

Final Report
San Diego County Eye Gnat Research and
Education Project 2016-17
Escondido

Biology and Control of the Eye Gnat
Liohippelates collusor

Bryan Vander Mey, Leah Taylor, and James A. Bethke
University of California Cooperative Extension, San Diego
9335 Hazard Way, Suite 201
San Diego, CA 92123

CONTENTS

PROJECT LEADERS AND OBJECTIVES	3
BACKGROUND	4
INTRODUCTION	5
EXECUTIVE SUMMARY	6-7
OBJECTIVE #1 – LABORATORY AND GREENHOUSE STUDIES Soil Samples Used to Determine Source of Eye Gnat Development	8-9
OBJECTIVE #2 – ANNUAL ADULT EYE GNAT COLLAR TRAPPING Adult Eye Gnat Population Density Study in South Escondido	10-13
OBJECTIVE #3 – POTENTIAL EFFECTS OF WIND DIRECTION AND INTENSITY ON MIGRATION OF ADULT EYE GNATS	
OBJECTIVE #4 – EMEREGENCE TRAPPING Study of Landscape Groundcover as Potential Breeding Site of Eye Gnats	16-18
OBJECTIVE #6 – PROVIDE ADDITIONAL SERVICES AS NEEDED ON EYE GNAT REALTED ISSUES Investigation into the Source of Adult Eye Gnats Around Trap DEH#19	19-21
EXTENSION ACTIVITY	22
APPENDIX I Figures and Photos	23-32
APPENDIX II Weather data	33-39

PROJECT LEADERS:

James A. Bethke, Floriculture and Nursery Farm Advisor, UCCE San Diego

Bryan Vander Mey, Staff Research Associate, UCCE San Diego

Leah Taylor, Agricultural Technician, UCCE San Diego

RESEARCH PROJECT GOALS 2016-17

- Continue laboratory /greenhouse trials on the biology and control of eye gnats.
 - Continue studies on methods of control for eye gnat larvae and adults.
 - Continue studies on the ability of eye gnat eggs to survive and develop in response to dehydration and rehydration.
 - Study the effects of various compost compositions on eye gnat larval development and survival.
- Continue grid trapping to document eye gnat population dynamics.
 - Continue area-wide trapping on a grid system to determine annual abundance and the population dynamics of eye gnats over time.
 - Conduct critical mitigation trapping in one canyon between Inspiration Lane, Beethoven Drive, Huckleberry Lane, and Sierra Linda Drive in South Escondido
- Conduct studies on the effect of wind direction and intensity has on the migration of eye gnats into local canyons and residential areas
- Conduct emergence trap studies
 - Investigate potential eye gnat reproductive sources in the Lake Hodges vicinity, agricultural areas, and surrounding community areas (turf and landscape).
- Extend and educate the public on eye gnats and their control.
- Provide additional services as needed on eye gnat related issues.

BACKGROUND

Eye gnats are prevalent in the Southern United States, primarily in parts of California and Arizona. In San Diego County, especially in the Jacumba and Escondido areas, they have been a problem for many years and are the source of numerous citizen complaints to Departments of Environmental Health - Vector Control, and Agriculture Weights and Measures. Research has determined that local agriculture is the source of the problem, and the community residents are looking to the County for a solution. Eye gnats are problems in other agricultural areas in Southern California and have been extensively studied for more than a century. These nuisance problems have been successfully addressed by identifying the source, altering land management practices, implementing integrated pest management (IPM), and conducting a sound public outreach and education program.

Benefit to the County

In utilizing our technical and expert resources with UCCE, we can more efficiently offer the County's residents easier access to current and applicable information and educational opportunities to understand and manage the eye gnat problem. Increased awareness of this problem, its causes and possible solutions will assist county departments in dealing with citizen complaints.

Introduction

The eye gnat (*Liohippелates* and *Hippelates* spp.) has been a nuisance pest since the turn of the 20th century. *Liohippелates collusor* (Townsend), formerly known as *Hippelates collusor* in the scientific literature is the primary species in southern California and was implicated in an epidemic of bacterial conjunctivitis (pinkeye) in the Coachella Valley California and in the southern U.S. (Anonymous 1929, Buehler et al. 1983). There is no scientific evidence, however, to substantiate the inference. Eye gnats created problems in other cultivated areas such as the Imperial and San Joaquin valleys of California. In addition, they are present in many desert areas of California, such as the Mojave Desert, and could create problems if and when such areas are intensively cultivated and irrigated.

Problems are heightened when irrigated agriculture is in close proximity to urban areas. Research has shown that irrigated agriculture provides good reproductive potential for eye gnat production (Mulla 1963). However, female gnats need a protein food source (mucus, blood, scabs, etc.) in order to produce their young and that protein source is largely unavailable in agriculture. Therefore, since eye gnats can disperse approximately 4 miles both upwind and downwind, humans and domesticated animals living in close proximity to eye gnat producing areas can become a food source.

EXECUTIVE SUMMARY

Introduction

Trials were completed with the help of the City of San Diego, San Dieguito River Park, Kit Carson Park, The Pinery and the Center for Applied Horticultural Research in Vista, CA.

OBJECTIVE #1 – Laboratory and Greenhouse Studies.

- Seventeen soil samples were taken from various potential breeding sites in South Escondido, brought to the laboratory and monitored for adult eye gnat emergence. No adult eye gnat emergence was observed from any collected soil sample during this term.

OBJECTIVE #2 – Annual Adult Eye Gnat Collar Trapping

- Adult eye gnats were collected for four consecutive days during the months of July, August, September and October. Traps were placed in the same locations as in previous years. During the 2016 trapping season we collected an average of 12.84 gnats/trap/day. This is down from 45.28 gnats/trap/day collected the previous year, 2015. Traps counts in 2016, showed an overall decrease of 95% in the number of adult gnats caught compared to 2011 and a decrease of 71% from the previous year. Historical data has not indicated a clear, monthly population peak throughout the typical eye gnat season (July-Oct) suggesting that an overall seasonal average of eye gnats per trap per day was the best indicator of local or regional population trends. The lack of a peak during any one month of data is likely due to changing environmental conditions (temperature, rainfall events, wind, etc.) during shorter intervals such as weeks or specific groups of days.

OBJECTIVE #3 – Potential Effects of Wind Direction and Intensity on Migration of Adult Eye Gnats

- Data collected during the DEH#19 trap (Department of Environmental health trap #19) study showed a dominate wind direction from the WSW at a maximum average velocity of 1.45 mph during 12-4 p.m. Wind velocity was low enough during the early morning and evenings of the study period to allow for eye gnat flight.

OBJECTIVE #4 – Emergence Trapping

- Adult eye gnats were captured in emergence traps that were placed in various landscape groundcovers used on the hillsides in the Sonata neighborhood in south Escondido. The impact that these emerging eye gnats have on the overall adult eye gnat population in the area is unknown, and further investigation is warranted.

OBJECTIVE #5 – Extend and Educate the Public on Eye Gnats and Their Control

- Meetings were attended and data shared to community leaders, the farm, and the county. Information was made available on the Internet.

OBJECTIVE #6 – Provide Additional Services as Needed on Eye Gnat Related Issues

- A special investigation was requested by county staff that was based on large numbers of adult eye gnats captured in DEH#19 (Department of Environmental health trap #19). Collar traps were placed equidistant from DEH#19 in an attempt to determine the direction of travel of adult eye gnats or a potential eye gnat source. During the course of this study, the traps located nearest to Highland Valley Road and in a relatively straight line captured the highest number of gnats. However, the directional source of the adult eye gnats could not be determined. Further, extensive surveys of soil and plants in the surrounding area did not produce any emerging eye gnat adults. Collar traps placed just north or south along the road captured low numbers of adult eye gnats, which contradicts eye gnat studies of the past that indicate eye gnats preferred sheltered areas like brush or dense landscape. Further study of the area is warranted.

OBJECTIVE #1 – Laboratory and Greenhouse Studies

INVESTIGATION OF SUSPECTED EYE GNAT LARVAL AND PUPAL POPULATIONS

Objective

The intention of the following study is to try to identify sources of eye gnat immature stages (larvae and pupae) in various soils and from under different plant types in the surrounding impacted areas. It is well known that eye gnat larvae need moist friable soil that contains organic matter in order to develop and reproduce. Further, eye gnat larvae tend to pupate near the soil surface. Therefore, taking samples from the soil surface can provide an indicator of a good eye gnat-producing source.

Materials and Methods

Sampling: Seventeen separate soil samples were taken from different locations (Table 1) and depths consistent with high collar trap or emergence trap finds. Samples were taken to the laboratory and placed in cages and observed for eye gnat adult emergence. Soil was held in cages for at least one eye gnat life cycle to make sure any eye gnat eggs laid in the soil would develop to an adult during the study period (approx. 30 days).

Cage type: Soil was placed in a fourteen-quart translucent plastic tub (Figure 1). A circular hole was cut in the top of the tub and a funnel inverted and glued over the hole. A hole was cut in the lid of a 40-dram plastic vial, which was inverted and placed over the narrow end of the funnel. The light from above attracts adult eye gnats through the funnel opening and into the 40-dram vial.

Table 1. The sites where soil samples were taken in south Escondido are described. Soil samples were taken to the lab on three separate dates, placed in plastic tubs and observed over time for eye gnat adult emergence.

Date Taken	Sample #	Sample Site Description
7/16	1	Mulch from compost mountain at nursery, nearest living plant: palms
7/16	2	Sand from compost mountain at nursery, nearest living plant: palms
7/16	3	Rootball of bunchgrass in dry creek bed along Highland Valley
7/16	4	Loose dirt under bunchgrass in dry bed along Highland Valley
8/8	1	Dirt from under palm fronds at nursery, south
8/8	2	By trap UC#22 from grid, sandy dirt, nearest plants: oak, dry weeds, bunchgrass
8/8	3	Dirt from under palm fronds at nursery, north
8/8	4	Inspiration Way, from dry dirt in a dry gully
8/8	5	Potting soil collected from palm planter box at nursery
8/8	6	East side of Beethoven, next to emergence trap 3, hill with ice plant

8/8	7	East side of Alton, next to emergence trap 7 Alton West, hill with ice plant
9/29	1	Trap DEH#19 study- dirt next to trap NE, surrounded by willow on three sides
9/29	2	Dirt from palm planter box at nursery: Palm
9/29	3	Dirt from under fallen palm fronds at nursery
9/29	4	Dirt from next to Emergence Trap Alton W in Sonata landscape
9/29	5	Dirt from next to Emergence Trap Beethoven S in Sonata landscape
9/29	6	Dirt from next to Emergence Trap Beethoven N in Sonata landscape

Results

None of the samples taken from any site on any date produced adult eye gnats.

Objective #2 – Annual Adult Eye Gnat Collar Trapping

ADULT EYE GNAT POPULATION DENSITY STUDY IN SOUTH ESCONDIDO

Objective

This study documents the annual eye gnat population dynamics (changes in size and dispersion) in the general area of south Escondido.

Materials and Methods

Experimental Unit- UCCE based 4-hole collar traps were used for monitoring. The lower portions of the trap are painted flat black and the top portion is clear plastic (Figure 2 & 3). Traps were attached to 3' wooden stakes using electrical tape. Putrefied egg was added as standard eye gnat bait to the lower PVC container.

Experimental Design- Twenty-three collar traps were placed on a 5-trap by 5-trap grid pattern approximately one-half mile apart (Figures 4 & 5) in south Escondido. Trap numbers in Table 2 correspond to the numbers on the pins in Figure 5. Trap UC#7 is not present in the study because Lake Hodges precluded its placement. Trap UC#16 was discontinued after 2011 because of its difficult accessibility within a gated community.

Sampling- Trap tops containing captured adult eye gnats collected over a four consecutive day period in the months of July-October. Trap tops were removed and replaced by a clean trap top. The trap tops with the eye gnats were placed in a Ziploc bag to prevent any gnats from escaping, brought back to the laboratory, and placed in the oven overnight to kill the gnats. Eye gnats were separated from other fly species, counted and recorded.

Analysis – Data were analyzed using descriptive statistics. Selected data sets were pooled in search of trends.

Results

Table 2 lists the annual mean number of adult eye gnats captured/trap/day in traps located a half mile apart on a grid delineated by GPS coordinates first established in 2011 (Figure 5). The means from table 2 are graphed below and an additional figure shows data only for the month of October 2011-2016. Overall population in 2016 was down compared to the proceeding two years. The main difference in 2016 was that traps UC#4, UC#10, UC#15, and UC#18 showed a significant decline of the number of gnats/trap/day compared to previous years.

Eye gnats are concentrated adjacent to a local organic farm (Table 4) with nearly twice as many gnats as those traps within one half mile of the farm (23.78 gnats/trap/day vs. 14.12 gnats/trap/day). Traps within residential areas recorded an average of 12.29 adult eye gnats/trap/day.

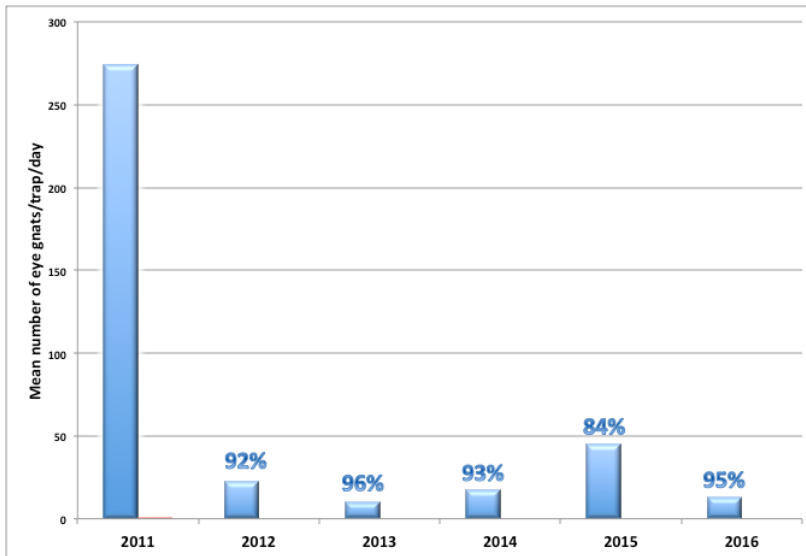
Traps counts in 2016, showed an overall decrease of 95% in the number of adult gnats caught compared to 2011 and a decrease of 71% from the previous year.

Table 2. Mean number of eye gnat adults/trap/day from 23 traps throughout south Escondido. Traps were located a half-mile apart on a grid delineated by GPS coordinates (Figure 5) first established in 2011. Data were collected on four consecutive days from June through October.

Trap UC#	2011*	2012	2013	2014	2015	2016
1	86.50	2.24	0.75	2.44	3.64	3.67
2	25.00	11.13	3.00	0.56	2.28	0.44
3	183.25	47.13	5.13	12.43	62.19	25.73
4	417.00	14.05	31.88	59.69	90.80	5.65
5	50.00	3.80	0.88	3.96	11.67	0.22
6	15.00	1.38	0.63	6.27	6.31	2.65
8	130.50	100.18	9.35	15.44	45.39	10.93
9	44.00	21.50	15.25	7.56	51.67	8.83
10	283.00	3.40	18.88	18.25	41.47	5.71
11	289.75	14.18	3.38	11.67	6.53	3.75
12	63.00	5.64	0.63	5.25	6.31	0.58
13	317.25	8.18	10.63	9.68	10.69	4.27
14	271.67	5.46	2.63	4.21	7.00	2.31
15	354.00	37.00	16.25	49.43	40.75	16.28
16	4.25	n/a	n/a	n/a	n/a	n/a
17	167.75	0.95	3.25	5.08	8.44	1.40
18	763.25	16.38	73.13	32.49	99.89	11.21
19	1050.00	70.98	10.9	31.69	98.36	60.03
20	386.00	110.05	19.13	132.06	260.36	77.16
21	8.67	3.63	0.25	6.67	1.69	0.79
22	1083.00	13.33	3.88	34.73	144.86	35.49
23	119.25	5.30	1.38	9.69	1.53	3.27
24	384.00	14.05	2.88	12.13	30.89	13.98
25	81.00	8.75	0.75	12.58	8.81	0.88
Mean	274.06	22.9	10.2	17.75	45.28	12.84

* Data collected only in month of October 2011

Graphic representation of annual mean from table 2. Percentages represent change from 2011 baseline.



Mean number of captured adult eye gnats/trap/day during a one-week period in the month of October for each year of data collected. Gnats were collected using UCCE collar traps as part of the historical grid sampling in south Escondido, CA.

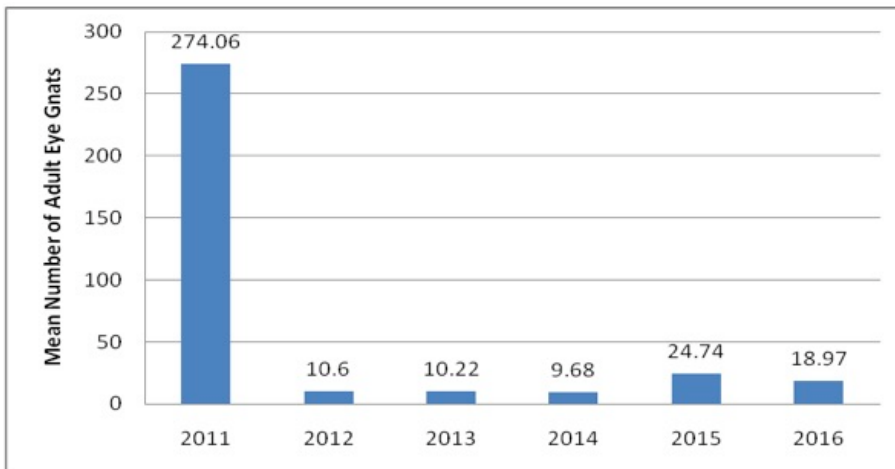


Table 4. Grouping of selected UC traps into areas of interest in 2016. Gnats were collected using UCCE collar traps as part of the historical grid sampling in south Escondido, CA.

Description of Area	UC Trap Numbers	# of Traps	Mean Gnats/Trap/Day	Importance
Proximity to Organic Farm	8, 9, 10, 15, 20	5	23.78	Population potential near the farm
South of farm (Highland Valley Rd)	2, 3, 4, 5	4	8.01	Proximity to the farm but across open space
West of I-15	1, 6, 11, 21	4	1.14	Furthest from the farm, across freeway
Traps within a half mile of the farm	3, 4, 5, 13, 14, 19, 25	7	14.12	Half mile proximity to farm
Traps greater than a mile of the farm	1, 17, 21, 22, 23	5	7.75	Mile proximity to farm
Traps in open areas	2, 3, 4, 5, 6, 12, 17, 22	8	9.02	Natural environment
Traps within residential areas	11, 13, 14, 19, 21, 24, 25	7	12.29	Residential landscaping

Objective #3 – Potential Effects of Wind Direction and Intensity on Migration of Adult Eye Gnats

Objective

As part of the investigation into the high number of adult eye gnats caught in DEH#19 trap, an anemometer was installed to measure the wind speed and direction in the proximity of the trap.

Materials and Methods

Experimental Unit- RainWise®Windlog™ Wind Data Logger. WindSoft software. Unit was placed off Highland Valley Road in south Escondido, CA (GPS coordinates: 33°03'26.99"N, 117°01'54.17"N, Figure 4). Data were collected at different times during the month of July, 2016.

Results & Discussion

Wind data collected during the DEH#19 study showed a dominant direction from the WSW at an average of 0.55 mph from the hours of 8 a.m. to 12 p.m. The direction shifted slightly more westerly in the hours of 12 p.m. to 4 p.m. with an average of 1.45 mph. Wind during this time had a low variance in speed and direction. From the hours of 4 p.m. to 8 p.m., the wind averaged almost directly from the west at an average speed of 1.07 mph. Average wind velocities were low enough during daylight hours in month of July to allow for eye gnat flight (Gerhardt & Axtell, 1972).

Since average wind velocities at this time of year are low enough to allow adult eye gnat flight, it is possible that the gnats are being 'pushed' to this location. The data suggests an eye gnat source upwind from the traps, but extensive surveys during this annual cycle and in previous years have not indicated a source in that direction.

Table 5. Data collected from RainWise®Windlog™ Wind Data Logger and summarized into three time periods. (Direction of wind from origin: 90=east, 180=south, 270=west, 360=north) Speed recorded in miles/hour.

Date	Direction			Speed (mph)		
	8-12pm	12-4pm	4-8pm	8-12pm	12-4pm	4-8pm
7/5/2016	n/a	239	275	n/a	1.34	1.19
7/6/2016	250	248	260	0.61	1.56	0.95
7/7/2016	220	256	280	0.54	1.35	1.13
7/8/2016	267	240	268	0.45	1.33	1.08
7/9/2016	232	258	266	0.43	1.68	1.19
7/10/2016	268	248	277	0.66	1.44	1.38
7/11/2016	158	265	257	0.74	1.74	0.99
7/12/2106	202	253	266	0.45	1.29	1.16
7/13/2016	209	250	276	0.53	1.4	1.2
7/14/2016	245	260	272	0.36	1.34	0.85
7/15/2016	266	258	283	0.48	1.34	1.05
7/16/2016	194	244	263	0.61	1.38	0.83
7/17/2016	243	246	264	0.65	1.44	0.99
7/18/2016	183	248	276	0.61	1.63	1.09
7/19/2016	253	231	277	0.44	1.53	1.16
7/20/2016	226	212	233	0.41	1.34	0.81
7/21/2016	225	232	268	0.43	1.24	0.93
7/22/2016	252	237	252	0.47	1.49	0.99
7/23/2016	257	222	259	0.53	1.58	0.86
7/24/2016	255	252	257	0.83	1.04	0.83
7/25/2016	162	253	283	0.26	0.73	0.93
7/26/2016	248	250	271	0.58	1.43	1.13
7/27/2016	242	251	252	0.64	1.48	0.86
7/28/2016	225	232	243	0.47	1.37	1.02
Mean	240.0909	255.8696	277.3043	0.553636	1.456087	1.069565

Objective #4 – Emergence Trapping

INVESTIGATION OF LANDSCAPE GROUNDCOVER AS POTENTIAL BREEDING SITE OF EYE GNATS

Objective

The purpose of this study was to determine if landscape groundcover in the local community of south Escondido is a potential breeding site for eye gnat development and a contributing source of eye gnats.

Materials and Methods

Trap type: Emergence traps consisting of a 3 X 3 X 1 feet PVC frame, covered with black cotton cloth. An inverted nalgene funnel with a pint mason collection jar was placed in one corner of the trap to collect flying insects (Figure 6).

Sampling: Jars were collected every 1-3 days. Content of the jars was sorted, counted and recorded in the laboratory at the Center for Applied Horticultural Research in Vista, CA.

Trial 1.

Seven emergence traps were placed at various locations within the Sonata neighborhood from August 8 to August 24, 2016 (Figures 4 & 7). Table 5 lists the location and description.

Table 5. Total number of adult eye gnats captured, the trap locations and a description of the area where the traps were placed in south Escondido.

Trap Number	Location on Figure 6	GPS Coordinates		Location and Description	Total Number of Gnats
		North	West		
1	A	33°03'59.90"	117°03'23.40"	Corner of Primrose and Huckleberry, red apple	3
2	B	33°03'52.62"	117°03'25.17"	Along Beethoven on hill, furthest north, ice plant	12
3	C	33°03'51.78"	117°03'25.62"	Along Beethoven on hill, between north and south, ice plant	2
4	D	33°03'51.02"	117°03'25.76"	Along Beethoven on hill, furthest south, ice plant	58
5	E	33°03'55.39"	117°03'05.91"	In dry drainage wash	0
6	G	33°03'51.93"	117°02'56.74"	Alton Way, on hill, red apple, east	16

7	F	33°03'52.21"	117°02'57.23"	Alton Way, on hill, red apple, west	1
---	---	--------------	---------------	----------------------------------------	---

Trial 2.

Based on the results from Trial 1, groups of traps consisting of four traps each were placed in areas with a higher number of gnats caught (Figure 7). This trial was run from August 29 to September 13. Table 6 lists the location and description of where the traps were placed while Table 7 gives the number of adult eye gnats captured in the individual traps.

Table 6. Emergence trap location and description in south Escondido

Trap Number(s)	Letter on Figure 6	GPS Coordinates		Trap Location and Description
		North	West	
1,2,3,4	H	33°03'53.41"	117°03'24.77"	Beethoven North- Dry Soil. On Beethoven, top of hill in dry dirt
5,6,7,8	B	33°03'52.62"	117°03'25.17"	Beethoven North- Wet Soil. On Beethoven, by original North Trap, in wet ice plant
9,10,11,12	D	33°03'51.02"	117°03'25.76"	Beethoven South. On Beethoven, by original South Trap, in wet ice plant
13,14,15,16	F	33°03'51.93"	117°02'56.74"	Alton West. On Alton, by original Alton W trap, in wet red apple
17	G	33°03'52.21"	117°02'57.23"	Alton East. On Alton, same as trap 6 in trial 1, in wet red apple

Table 7. Total number of adult eye gnats captured in individual emergence traps.

Trap Number and Description	Total Number of Adult Eye Gnats (14 days)
Beethoven- North Dry Soil- Trap 1	0
Beethoven- North Dry Soil- Trap 2	0
Beethoven- North Dry Soil- Trap 3	0
Beethoven- North Dry Soil- Trap 4	0
Beethoven- North Wet Iceplant- Trap 5	2
Beethoven- North Wet Iceplant- Trap 6	4
Beethoven- North Wet Iceplant- Trap 7	12
Beethoven- North Wet Iceplant- Trap 8	11
Beethoven- South Wet Iceplant- Trap 9	11
Beethoven- South Wet Iceplant- Trap 10	1
Beethoven- South Wet Iceplant- Trap 11	95
Beethoven- South Wet Iceplant- Trap 12	34
Alton West- Trap 13, red apple	35

Alton West- Trap 14, red apple	0
Alton West- Trap 15, red apple	109
Alton West- Trap 16, red apple	13
Alton East- Trap 17, red apple	100

Results

Adult eye gnats were emerging from the irrigated ground cover used for erosion control on the hillsides in the Sonata community. Some locations indicated that a significant source of eye gnats could be present and developing within the succulent patches. Eye gnats were commonly found in both iceplant (*Delosperma* spp.) and red apple (*Aptenia* spp.) plantings. No eye gnats were found coming from non-irrigated or native habitats. These data suggest that further study of these areas and the potential for these succulents to produce eye gnats is warranted. Laboratory studies are underway to determine the potential for these plants to be hosts (food source) for the eye gnat larvae.

Objective #6 – Provide Additional Services as Needed on Eye Gnat Related Issues

INVESTIGATION INTO THE SOURCE OF ADULT EYE GNATS AROUND TRAP DEH#19

Objective

Previous studies indicated that DEH#19 is located in an area not know to produce eye gnats. However, this trap is consistently filled with high numbers of adult eye gnats and is clearly an anomaly requiring investigation. This study was conducted to determine the potential source of eye gnats that constantly fill DEH#19.

Materials and Methods

Experimental Unit- Modified PVC UCCE designed 4-hole collar traps were used for monitoring. The lower portions of the trap are painted flat black and the top portion is clear plastic (Figure 2 & 3). Traps were attached to 3' wooden stakes using electrical tape. Putrefied egg was added as standard eye gnat bait to the lower PVC container.

Experimental Design- Collar traps were placed 200 feet away in a circular pattern around DEH#19 in south Escondido to determine a possible direction in which the gnats were traveling to get to trap DEH#19 (Figure 8). Once the initial survey was done, additional traps were set an additional 200 feet from the previous trap(s) with the highest counts to try to determine direction of travel of adult eye gnats.

Experimental Design and Sampling- The initial traps were placed on July 5, 2016, and the last traps removed on August 19. Eye gnats were collected and counted daily from each trap for a period on 3-4 days for each consecutive region trial. Three sets of data were collected.

Initial Survey

Eight traps were placed at forty-five degree angles from a center position, the location of trap DEH#19 (nine traps total) (Figure 8). Each trap was placed 200 feet from trap DEH#19. Table 8 is a description of the surroundings of the traps with Table 9 listing the number of gnats caught.

Table 8. Trap location in reference to the center trap, DEH#19. The area surrounding each trap is briefly described for reference.

Trap Location	Surroundings
Center	In dirt and leaf debris. Next to gully with large oaks and willows, open space to one side (driveway, road)
North	In dead grass open space, dead trees 20 feet in most directions
South	In gully south of center, surrounded by green bunch grasses and overgrowth
East	In 4' tall brush/weeds, surrounded on all sides
West	Near road, open on 3 sides, large oak on road facing side
Northeast	Along fence line, fence on one side, dry tall brush/weeds on other side
Southeast	Along road into facility, surrounded by dry tall brush/weeds
Northwest	Near gully across from center, surrounded on all sides by tall willow/oaks
Southwest	Up large hill, approx. 400' elevation, surrounded on all sides by dry brush/weeds

Table 9. Total number of adult eye gnats caught per trap from July 5 – 22, 2016

Trap Name	Figure 6 letter correlation	Total number of eye gnats captured	Average # eye gnats/trap/day
Center	A (trap # DEH19)	339	24.2
North	B	12	0.8
South	F	7	0.5
East	D	40	2.8
West	H	75	5.3
Northeast	C	424	30.2
Southeast	E	39	2.7
Northwest	I	16	1.1
Southwest	G	113	8.1

Initial Survey Results

Traps C&G captured the most eye gnats, and when the three traps including DEH#19 was added, it formed a straight line. Therefore, we decided to place traps along that line and continue to investigate.

Second Survey

From the results of the initial study data, we decided to place additional traps 200 feet parallel to the southwest and northeast traps (Figure 9). Surveys were conducted between July 25 and August 12 with five sets of data being collected. Table 10 lists the number of gnats caught during the time period.

Table 10. Total number and average of gnats caught (Second Survey)

Trap Name (Figure 8)	Total number of gnats caught	Average # gnats/trap/day
J	33	6.6
G	2	0.4
A (trap DEH#19)	25	5.0
C	76	15.2
K	160	32.0

Second Survey Results

Again, a high numbers of gnats were caught in the northeast quadrant with less caught in the southwest quadrant. From these data, we decided to investigate the northeast quadrant since it consistently had higher numbers during the first two phases.

Third Survey

Three additional traps were placed using trap K as a center point (Figure 10). The first trap was placed approximately 200 feet in line with trap DEH#19 and trap C. The others were placed approximately 200 feet north and west (the north trap was less than 200 feet due to dense brush). Table 11 lists the total number of gnats caught from August 16 to August 19.

Table 11. Total and average number of gnats caught in emergence traps (Third Survey, Figure 10)

Trap Name	Total number of gnats caught	Average number of gnats caught
C	200	66.6
L	9	3
K	195	65
M	27	9
N	65	21.6
A (trap DEH#19)	40	13.3

Third Survey Results

A high numbers of gnats were caught in the northeast quadrant with less caught in the newly established traps.

Overall Results

During the course of this study, the traps located nearest to Highland Valley Road and in a relatively straight line captured the highest number of gnats (Figure 11). However, the directional source of the adult eye gnats could not be determined. Further, extensive surveys of soil and plants in the surrounding area did not produce any emerging eye gnat adults. Collar traps placed just north or south along the road captured low numbers of adult eye gnats, which contradicts eye gnat studies of the past that indicate eye gnats preferred sheltered areas like brush or dense landscape. Further study of the area is warranted.

Extension Activity

ADDITIONS TO THE SAN DIEGO EYE GNAT RESEARCH AND EDUCATION PROJECT
WEB SITE (<http://ucanr.org/eyegnats>)

County Eye Gnat Report Research Report, 2011-15
Eye Gnat Research and Education Symposium, 2012

EYE GNAT PRESENTATIONS AND PUBLICATIONS

Bethke, J. A., Vander Mey, B., and I. DeBonis. Final Report: San Diego County Eye Gnat Research and Education Project 2011. In fulfillment of San Diego County Contract #532716. 36pgs. Available online: <http://ucanr.org/eyegnats>

Bethke, J. A., Vander Mey, B., and S. Zambrano. Final Report: San Diego County Eye Gnat Research and Education Project 2012. In fulfillment of San Diego County Contract #532716. 29pgs. Available online: <http://ucanr.org/eyegnats>

Bethke, J. A., Vander Mey, B., and S. Zambrano. Final Report: San Diego County Eye Gnat Research and Education Project 2013. In fulfillment of San Diego County Contract #532716. 21pgs. Available online: <http://ucanr.org/eyegnats>

Bethke, J. A., Vander Mey, B., Tanazaki, G., and Lea Corkidi. Final Report: San Diego County Eye Gnat Research and Education Project 2014. In fulfillment of San Diego County Contract #532716. 24pgs. Available online: <http://ucanr.org/eyegnats>

Bethke, J. A., Vander Mey, B., Corkidi. Final Report: San Diego County Eye Gnat Research and Education Project 2015. In fulfillment of San Diego County Contract #554912. 19pgs. Available online: <http://ucanr.org/eyegnats>

SELECTED REFERENCES

- Anonymous. 1929. The California eye gnat. *Science* 69:14.
- Buehler J.W., J. T. Holloway, R. A. Goodman, and R. K. Sikes. 1983. Gnat sore eyes - seasonal, acute conjunctivitis in a southern state. *Southern Medical Journal*. 76(5):587-589.
- Gerhardt, R.R. and Axtell R. C. 1972. Flight of the eye gnat, *Hippelates pussio* (Diptera:Chloropidea): Effect of temperature, light, moisture and wind velocity. *J. Med. Ent.* 9(5):425-8.
- Mulla, M. S. 1963. An ecological basis for suppression of *Hippelates* eye gnats. *Journal of Economic Entomology*. 56(6): 768

APPENDIX I

Photos and Figures

Figure 1. Fourteen-quart clear plastic tub used for monitoring emergence of eye gnats from soil samples. A hole was cut on the lid with an inverted funnel glued to the top. A 40-dram vial is attached to the spout of the funnel to collect emerged adult gnats.



Figure 2. Components used to make UCCE collar traps. Bait jar (3-inch drainage pipe with cemented cap), 3-inch PVC collar with $\frac{3}{4}$ inch holes, plastic champagne glass, 3-inch drainage pipe used to connect 32-ounce pinch grip plastic container. Painted flat black to attract more gnats.



Figure 3. Assembled UCCE collar trap



Figure 4. Overview of South Escondido where eye gnat trials took place. The purple rectangle represents area where grid sampling took place. The gray rectangle represents area where emergence traps were placed. The yellow rectangle represents area where trap DEH#19 study took place. The orange arrow represents approximate location of anemometer and predominate wind direction.

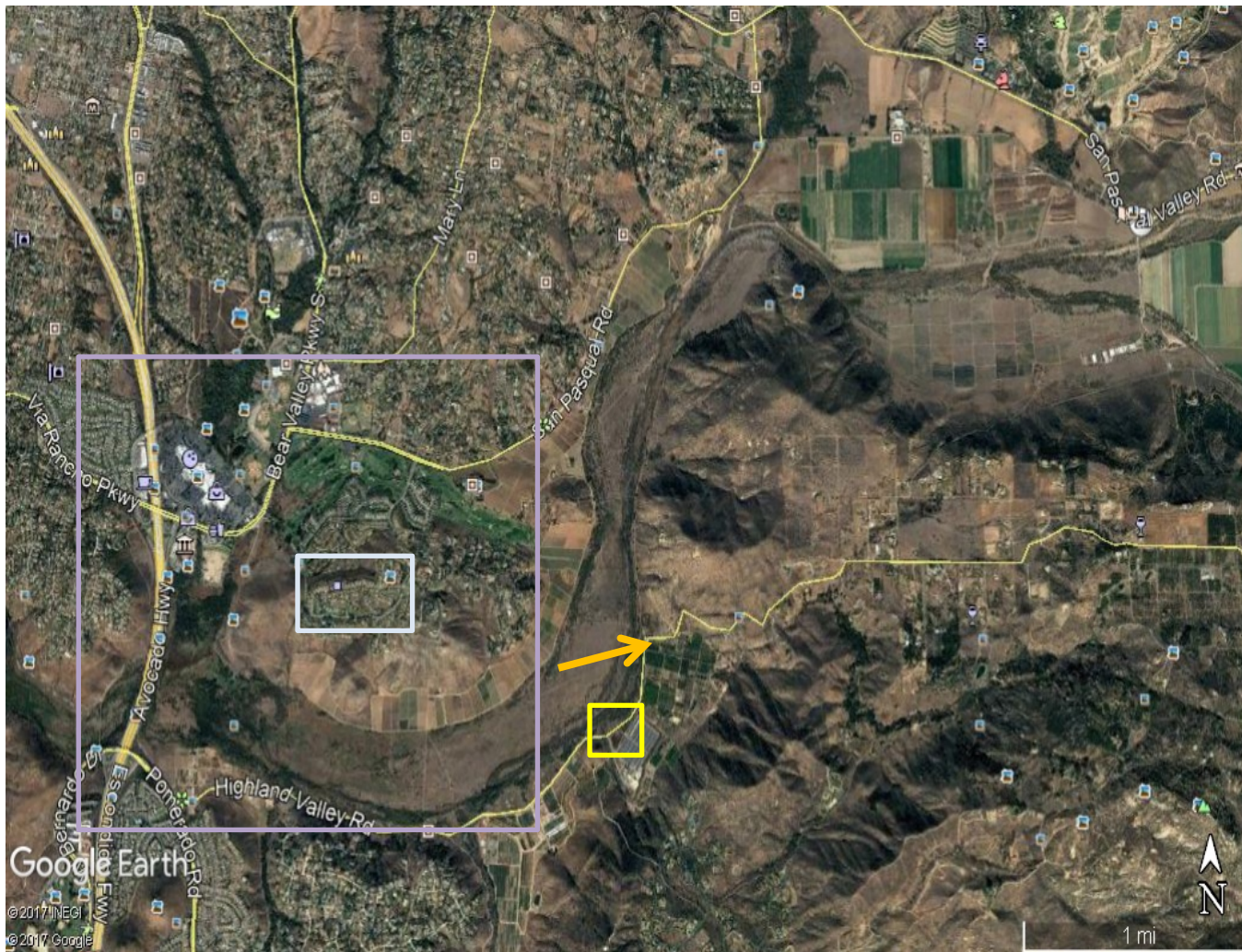


Figure 5. Location of UCCE eye gnat collar traps used for yearly monitoring of adult populations. Grid uses traps placed approximately half mile equidistant. Numbers are those assigned to trap and correspond to the number of gnats caught in Table 2.

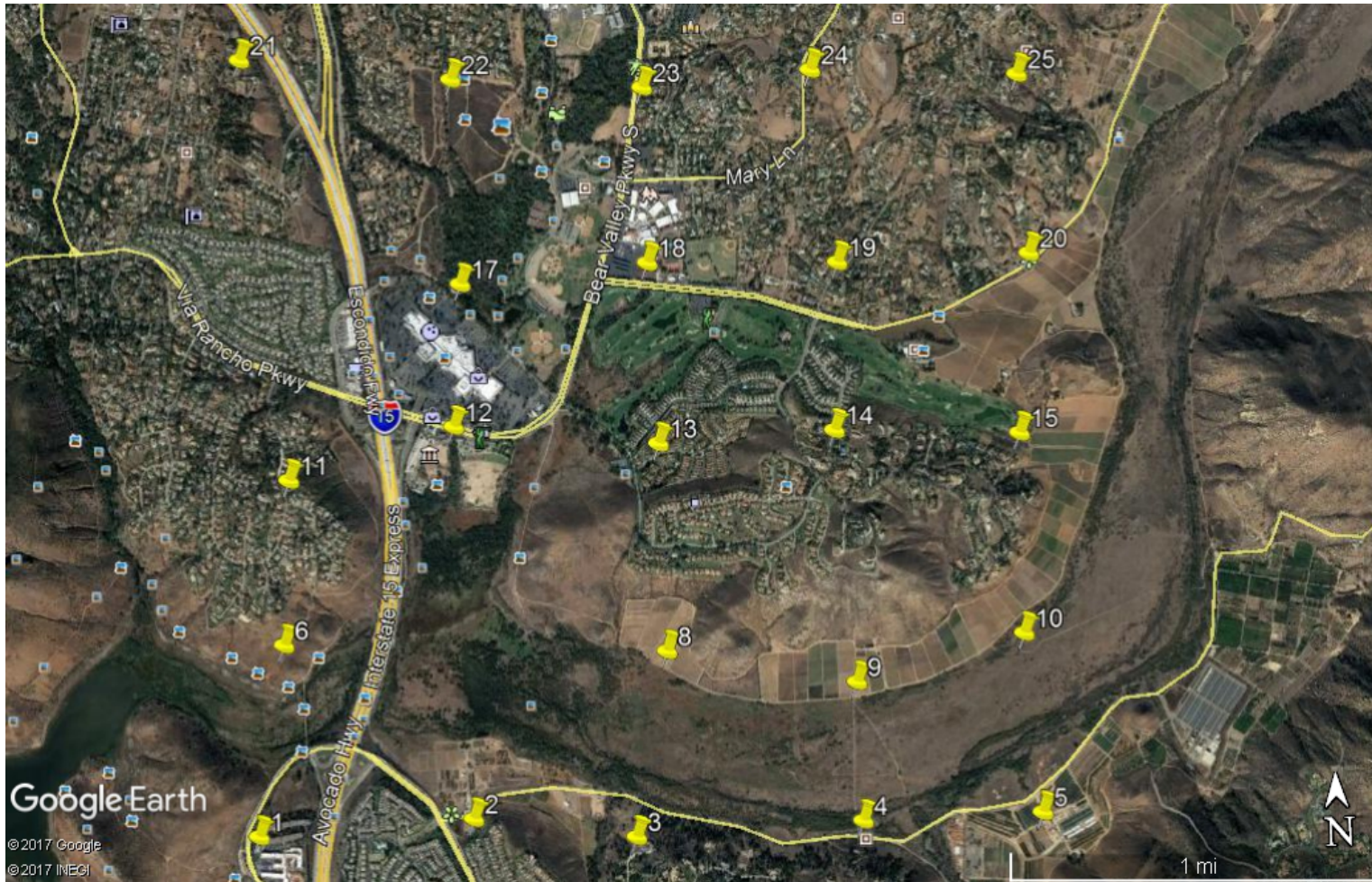


Figure 6. Emergence trap. 3 X 3 X 1 feet PVC frame covered with a black cloth. Edges covered with soil to prevent gnats from escaping. One pint mason jar used as collection jar with nalgene funnel.

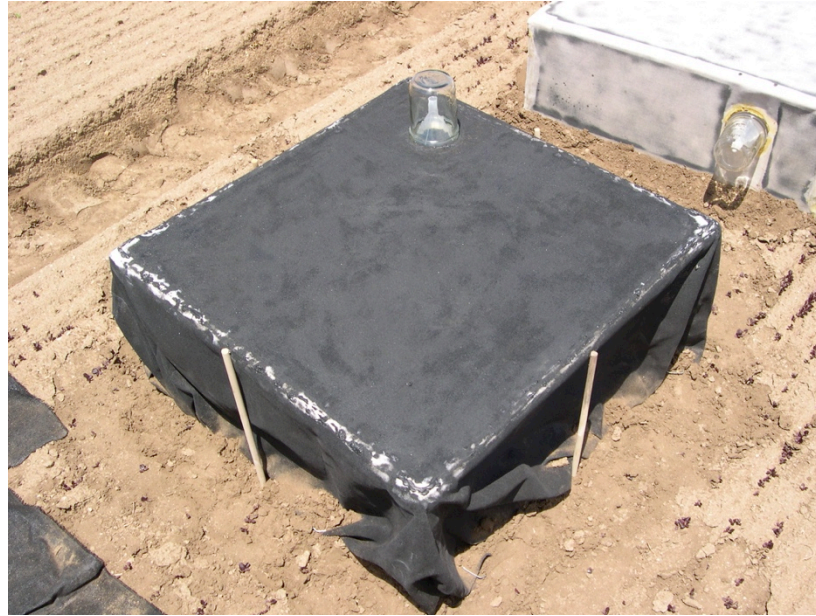


Figure 7. Location of emergence traps on landscape groundcover within the Sonata community in south Escondido. Letters correspond to Tables 5 & 6.

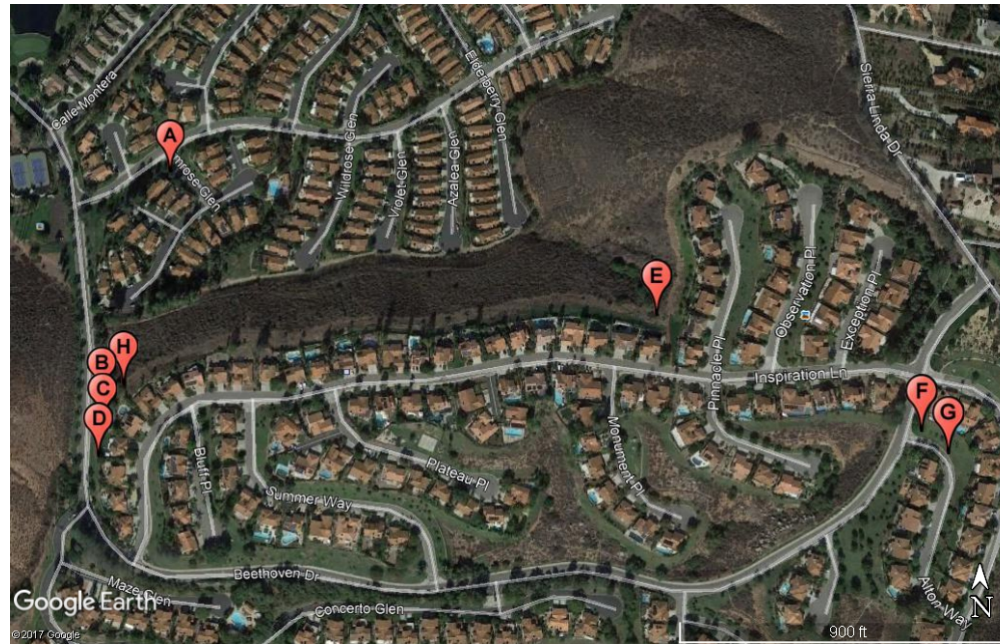


Figure 8. Location of UCCE collar traps in Initial Study of trap DEH#19. Traps placed approximately 200 feet using DEH#19 trap as the center. Letters correspond to Table #9.



Figure 9. Location of UCCE collar traps for the second study of DEH#19 trap. Additional traps were placed linearly 200 feet beyond the traps that caught the most gnats. Letters correspond to Table #10.

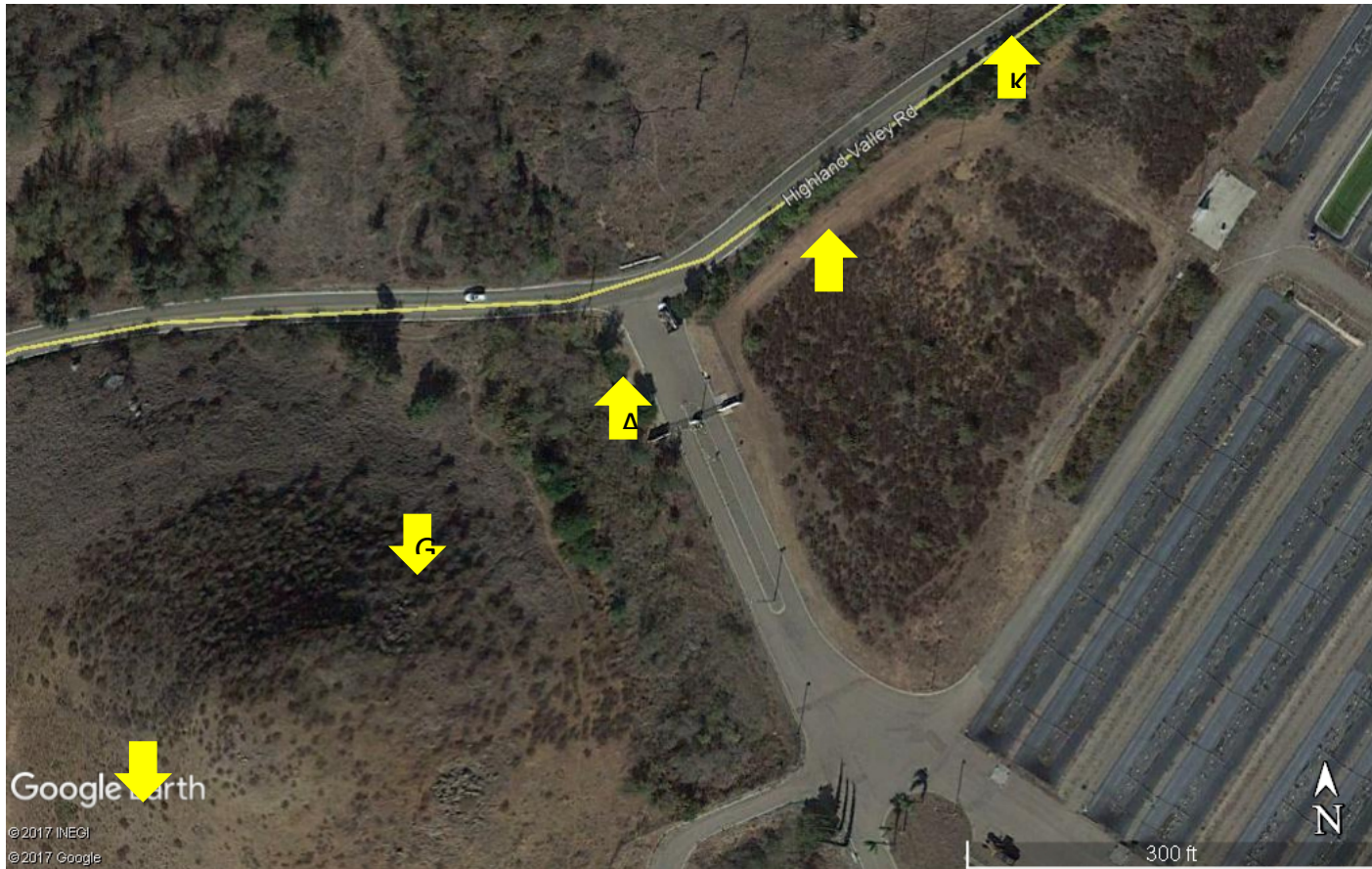
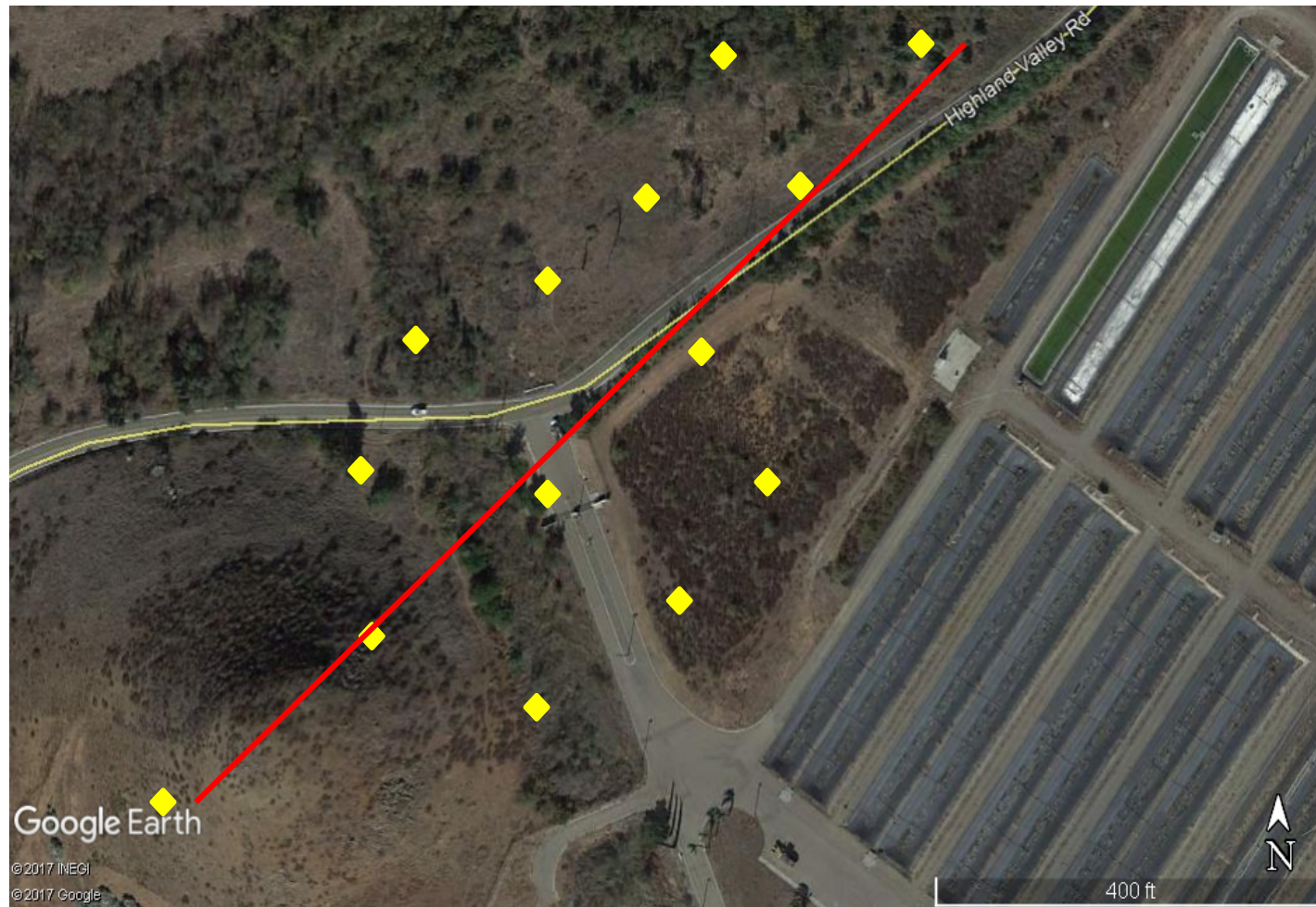


Figure 10. Location of UCCE collar traps for the third study of DEH#19 trap. Additional traps were placed approximately 200 feet radially beyond the furthest northeast trap. Letters correspond to Table #11.



Figure 11. Location of all UCCE collar traps placed during the trap DEH#19 study. The red line connects the line of traps that consistently caught the most gnats.



APPENDIX II

Weather for Escondido, CA

California Irrigation Management Information System (CIMIS)

CIMIS Daily Report

Rendered in ENGLISH Units.

Wednesday, June 01, 2016 - Monday, October 31, 2016

Printed on Thursday, May 25, 2017

Escondido SPV - South Coast Valleys - Station 153

Date	ETo (in)	Precip (in)	Sol Rad (Ly/day)	Avg Vap Pres (mBars)	Max Air Temp (°F)	Min Air Temp (°F)	Avg Air Temp (°F)	Max Rel Hum (%)	Min Rel Hum (%)	Avg Rel Hum (%)	Dew Point (°F)	Avg Wind Speed (mph)	Wind Run (miles)	Avg Soil Temp (°F)
6/1/2016	0.16	0.00	536	17.0	77.0	51.9	63.2	97	65	86	58.8	3.1	74.6	71.2
6/2/2016	0.22	0.00	644	17.1	88.7	47.8	67.8	98	46	74	59.1	1.9 R	45.3 R	70.8
6/3/2016	0.24 R	0.00	644	17.1	94.7 Y	52.4	69.9	97	33	68	59.0	2.4 Y	58.6 Y	72.2
6/4/2016	0.23	0.00	665	17.1	88.6	49.9	69.3	97	42	70	59.1	2.5 Y	60.3 Y	72.5
6/5/2016	0.21 R	0.00	629	16.8	81.0	53.8	65.1	97	55	79	58.5	3.7	89.7	72.6
6/6/2016	0.21	0.00	619	16.5	77.9	54.8	65.3	96	54	77	58.1	3.7	88.6	72.3
6/7/2016	0.19 R	0.00	577	16.5	77.5	54.9	64.8	93	60	79	58.1	3.3	78.5	72.1
6/8/2016	0.20 R	0.00	603	17.6	80.1	60.0	67.5	92	59	76	59.8	2.9 Y	69.1 Y	72.3
6/9/2016	0.18 R	0.00	547	17.8	78.7	59.8	66.8	92	62	79	60.2	3.1 Y	74.9 Y	72.7
6/10/2016	0.20	0.00	590	17.7	80.4	60.0	67.7	90	56	76	60.0	3.8	90.5	73.0
6/11/2016	0.03	0.00	165	16.4	67.9	60.9	63.8	87	75	81	58.0	2.4 Y	58.7 Y	72.4
6/12/2016	0.17	0.00	560	15.8	74.5	56.5	64.3	94	60	77	56.9	2.3 R	55.4 R	71.5
6/13/2016	0.15	0.00	488	15.4	76.5	58.6	64.1	90	57	75	56.2	2.0 R	46.8 R	71.5
6/14/2016	0.18	0.00	551	16.6	77.8	59.2	66.2	88	57	76	58.3	2.3 R	54.3 R	71.8
6/15/2016	0.21	0.00	633	15.3	78.1	54.3	65.8	92	50	70	55.9	3.2 Y	76.1 Y	72.3
6/16/2016	0.23 R	0.00	660	13.6	82.9	50.6	66.9	95	34	60	52.7	2.1 R	51.3 R	72.2
6/17/2016	0.24 R	0.00	666	12.4 Y	92.6	47.1	70.0	94	25	49 Y	50.2 Y	1.7 R	41.3 R	72.3
6/18/2016	0.17	0.00	483	13.1	95.1	46.8	70.7	93	25	51	51.7	1.5 R	35.1 R	72.5

Date	ETo (in)	Precip (in)	Sol Rad (Ly/day)	Avg Vap Pres (mBars)	Max Air Temp (°F)	Min Air Temp (°F)	Avg Air Temp (°F)	Max Rel Hum (%)	Min Rel Hum (%)	Avg Rel Hum (%)	Dew Point (°F)	Avg Wind Speed (mph)	Wind Run (miles)	Avg Soil Temp (°F)
6/19/2016	0.28 R	0.00	652	12.3 Y	105.7 R	54.1	79.6 R	88 H	14 H	-- R	-- I	3.0 Y	71.0 Y	73.4
6/20/2016	0.27 R	0.00	645	13.6	-- S	56.6	-- S	84 H	15 H	-- Q	-- Q	3.9	92.5	75.3
6/21/2016	0.08 R	0.00	271	17.9	87.2	58.9	70.9	86	40	69	60.4	1.7 R	40.8 R	75.7
6/22/2016	0.24 R	0.00	616	18.8	89.9	59.5	73.3	98	42	67	61.8	4.3	103.1	74.5
6/23/2016	0.23 R	0.00	616	18.6	85.5	59.6	70.4	98	48	73	61.5	4.4	106.5	72.6
6/24/2016	0.24 R	0.00	640	17.9	83.6	56.8	69.3	95	53	73	60.3	5.0	120.0	73.4
6/25/2016	0.23 R	0.00	622	17.5	83.7	56.1	69.3	95	50	72	59.7	3.8	90.9	73.3
6/26/2016	0.23 R	0.00	610	19.0	87.6	55.2	72.1	96	48	71	62.0	3.8	90.8	73.6
6/27/2016	0.24 R	0.00	577	20.3	93.0	63.0	76.1	93	41	66	63.9	4.0	96.0	74.7
6/28/2016	0.25 R	0.00	625	19.8	90.8	59.4	74.8	96	44	67	63.2	4.0	96.6	75.3
6/29/2016	0.24 R	0.00	620	19.5	90.7	57.7	73.4	96	45	69	62.8	4.0	96.5	75.4
6/30/2016	0.22 R	0.00	601	20.1	84.9	62.0	71.8	95	57	76	63.7	4.3	103.6	75.7
Tots/Avgs	6.17	0.00	579	16.8	84.6	55.9	69.0	93	47	72	58.9	3.1	75.2	73.0

Escondido SPV - South Coast Valleys - Station 153

Date	ETo (in)	Precip (in)	Sol Rad (Ly/day)	Avg Vap Pres (mBars)	Max Air Temp (°F)	Min Air Temp (°F)	Avg Air Temp (°F)	Max Rel Hum (%)	Min Rel Hum (%)	Avg Rel Hum (%)	Dew Point (°F)	Avg Wind Speed (mph)	Wind Run (miles)	Avg Soil Temp (°F)
7/1/2016	0.21 R	0.00	595	18.8	80.1	58.2	69.6	93	59	76	61.7	4.5	108.2	75.5
7/2/2016	0.21	0.00	604	17.4	81.8	60.1	68.5	89	54	73	59.5	3.7	87.8	75.1
7/3/2016	0.19 R	0.00	607	18.2	74.4 Y	51.8	64.8	98	75	87	60.9	3.8	92.1	74.7
7/4/2016	0.20 R	0.00	602	17.3	81.0	50.6	65.3	98	57	81	59.3	2.7 Y	64.9 Y	71.5 Y
7/5/2016	0.22	0.00	622	17.9	81.3	60.4	69.9	91	54	72	60.3	3.6	85.8	72.7
7/6/2016	0.22	0.00	621	17.7	79.8	56.6	69.4	93	60	72	60.1	4.3	103.4	73.4
7/7/2016	0.21 R	0.00	591	17.8	82.7	57.1	68.5	95	52	75	60.2	3.2	76.7	73.4
7/8/2016	0.21	0.00	609	18.4	82.8	55.4	67.8	97	57	79	61.1	3.5	83.6	73.5
7/9/2016	0.22	0.00	636	17.8	85.7	51.2	66.2	98	48	81	60.2	3.4	81.0	72.9
7/10/2016	0.21 H	0.00	608	15.9	84.2	-- S	63.0 Y	99 H	50 H	81 Y	57.0 Y	3.6	87.1	71.0 Y
7/11/2016	0.22 R	0.00	616	17.6	82.2	56.1	68.3	97	51	74	59.8	3.8	91.9	72.3
7/12/2016	0.21 R	0.00	605	17.8	81.7	56.7	68.6	96	54	75	60.2	3.8	90.4	73.1
7/13/2016	0.23 R	0.00	812 R	19.2	86.8	-- S	75.4	97	48	64	62.4	4.7	112.2	75.1
7/14/2016	0.22	0.00	602	18.2	89.6	54.1	70.4	97	42	72	60.8	3.2	77.8	75.6

Date	ETo (in)	Precip (in)	Sol Rad (Ly/day)	Avg Vap Pres (mBars)	Max Air Temp (°F)	Min Air Temp (°F)	Avg Air Temp (°F)	Max Rel Hum (%)	Min Rel Hum (%)	Avg Rel Hum (%)	Dew Point (°F)	Avg Wind Speed (mph)	Wind Run (miles)	Avg Soil Temp (°F)
7/15/2016	0.24	0.00	634	18.4	90.6	56.2	72.2	96	39	68	61.1	3.8	90.7	77.0
7/16/2016	0.24	0.00	610	18.0	88.4	60.6	72.8	94	39	66	60.6	4.1	99.5	78.1
7/17/2016	0.24	0.00	616	18.5	87.8	60.0	71.8	92	44	70	61.3	4.6	109.5	78.5
7/18/2016	0.24 R	0.00	618	17.8	85.3	58.3	71.5	98	34	68	60.2	4.4	105.1	78.4
7/19/2016	0.24 R	0.00	623	18.4	91.3	56.1	72.8	99	36	67	61.1	3.6	85.5	75.9
7/20/2016	0.25	0.00	621	17.6	95.5	59.5	77.1	96	30	55	59.9	2.9 Y	69.2 Y	77.5
7/21/2016	0.26 R	0.00	617	16.4	97.4	59.6	78.9	88	22	49	57.9	2.9 Y	68.5 Y	79.1
7/22/2016	0.27 R	0.00	631	16.0	100.5 Y	56.8	79.6 Y	90	23	46 Y	57.1 Y	2.8 Y	66.6 Y	80.3
7/23/2016	0.25 R	0.00	609	17.2	96.7	57.9	76.7	85	27	55	59.3	3.6	86.6	80.8
7/24/2016	0.24 R	0.00	608	19.7	91.9	60.4	76.4	89	39	63	63.1	3.7	87.7	81.2
7/25/2016	0.10 R	0.00	338	21.3	85.2	65.2	75.2	90	52	72	65.4	1.9 R	46.4 R	81.3
7/26/2016	0.24 R	0.00	594	19.5	92.0	62.4	77.2	95	37	61	62.8	3.2	77.2	81.4
7/27/2016	0.23 R	0.00	592	18.8	91.0	62.2	76.8	91	39	60	61.8	2.7 Y	65.2 Y	82.5 Y
7/28/2016	0.22 R	0.00	586	19.0	87.3	61.7	73.2	97	38	68	62.0	3.3	79.4	82.4 Y
7/29/2016	0.20 R	0.00	567	21.2	88.9	58.4	72.8	98	55	77	65.1	2.6 Y	61.3 Y	77.9
7/30/2016	0.19	0.00	493	21.8	89.8	64.4	75.0	96	49	74	65.9	4.2	100.6	79.1
7/31/2016	0.20 R	0.00	546	21.8	86.8	64.5	73.8	96	57	77	66.0	3.8	90.1	80.2
Tots/Avgs	6.83	0.00	601	18.4	87.1	58.4	71.9	94	46	70	61.1	3.5	84.9	76.8

Escondido SPV - South Coast Valleys - Station 153

Date	ETo (in)	Precip (in)	Sol Rad (Ly/day)	Avg Vap Pres (mBars)	Max Air Temp (°F)	Min Air Temp (°F)	Avg Air Temp (°F)	Max Rel Hum (%)	Min Rel Hum (%)	Avg Rel Hum (%)	Dew Point (°F)	Avg Wind Speed (mph)	Wind Run (miles)	Avg Soil Temp (°F)
8/1/2016	0.21 R	0.00	567	20.5	85.2	61.7	72.8	96	54	74	64.2	3.5	84.4	80.7
8/2/2016	0.21 R	0.00	565	20.5	86.6	61.5	73.0	96	49	74	64.2	3.3	80.2	81.1
8/3/2016	0.20 R	0.00	554	20.6	84.8	62.6	72.8	95	56	75	64.4	3.3	79.5	81.8 Y
8/4/2016	0.20	0.00	560	20.5	83.9	64.0	73.0	92	56	74	64.2	2.9	70.1	82.5 Y
8/5/2016	0.19 R	0.00	530	20.9	83.7	65.4	72.5	90	59	77	64.7	2.8 Y	66.7 Y	82.9 Y
8/6/2016	0.20 R	0.00	552	20.4	83.2	63.4	72.6	91	60	75	64.1	3.0	72.5	83.2 R
8/7/2016	0.19 R	0.00	544	20.0	85.2	62.7	71.9	91	55	75	63.5	2.8	68.3	83.3 R
8/8/2016	0.20 R	0.00	549	19.6	83.8	60.7	70.9	91	56	76	63.0	3.2	76.0	83.3 R
8/9/2016	0.22 R	0.00	600	17.1	85.5	57.3	70.6	92	43	67	59.1	3.1	75.5	83.1 R

Date	ETo (in)	Precip (in)	Sol Rad (Ly/day)	Avg Vap Pres (mBars)	Max Air Temp (°F)	Min Air Temp (°F)	Avg Air Temp (°F)	Max Rel Hum (%)	Min Rel Hum (%)	Avg Rel Hum (%)	Dew Point (°F)	Avg Wind Speed (mph)	Wind Run (miles)	Avg Soil Temp (°F)
8/10/2016	0.22 R	0.00	579	16.7	89.2	52.3	69.4	96	36	68	58.4	3.7	89.9	82.3 Y
8/11/2016	0.21	0.00	542	18.4	88.0	63.8	72.6	86	45	67	61.1	3.5	84.7	83.2 R
8/12/2016	0.21 R	0.00	557	19.3	89.1	60.5	73.5	95	45	68	62.4	3.5	83.6	83.8 R
8/13/2016	0.22 R	0.00	565	20.3	90.8	61.1	73.8	98	42	71	64.0	3.3	79.9	83.8 R
8/14/2016	0.23 R	0.00	572	19.7	94.3	57.7	76.1	98	39	64	63.0	2.9	70.6	81.4
8/15/2016	0.24 R	0.00	575	18.0	100.8 Y	62.0	79.7 Y	93	22	52 Y	60.5 Y	2.8	66.5	82.0 Y
8/16/2016	0.24 R	0.00	583	14.7	101.0 Y	56.1	77.2	87	19	46	54.9	2.4 Y	58.5 Y	81.4
8/17/2016	0.24 R	0.00	576	14.8	99.3	54.8	76.6	86	21	47	55.0	2.6	61.3	81.2
8/18/2016	0.22 R	0.00	555	18.2	93.3	58.2	73.4	92	35	65	60.7	3.1	74.2	81.8
8/19/2016	0.22 R	0.00	561	18.4	90.0	60.9	73.7	94	36	65	61.1	3.2	77.2	82.5
8/20/2016	0.20 R	0.00	551	19.2	85.5	60.5	71.8	95	48	72	62.4	2.9	69.8	82.8
8/21/2016	0.20 R	0.00	535	18.7	87.6	57.7	71.8	96	42	70	61.6	3.0	71.5	82.7
8/22/2016	0.20 R	0.00	553	18.4	86.9	58.2	70.5	96	42	72	61.1	3.2	76.8	82.7
8/23/2016	0.18	0.00	548	18.3	79.6	54.9	66.6	97	54	82	61.0	3.2	77.0	81.2
8/24/2016	0.19 R	0.00	515	17.7	87.6	53.6	69.1	98	42	73	60.1	2.9	69.0	75.2
8/25/2016	0.18 R	0.00	501	18.7	82.7	58.1	69.1	95	57	77	61.6	3.7	88.3	76.4
8/26/2016	0.17 R	0.00	500	17.2	80.0	59.5	67.0	92	56	76	59.2	3.3	78.0	76.6
8/27/2016	0.15 R	0.00	448	17.3	78.9	60.1	67.2	91	59	76	59.4	2.4	57.7	76.4
8/28/2016	0.18 R	0.00	511	19.2	84.1	60.0	70.5	93	56	75	62.4	2.4	57.1	77.5
8/29/2016	0.18 R	0.00	521	19.6	89.2	57.3	72.1	97	49	73	62.9	2.2	53.4	78.8
8/30/2016	0.20	0.00	518	20.2	91.8	59.3	74.6	96	43	69	63.8	2.8	68.0	80.2
8/31/2016	0.18 R	0.00	486	20.3	94.0	58.6	73.7	97	43	71	63.9	2.4	56.9	80.7
Tots/Avgs	6.28	0.00	544	18.8	87.9	59.5	72.3	94	46	70	61.7	3.0	72.4	81.2

Escondido SPV - South Coast Valleys - Station 153

Date	ETo (in)	Precip (in)	Sol Rad (Ly/day)	Avg Vap Pres (mBars)	Max Air Temp (°F)	Min Air Temp (°F)	Avg Air Temp (°F)	Max Rel Hum (%)	Min Rel Hum (%)	Avg Rel Hum (%)	Dew Point (°F)	Avg Wind Speed (mph)	Wind Run (miles)	Avg Soil Temp (°F)
9/1/2016	0.17 R	0.00	478	20.3	85.5	60.7	70.2	97	55	80	63.9	3.6	85.3	81.0
9/2/2016	0.18	0.00	507	18.4	82.5	59.4	69.5	93	51	75	61.2	3.5	82.9	81.2
9/3/2016	0.17	0.00	486	16.4	79.5	55.7	66.8	90	50	73	57.8	3.3	79.4	80.8
9/4/2016	0.16	0.00	484	15.3	78.9	57.3	66.5	91	46	69	56.0	2.9	68.8	80.1

Date	ETo (in)	Precip (in)	Sol Rad (Ly/day)	Avg Vap Pres (mBars)	Max Air Temp (°F)	Min Air Temp (°F)	Avg Air Temp (°F)	Max Rel Hum (%)	Min Rel Hum (%)	Avg Rel Hum (%)	Dew Point (°F)	Avg Wind Speed (mph)	Wind Run (miles)	Avg Soil Temp (°F)
9/5/2016	0.17 R	0.00	500	14.7	78.8	56.0	65.8	88	45	68	54.8	3.0	72.3	79.6
9/6/2016	0.18 R	0.00	508	15.5	84.4	51.9	66.7	93	41	69	56.4	3.2	77.4	78.9
9/7/2016	0.17 R	0.00	497	17.7	84.7	51.7	64.7	98	49	85	60.1	4.3	102.6	78.7
9/8/2016	0.17 R	0.00	473	18.1	81.8	58.9	68.1	99	53	77	60.6	3.3	79.3	76.6
9/9/2016	0.18 R	0.00	506	17.9	86.5	58.3	71.0	94	43	69	60.4	3.2	76.5	76.7
9/10/2016	0.18 R	0.00	505	17.2	88.2	52.4	69.1	97	41	71	59.2	2.9	69.5	76.2
9/11/2016	0.18	0.00	475	18.6	86.1	60.0	69.8	96	44	75	61.4	3.9	92.9	77.1
9/12/2016	0.15 R	0.00	449	17.1	76.6	62.2	67.0	88	60	76	59.0	3.9	94.1	77.5
9/13/2016	0.09	0.00	285	14.1	73.4	55.4	64.7	89	55	68	53.7	2.7	65.2	76.1
9/14/2016	0.17 R	0.00	500	14.1	79.4	52.9	64.2	93	40	69	53.8	2.7	63.9	75.2
9/15/2016	0.18 R	0.00	506	12.8	82.1	48.4	64.0	89	35	63	51.2	3.0	72.0	74.9
9/16/2016	0.17 R	0.00	490	14.3	81.1	44.9	62.6	97	44	74	54.0	3.2	76.5	72.7
9/17/2016	0.16 R	0.00	483	15.8	84.6	47.8	64.9	96	48	75	56.8	2.7	64.1	72.1
9/18/2016	0.18 R	0.00	483	14.6	94.9	47.3	70.3	97	24	58	54.7	2.3	54.9	72.6
9/19/2016	0.07 R	0.00	230	18.4	89.6	58.6	73.0	91	38	66	61.1	1.8 Y	44.1 Y	73.5
9/20/2016	0.00 R	0.26	53	23.2 Y	75.2	65.2 Y	71.1	97	78	89 Y	67.8 Y	1.4 Y	33.8 Y	73.6
9/21/2016	0.03 R	0.22	153	22.6 Y	77.0	64.1	68.9	100	81	94 Y	67.1 Y	2.0 Y	47.0 Y	74.7
9/22/2016	0.14	0.00	428	18.6	76.2	55.7	66.4	98	57	84	61.5	3.8	91.8	74.7
9/23/2016	0.15	0.00	467	14.8	78.7	52.8	64.7	97	43	71	55.0	2.2	53.3	73.3
9/24/2016	0.18	0.00	475	11.6	88.9	49.7	68.5	90	22	49	48.4	2.4	58.6	72.7
9/25/2016	0.19 R	0.00	478	11.1	95.6	52.2	72.7	81	16	41	47.4	2.2	52.5	73.3
9/26/2016	0.16 R	0.00	340	10.7	94.3	58.9	80.0 Y	53 H	18 H	31 Y	46.4 Y	3.4	81.7	73.8
9/27/2016	0.17 R	0.00	323	13.5	91.5	62.3	79.4 Y	71 H	27 H	39 Y	52.5 Y	4.2	100.1	75.6
9/28/2016	0.16 R	0.00	433	15.6	91.5	60.6	73.5	81	33	55	56.4	2.2	52.8	76.3
9/29/2016	0.17	0.00	436	16.4	90.4	56.7	73.2	90	35	59	57.9	2.8	68.0	76.8
9/30/2016	0.16 R	0.00	439	16.4	90.8	57.7	72.3	92	34	61	57.9	2.3	55.7	77.3
Tots/Avg	4.59	0.48	429	16.2	84.3	55.9	69.0	91	44	68	57.1	2.9	70.6	76.1

Escondido SPV - South Coast Valleys - Station 153

Date	ETo (in)	Precip (in)	Sol Rad (Ly/day)	Avg Vap Pres (mBars)	Max Air Temp (°F)	Min Air Temp (°F)	Avg Air Temp (°F)	Max Rel Hum (%)	Min Rel Hum (%)	Avg Rel Hum (%)	Dew Point (°F)	Avg Wind Speed (mph)	Wind Run (miles)	Avg Soil Temp (°F)
10/1/2016	0.16 R	0.00	439	15.3	87.3	53.8	68.3	94	35	65	56.1	2.4	56.7	76.9
10/2/2016	0.14 R	0.00	436	15.1	78.9	48.0	63.2	96	51	76	55.6	2.8	67.9	75.8
10/3/2016	0.14 R	0.00	426	13.6	75.8	50.0	62.1	91	47	71	52.7	2.8	66.4	74.6
10/4/2016	0.14	0.00	424	14.2	80.9	50.3	64.0	92	34	70	54.0	3.0	71.0	73.9
10/5/2016	0.14 A	0.00 P	384 P	14.2 P	77.6 P	53.9 P	63.4 P	-- M	-- M	-- M	-- M	2.6 P	-- M	74.5 P
10/6/2016	0.15 R	0.00	425	13.6	86.4	49.7	64.6	94	32	65	52.8	2.5	60.7	73.8
10/7/2016	0.16 R	0.00	418	10.4	90.0	43.6	63.3	98	21	52	45.6	2.7	65.2	72.3
10/8/2016	0.17	0.00	434	9.1	92.0	41.0	64.9	99	15	43	42.1	2.5	60.3	67.8
10/9/2016	0.16 R	0.00	411	10.0	93.5	47.5	67.1	82	18	44	44.6	2.5	60.9	68.6
10/10/2016	0.15 R	0.00	404	12.6	87.7	47.8	65.6	90	29	59	50.7	2.5	60.1	69.2
10/11/2016	0.12 R	0.00	391	15.6	76.6	52.6	63.0	95	59	79	56.5	3.4	82.4	70.0
10/12/2016	0.10	0.00	326	15.4	75.5	51.1	62.2	94	59	81	56.1	2.6	62.2	70.3
10/13/2016	0.12 R	0.00	398	14.4	79.3	48.1	61.9	96	48	76	54.3	2.1	50.4	69.5
10/14/2016	0.12	0.00	373	15.5	78.5	50.6	62.8	97	51	79	56.3	2.7	64.4	69.9
10/15/2016	0.12	0.00	373	15.5	77.6	51.1	62.9	97	51	79	56.3	2.6	62.0	69.8
10/16/2016	0.11	0.00	328	17.3	78.2	59.2	66.4	91	60	78	59.4	3.5	84.2	70.6
10/17/2016	0.07 R	0.00	255	17.9	73.1	58.0	64.7	95	72	86	60.3	2.3	54.8	70.7
10/18/2016	0.11 R	0.00	374	15.4	78.6	53.7	63.8	95	52	76	56.1	2.2	51.7	70.5
10/19/2016	0.13 R	0.00	383	13.0	91.7	45.8	64.7	97	17	62	51.5	1.8	42.7	69.3
10/20/2016	0.13 R	0.00	388	10.5	94.8	42.1	63.3	94	17	53	45.9	1.5	37.1	68.1
10/21/2016	0.13 R	0.00	385	10.4	90.5	38.4	59.1	98	22	60	45.5	1.9	45.6	65.5
10/22/2016	0.12 R	0.00	381	10.7	86.8	34.2	58.7	100	27	63	46.3	2.0	48.3	62.3
10/23/2016	0.05 R	0.00	162	12.5	80.9	47.5	63.0	88	39	64	50.5	1.5	35.7	62.3
10/24/2016	0.02 R	0.04	118	16.3	75.3	56.8	63.8	97	63	81	57.8	1.4	33.7	63.8
10/25/2016	0.10 R	0.03	346	16.3	76.0	54.3	63.4	97	60	81	57.7	1.9	45.4	65.1
10/26/2016	0.10 R	0.00	354	15.8	80.0	49.0	62.7	97	57	81	56.9	1.6	38.0	65.1
10/27/2016	0.05 R	0.02	186	16.2	81.5	50.1	64.2	97	55	79	57.6	1.1	27.1	65.0
10/28/2016	0.07 R	0.00	220	16.6	81.0	56.8	66.8	93	50	74	58.2	1.7	39.6	65.9
10/29/2016	0.09 R	0.00	295	17.1	86.2	53.2	67.6	96	46	74	59.1	1.3	30.3	66.0
10/30/2016	0.05 R	0.01	191	17.0	74.6	55.5	62.6	96	69	88	58.9	1.8	44.3	66.3

Date	ETo (in)	Precip (in)	Sol Rad (Ly/day)	Avg Vap Pres (mBars)	Max Air Temp (°F)	Min Air Temp (°F)	Avg Air Temp (°F)	Max Rel Hum (%)	Min Rel Hum (%)	Avg Rel Hum (%)	Dew Point (°F)	Avg Wind Speed (mph)	Wind Run (miles)	Avg Soil Temp (°F)
10/31/2016	0.06 R	0.00	249	14.7	69.7	50.7	59.4	97	65	85	54.9	1.7	41.1	65.9
Tots/Avgs	3.48	0.10	344	14.3	81.8	49.8	63.7	95	44	71	53.7	2.2	53.0	69.0

Flag Legend		
A - Historical Average	I - Ignore	R - Far out of normal range
C or N - Not Collected	M - Missing Data	S - Not in service
H - Hourly Missing or Flagged Data	Q - Related Sensor Missing	Y - Moderately out of range
Conversion Factors		
Ly/day/2.065=W/sq.m	inches * 25.4 = mm	(F-32) * 5/9 = c
mph * 0.447 = m/s	mBars * 0.1 = kPa	miles * 1.60934 = km