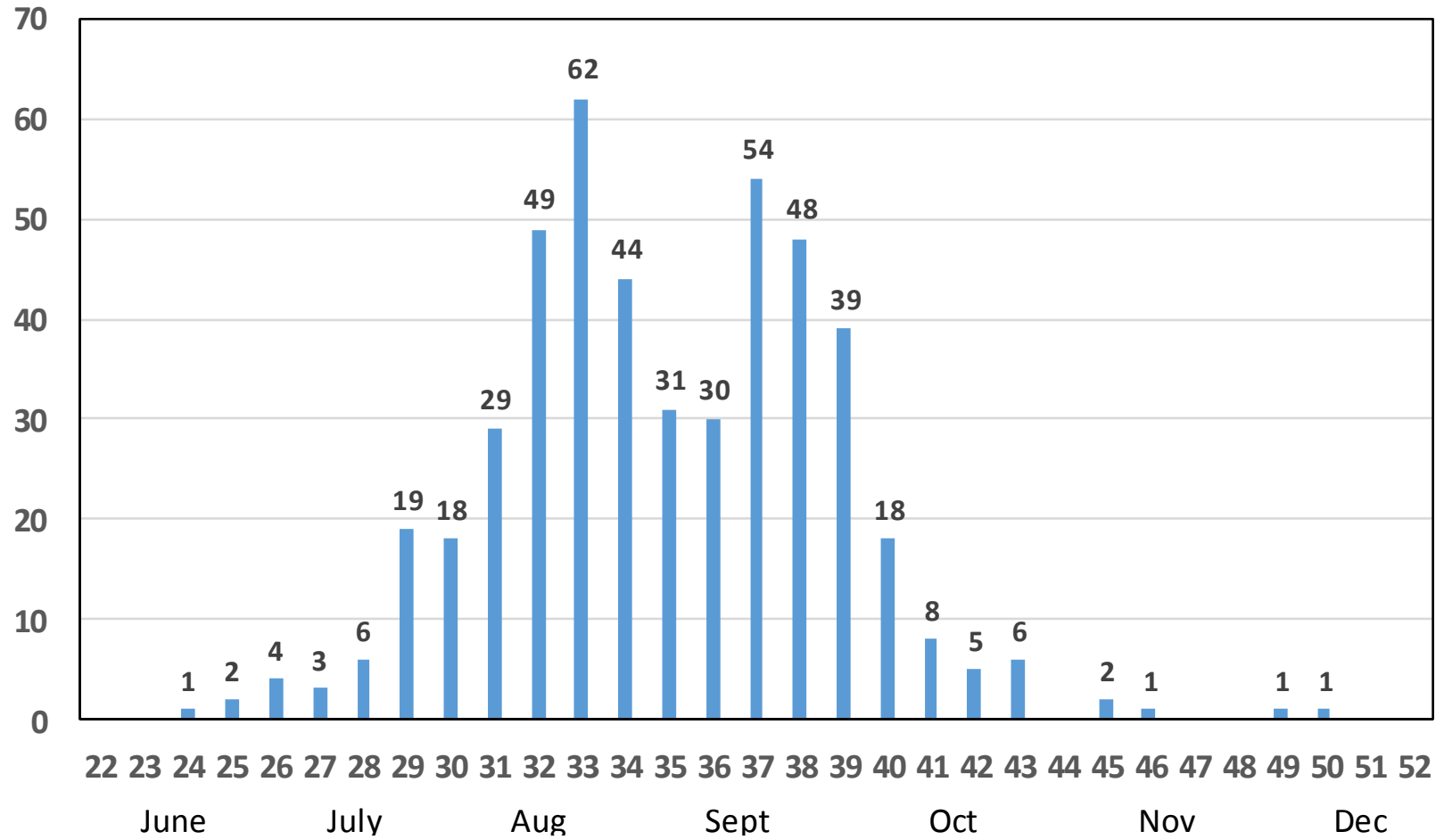
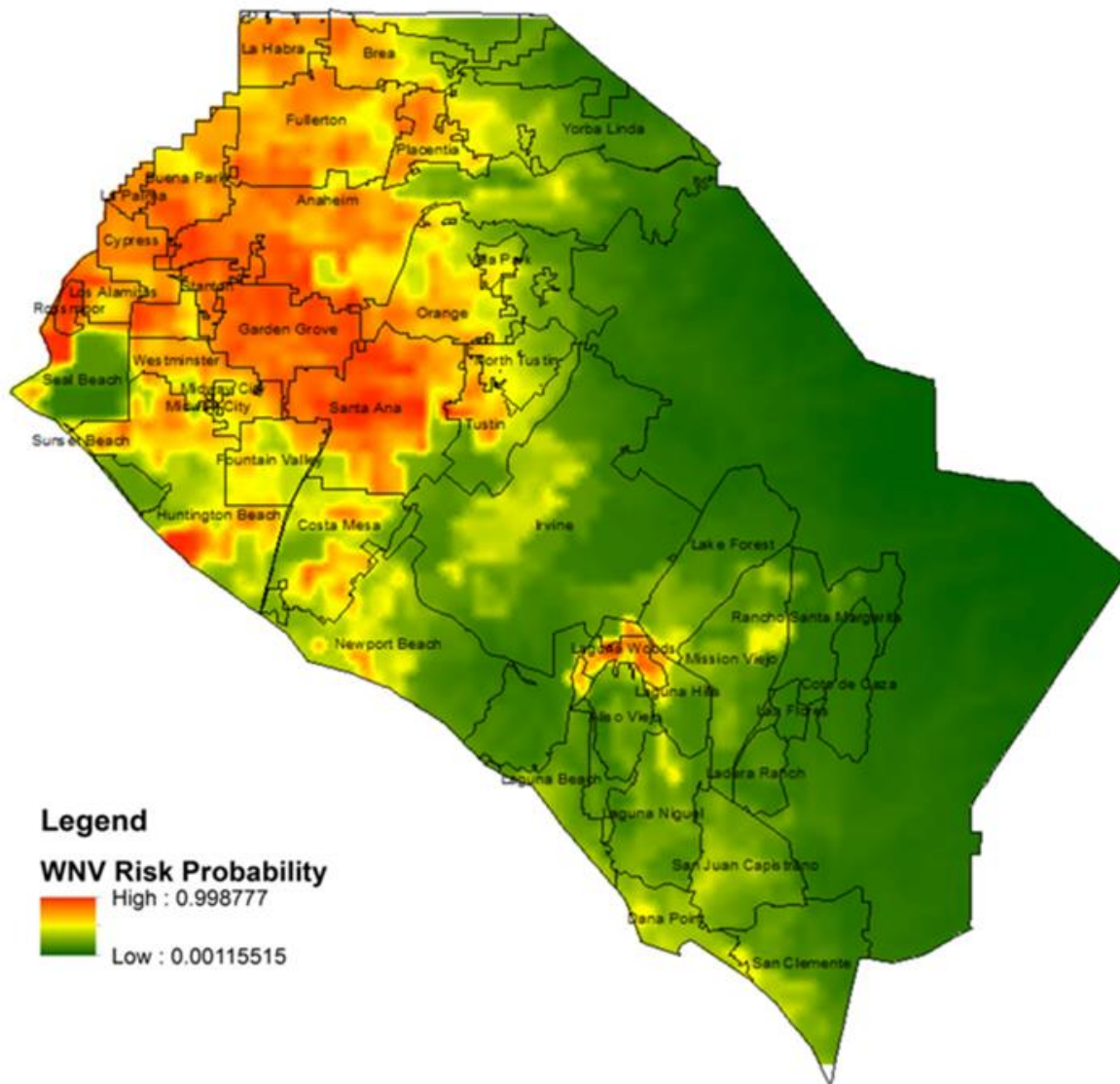


Figure 5 – WNV High Risk Area Based on Environmental and Historical Surveillance Factors, 2004-2013.



Appendix A

Appendix B
