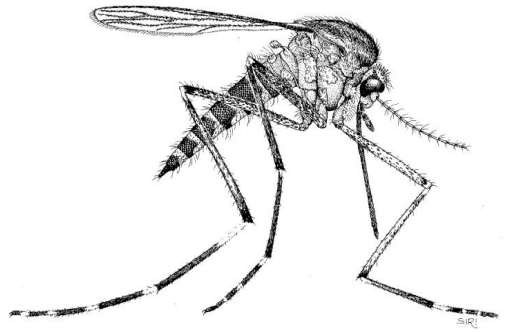
Common floodwater mosquitoes of California: the overlooked vectors?

Mark Novak, Ph.D.

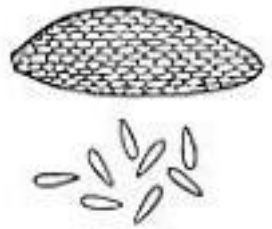
California Department of Public Health

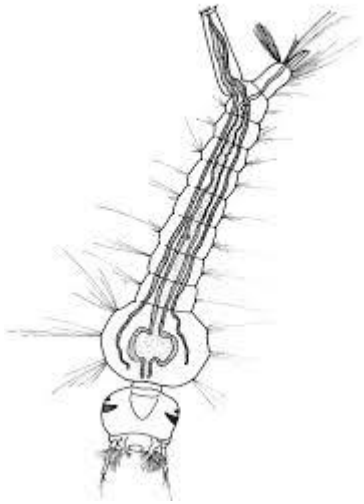
Vector-Borne Disease Section

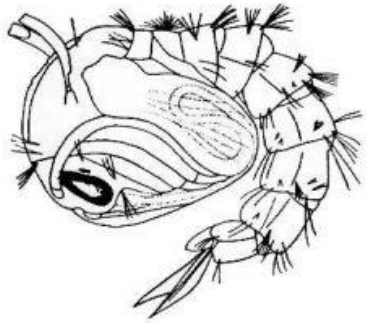


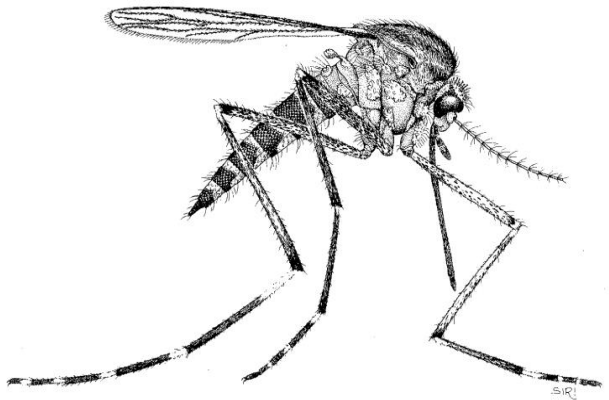
What is a floodwater mosquito?

- Not a taxonomic classification of mosquito
- No “official” definition
- And depends on how you define “floodwater”









What is a floodwater mosquito?

- Categorizing California genera by larval development site:
  - Floodwater: *Aedes* and *Psorophora*
  - Container/Treehole: *Aedes* and *Orthopodomyia*
  - Permanent Water:
    - *Anopheles, Coquillettidia, Culex, Culiseta,* and *Uranotaenia*


Alpine Co.

Napa Co.

Colusa Co.


Riverside Co.

What is floodwater?

- Water introduced onto a dry landscape for a limited time:
  - intentionally or unintentionally
  - naturally or artificially conveyed
- For mosquito control: new introduction of H_20, present long enough to allow mosquitoes to develop to adult emergence
- If there long enough, standing water becomes “semi-permanent” or “permanent”
  - Can lead to *Culex* and *Anopheles* production

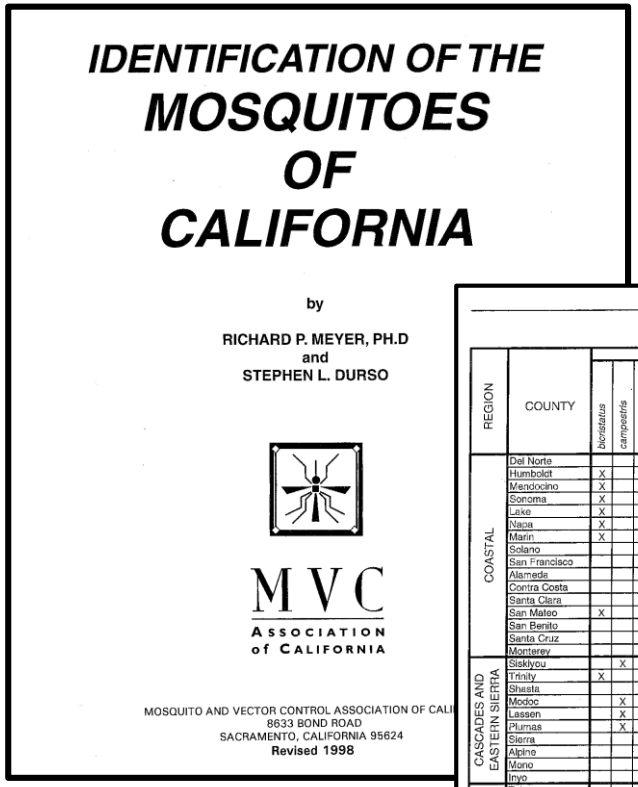
Not all floodwater yields “floodwater mosquitoes”

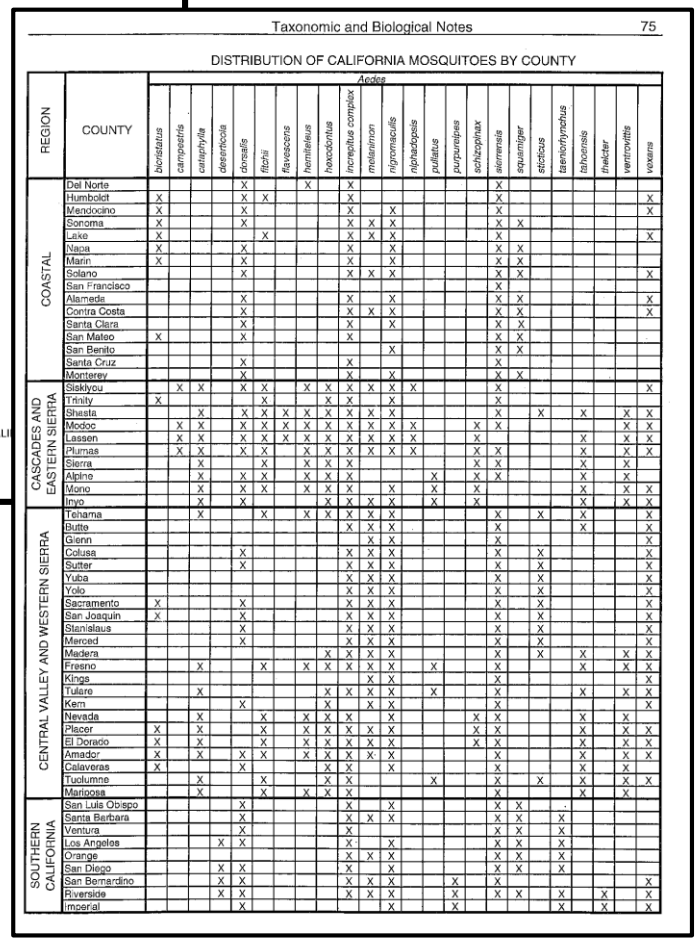
San Joaquin Co.

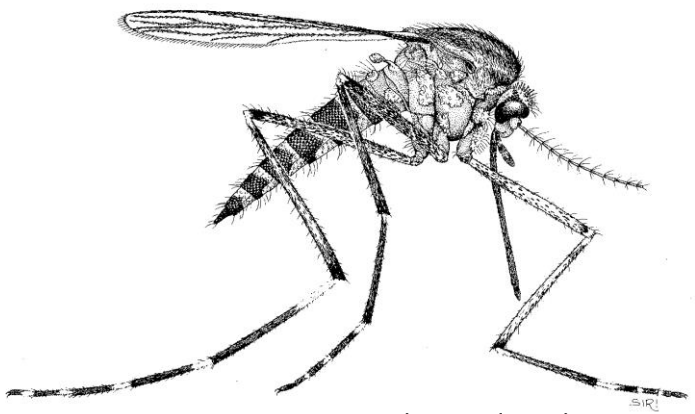
Not all floodwater yields “floodwater mosquitoes”

California Mosquitoes

- 56 species in California
- 25 of 56 (45%) “floodwater” species
  - 23 of 29 (79%) *Aedes* species
  - 2 *Psorophora* species







From: Bohart and Washino. Mosquitoes of California

Floodwater mosquitoes: 25 (45%) of 56 species in California

- *Aedes*:
  - *bicristatus**
  - *campestris**
  - *cataphylla**
  - *clivis**
  - *dorsalis*
  - *fitchii**
  - *flavescens**
  - *hemiteleus* (=*cinereus*)*
  - *hexodontus**
  - *increpitus**
  - *melanimon*
  - *nigromaculis*
  - *niphadopsis**
- *Aedes*
  - *pullatus**
  - *schizopinax**
  - *squamiger**
  - *sticticus**
  - *taeniorhynchus*
  - *tahoensis**
  - *thelcter**
  - *ventrovittus**
  - *vexans*
  - *washinoi*
- *Psorophora*
  - *columbiae*
  - *signipennis*

* Univoltine

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* Univoltine

snow pool species

Floodwater mosquitoes - The overlooked vectors??

- California Health and Safety Code Section 2002 (excerpts):
  - “Vector” means any animal capable of transmitting the causative agent of human disease or capable of producing human discomfort or injury, including, but not limited to, mosquitoes, flies, mites, ticks, other arthropods, and rodents and other vertebrates.
  - “Public nuisance” means any of the following:
    - Any water that is a breeding place for vectors.

Floodwater mosquitoes - The overlooked vectors??

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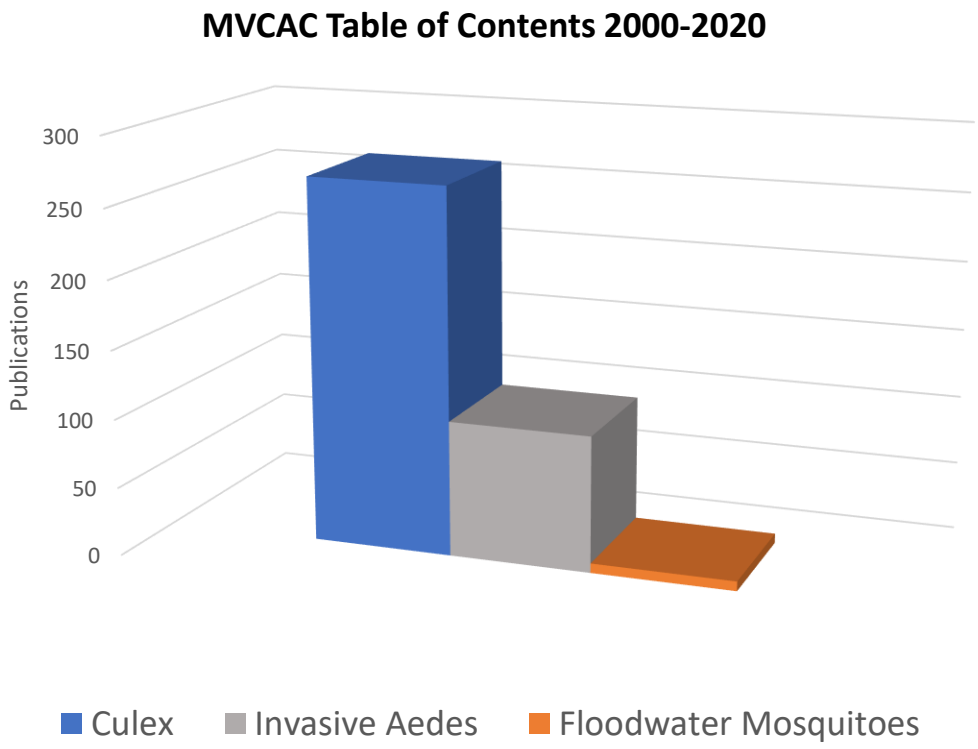
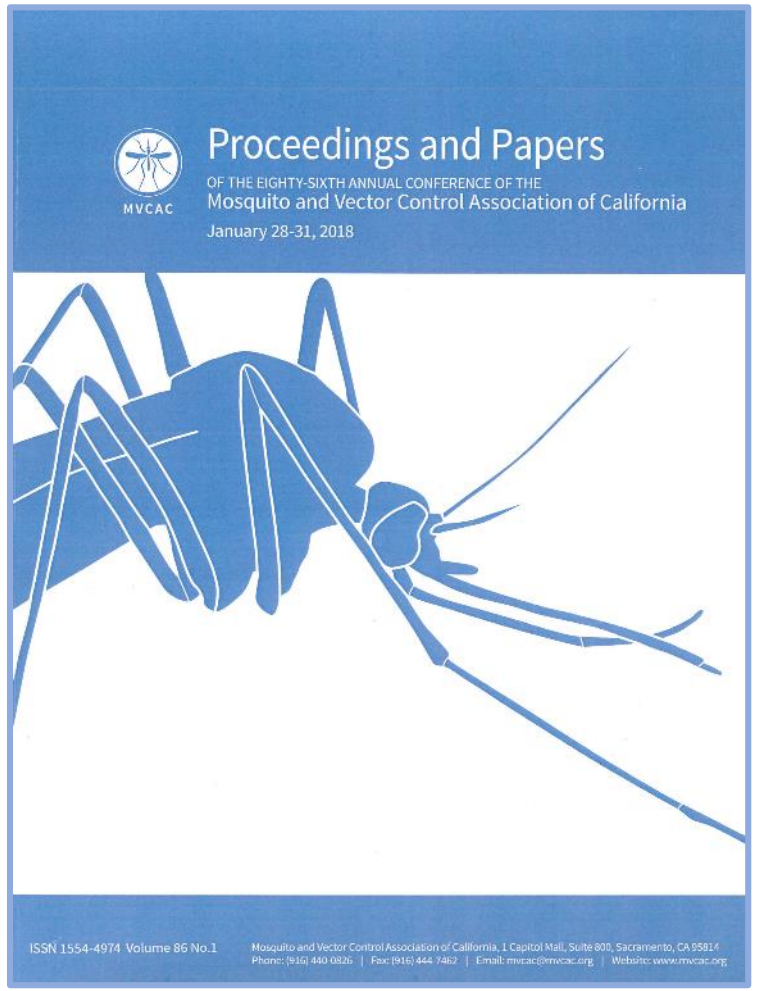
  - "Public nuisance" means any of the following:
    - Any water that is a breeding place for vectors.
- Floodwater mosquitoes are vectors!

Rob Miller, Owens Valley MAP

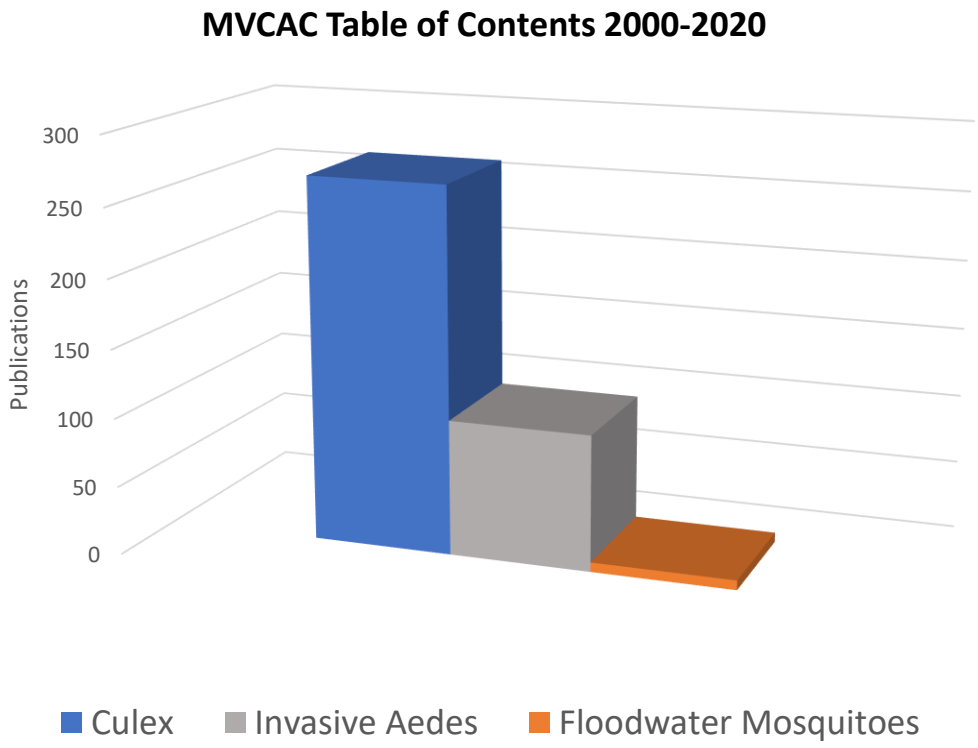
Overlooked vectors?

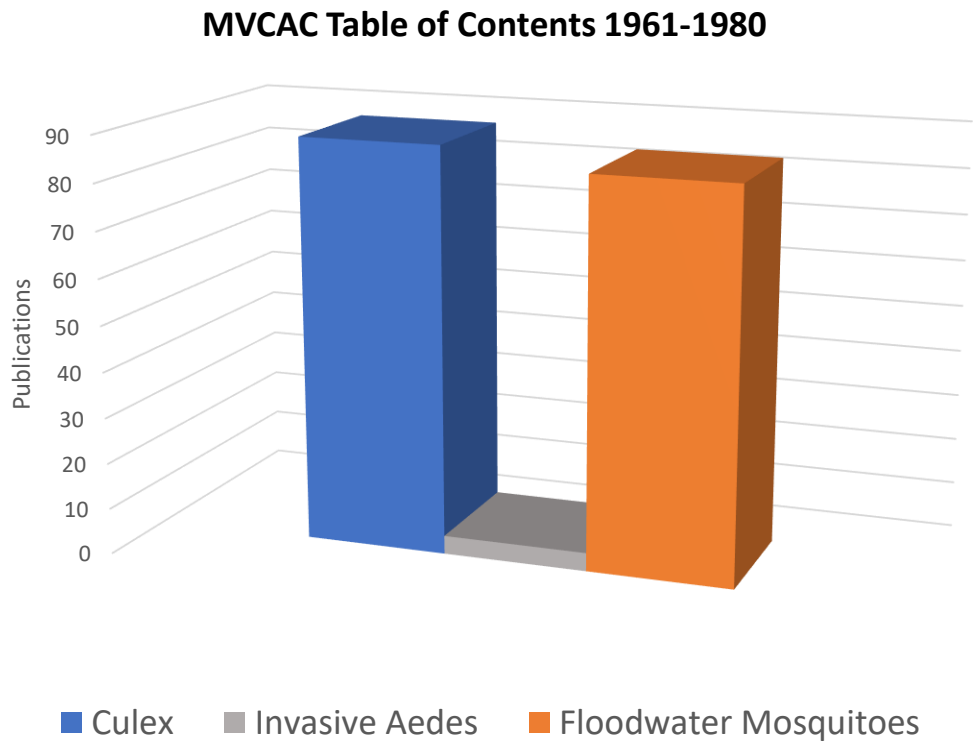
Review of Mosquito and Vector Control Association of California (MVCAC) Proceedings and Papers





Review of MVCAC Proceedings & Papers



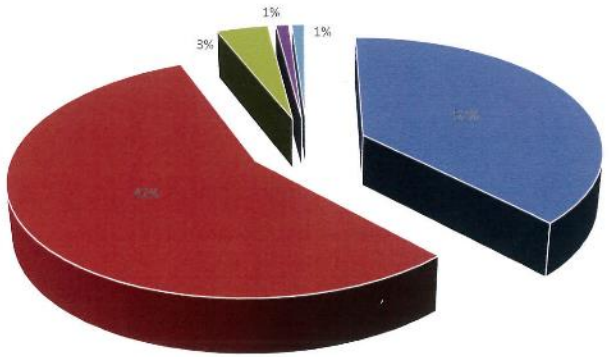


Butte County MVCD, 2018 Annual Report

2018 NEW JERSEY LIGHT TRAP COLLECTIONS
(FEMALES ONLY) MARCH 2018 - NOVEMBER 2018

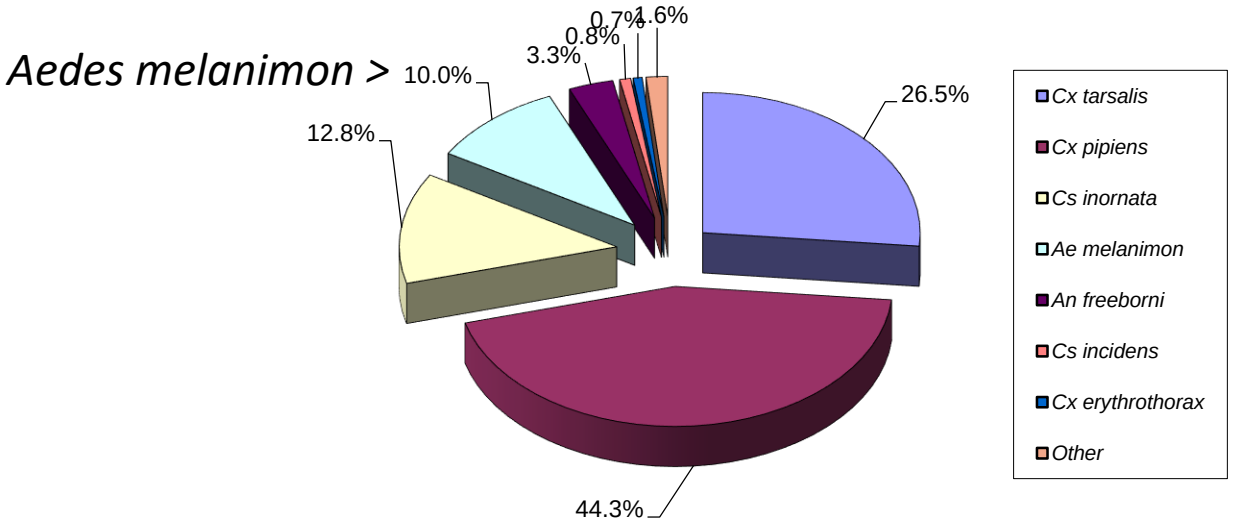
Ranking	Mosquito Species	Number Collected	% (Rounded)
1	*Aedes melanimon*	197627	56%
2	*Anopheles freeborni*	133940	38%
3	*Culex tarsalis*	15540	3%
4	*Culex pipiens*	2429	<1%
5	*Culiseta incidens*	2,414	<1%
6	*Culiseta inornata*	2,181	<1%
7	*Anopheles franciscanus*	652	<1%
8	*Aedes vexans*	212	<1%
9	*Aedes sierrensis*	158	<1%
10	*Culex stigmatosoma*	46	<1%
11	*Anopheles punctipennis*	38	<1%
12	*Aedes washinoi*	30	<1%
13	*Culex erythrothorax*	4	<1%
	Total Identified =	***355271***	***100.00%***

Aedes melanimon



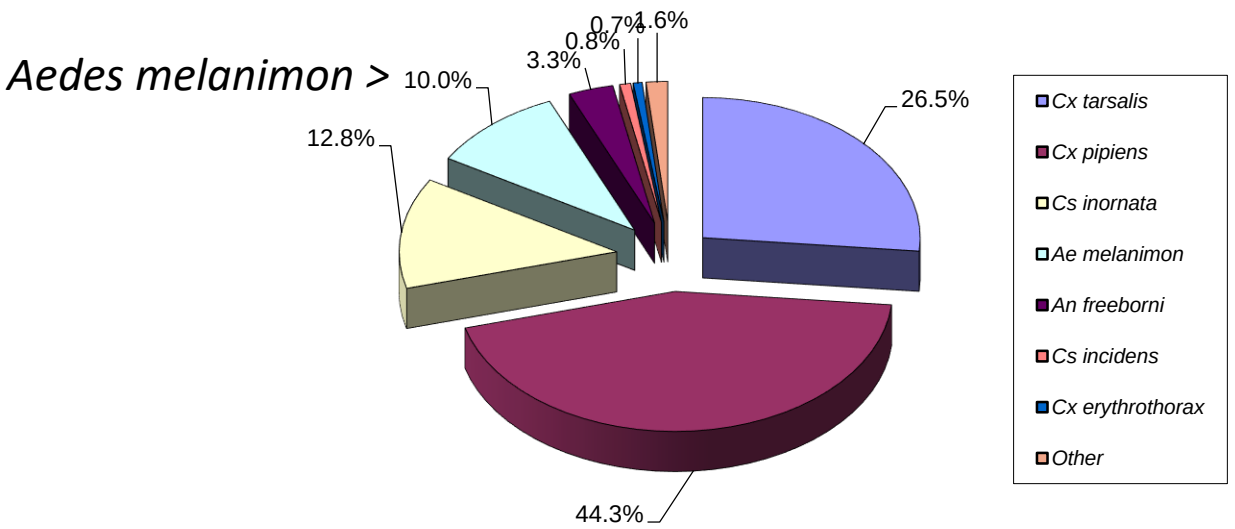
Sacramento-Yolo MVCD, 2019 Annual Report

District-wide American Light Trap Collection Data

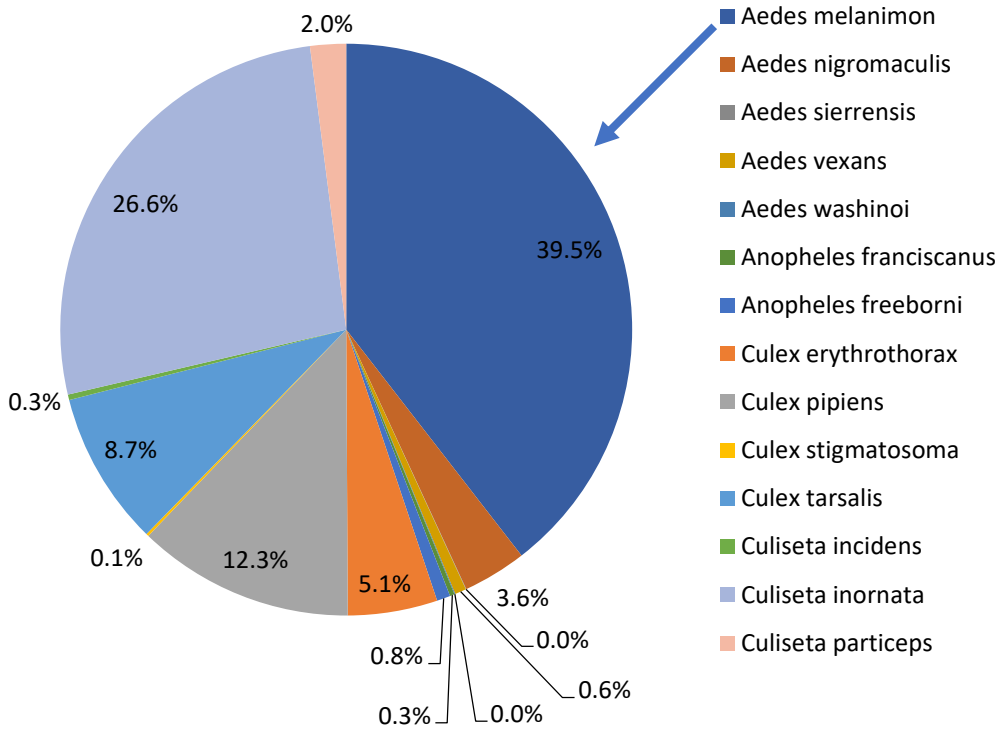


Sacramento-Yolo MVCD, 2019

District-wide American Light Trap Collection Data



Isleton ALT Trap Data 2019



Mosquito adaptations to floodwater habitats

- Eggs laid singly on moist ground
- Dormant egg stage
- Resistant to desiccation
- Asynchronous hatching of eggs
- Rapid larval development
- Oviposition cues:
  - Attractants/Stimulants: water vapor and soil moisture, shade, slope, plant type, leaf litter, inorganic salts
  - Repellents: inorganic salts, predators

Floodwater biotypes

- **Coastal**
- **Floodplain**
- **Irrigation**
- **Woodland / snow pool**



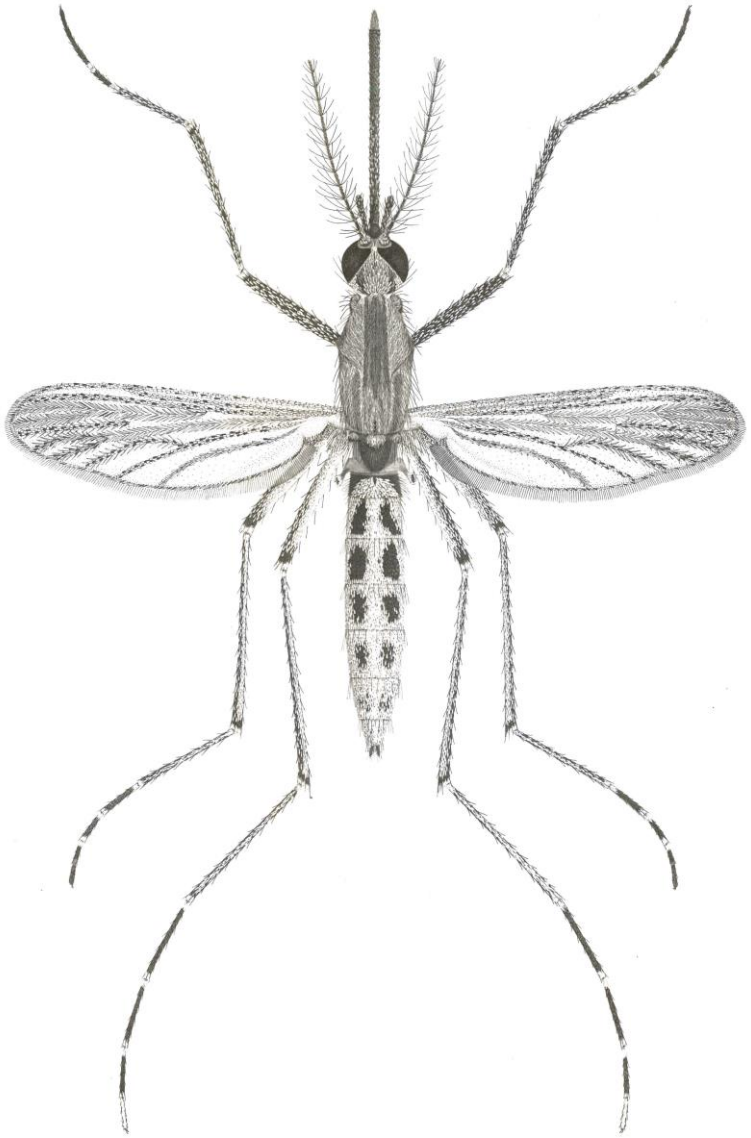

Adapted from: Valent Biosciences webpage: https://www.valentbiosciences.com/publichealth/pests/mosquitoes/mosquitoes-aedes-including-ochlerotatus/

Floodwater biotypes

- ***Coastal***
- General description: Coastal (or saltwater) mosquitoes develop in low-lying plains in coastal areas which include salt marshes, brackish swamps, and dredge spoils.
- Common coastal mosquitoes:
  - *Aedes dorsalis*
  - *Aedes squamiger*
  - *Aedes taeniorhynchus*

Aedes dorsalis

- Coastal saltmarshes, inland alkaline areas of the Central Valley, Great Basin and southeastern deserts
- Larvae tolerant of high salt content
- Multivoltine, spring to fall
- Day/evening biting
- Flies significant distances

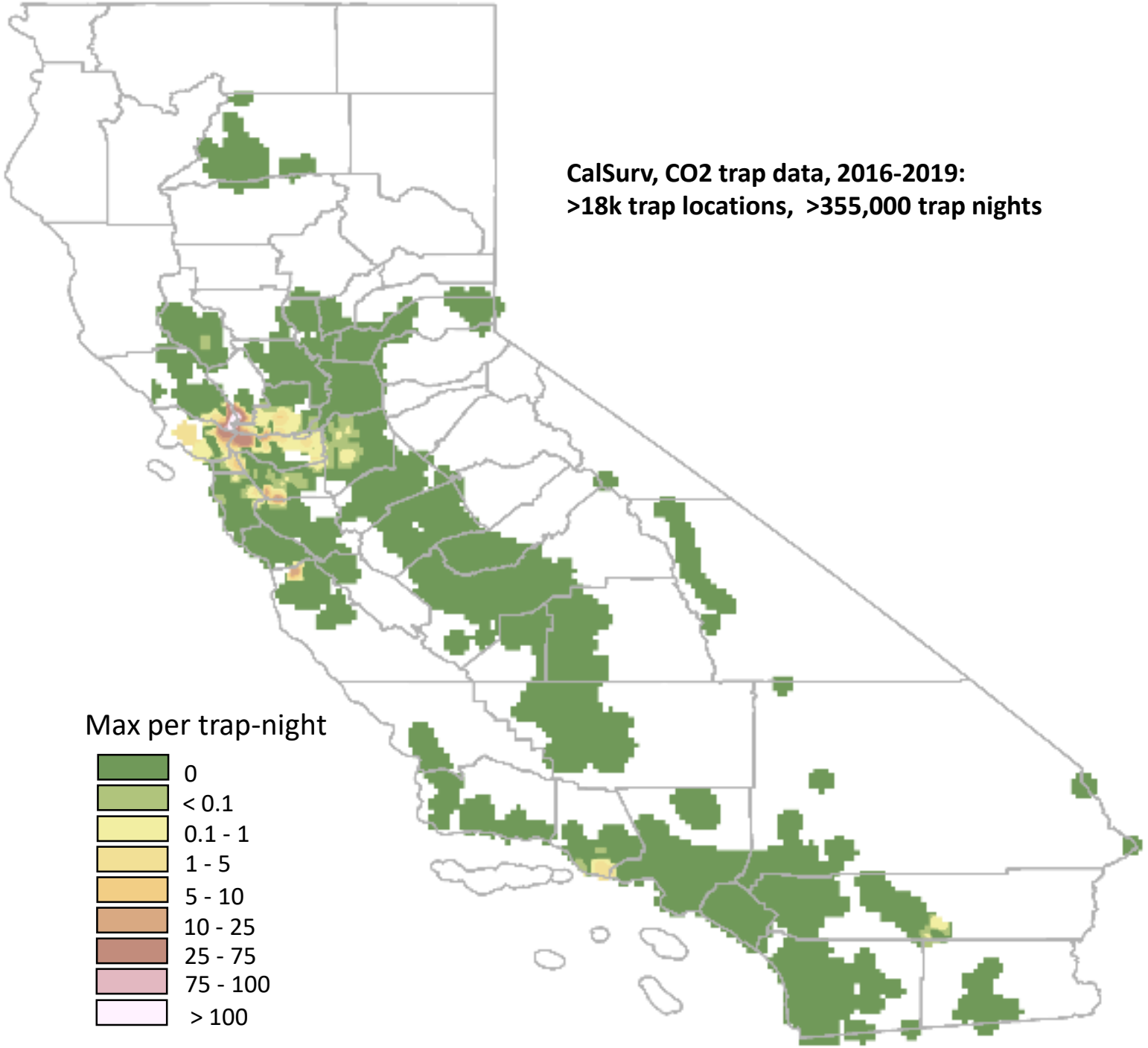


Carpenter and LaCasse, 1955.
Mosquitoes of North America

Aedes dorsalis

County collection records from:
MVCAC Identification of the Mosquitoes of California, 1998

CalSurv, CO2 trap data, 2016-2019:
>18k trap locations, >355,000 trap nights



Aedes dorsalis

For more info on CalSurv or VectorSurv:

https://www.youtube.com/watch?v=LySv9DiE340

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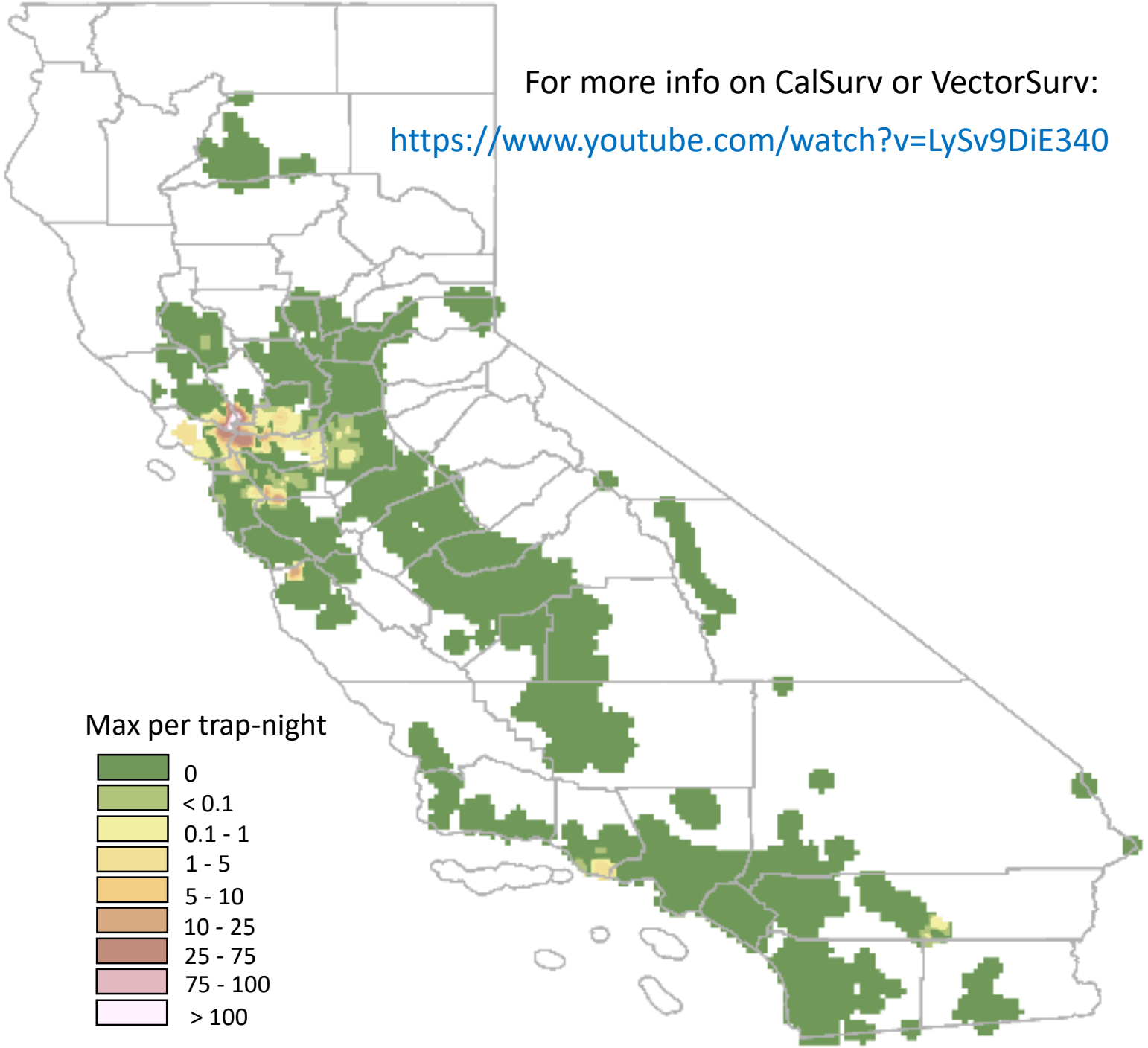
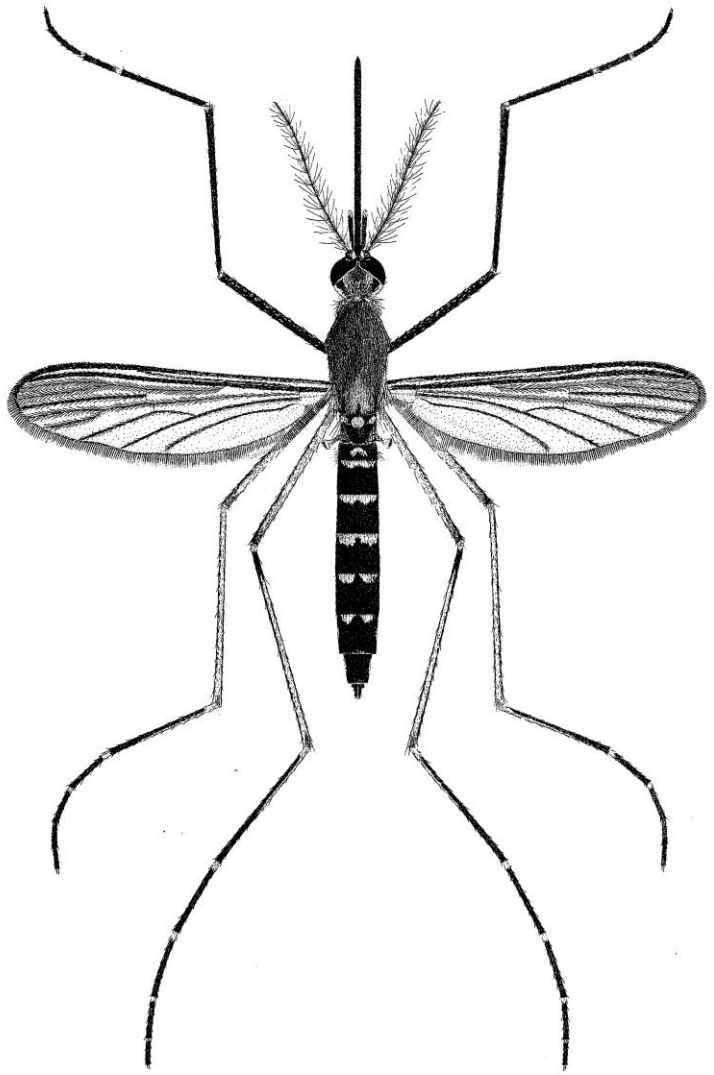


Floodwater biotypes

- ***Floodplain***
- General description: Floodplains include low-lying areas along rivers, streams, and lakes that are temporarily inundated at various points in the year. Other low-lying depressions, such as prairie potholes, are floodplains that will hold water following rain events.
- Common floodplain mosquitoes:
  - *Aedes sticticus*
  - *Aedes vexans*

Aedes vexans

- One of the most common and widely distributed floodwater species in the world.
- Widespread in CA: 33+/58 counties
- Multivoltine
- Breeds in a variety of sites; in CA, shady riparian areas important
- Can be a dog heartworm vector



Carpenter and LaCasse, 1955.
Mosquitoes of North America

Aedes vexans

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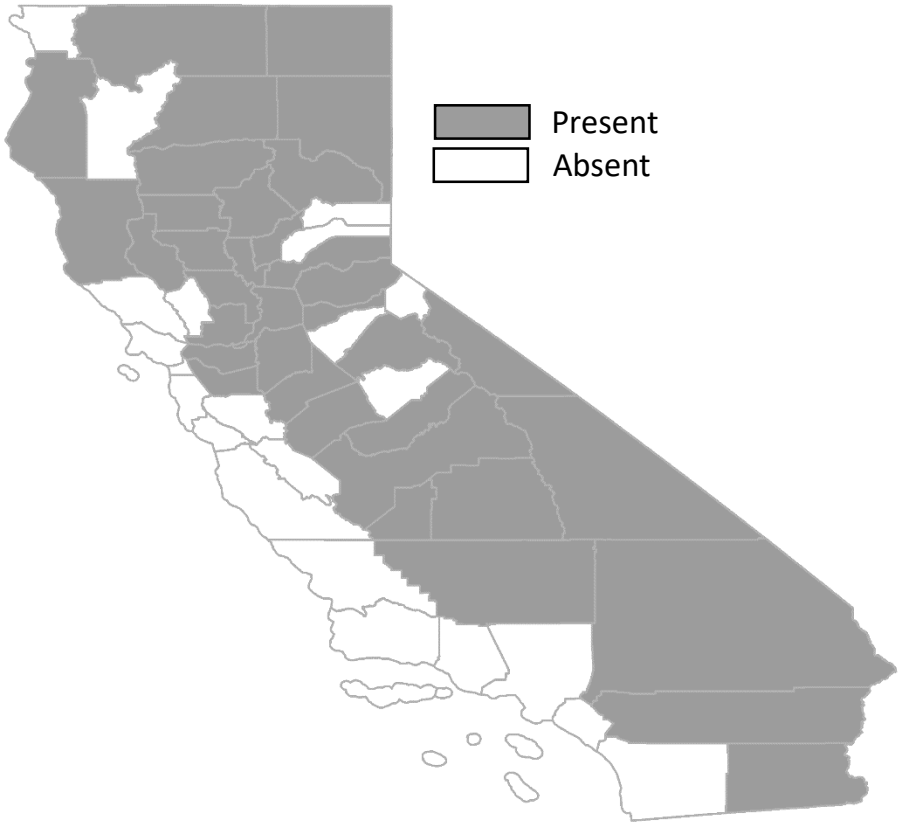

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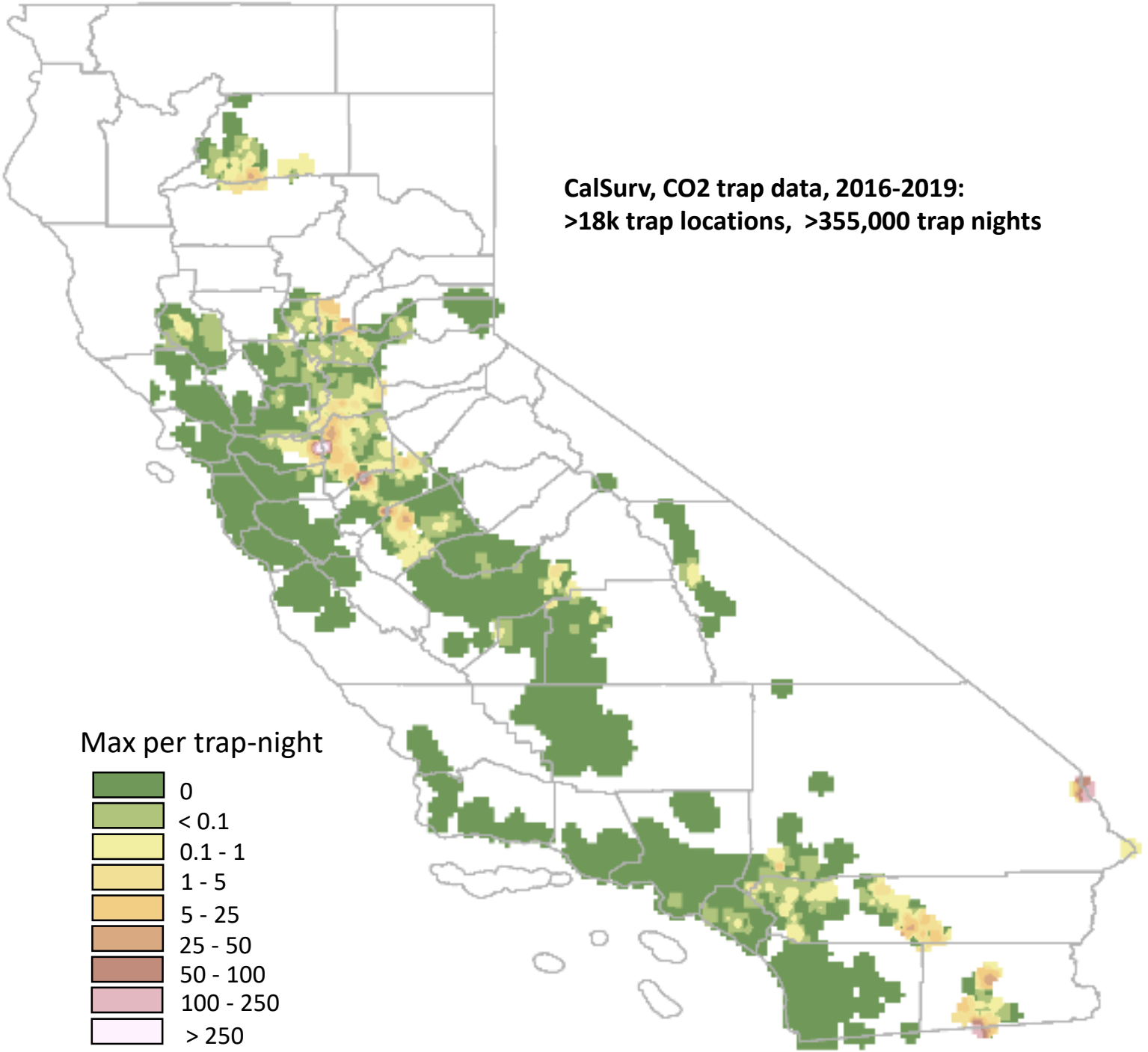
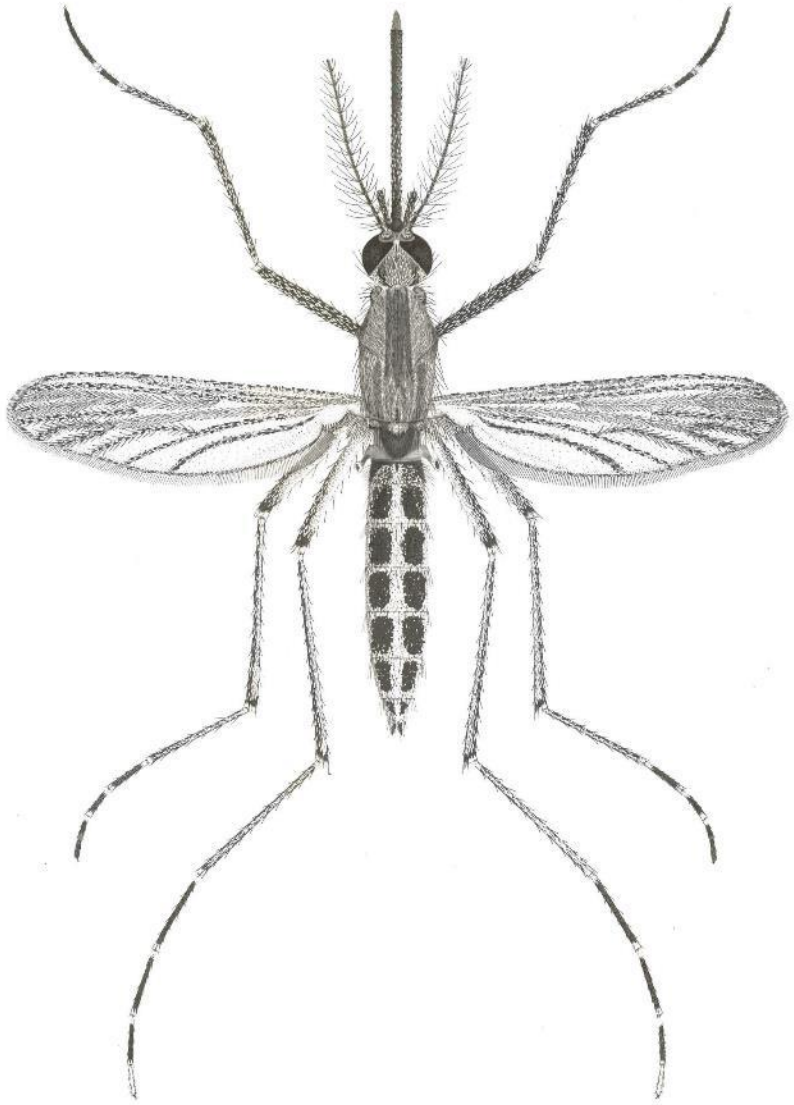


Floodwater biotypes

- ***Irrigation***
- General description: Many species of floodwater mosquitoes have adapted to develop in flood-irrigated habitats including flooded pastures, rice fields, and duck clubs/refuges.
- Common flooded irrigation mosquitoes include:
  - *Aedes melanimon*
  - *Aedes nigromaculis*
  - *Aedes vexans*
  - *Psorophora columbiae*

Aedes melanimon

- The most abundant/problematic floodwater species in the Central Valley and other areas
- Multivoltine, spring to fall
- Semi-open, sunlit, agricultural sources
  - Duck clubs / seasonal wetlands, reflooded rice, pastures
- Persistent biters, daytime – evening
- Secondary WEEV vector; vector of California Encephalitis virus



Aedes melanimon

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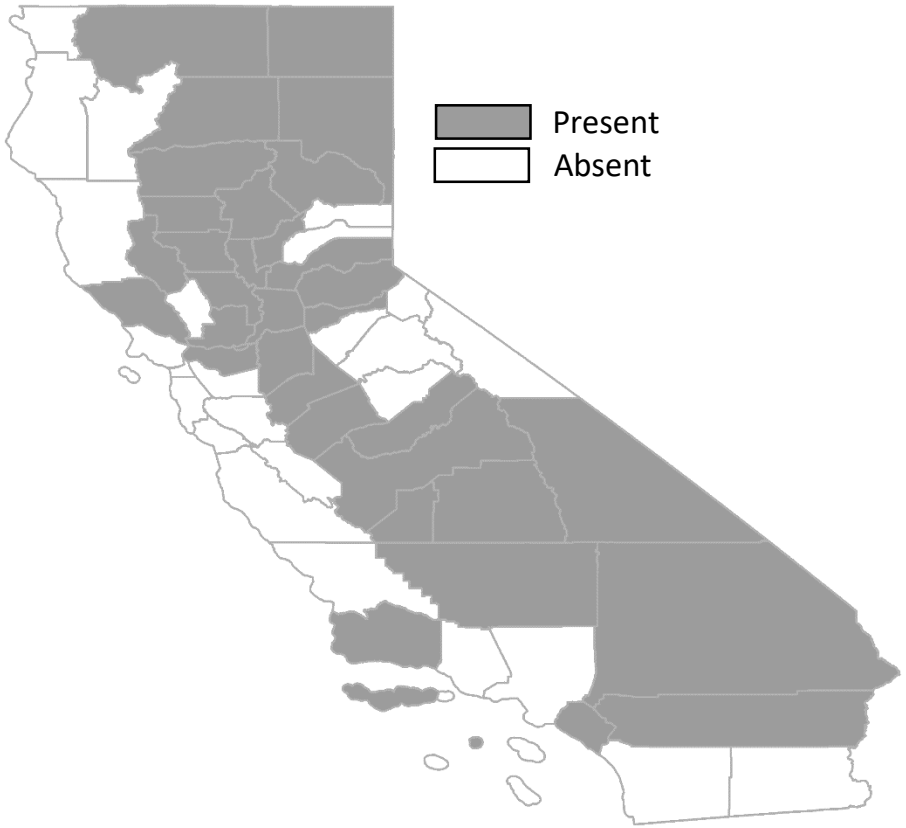

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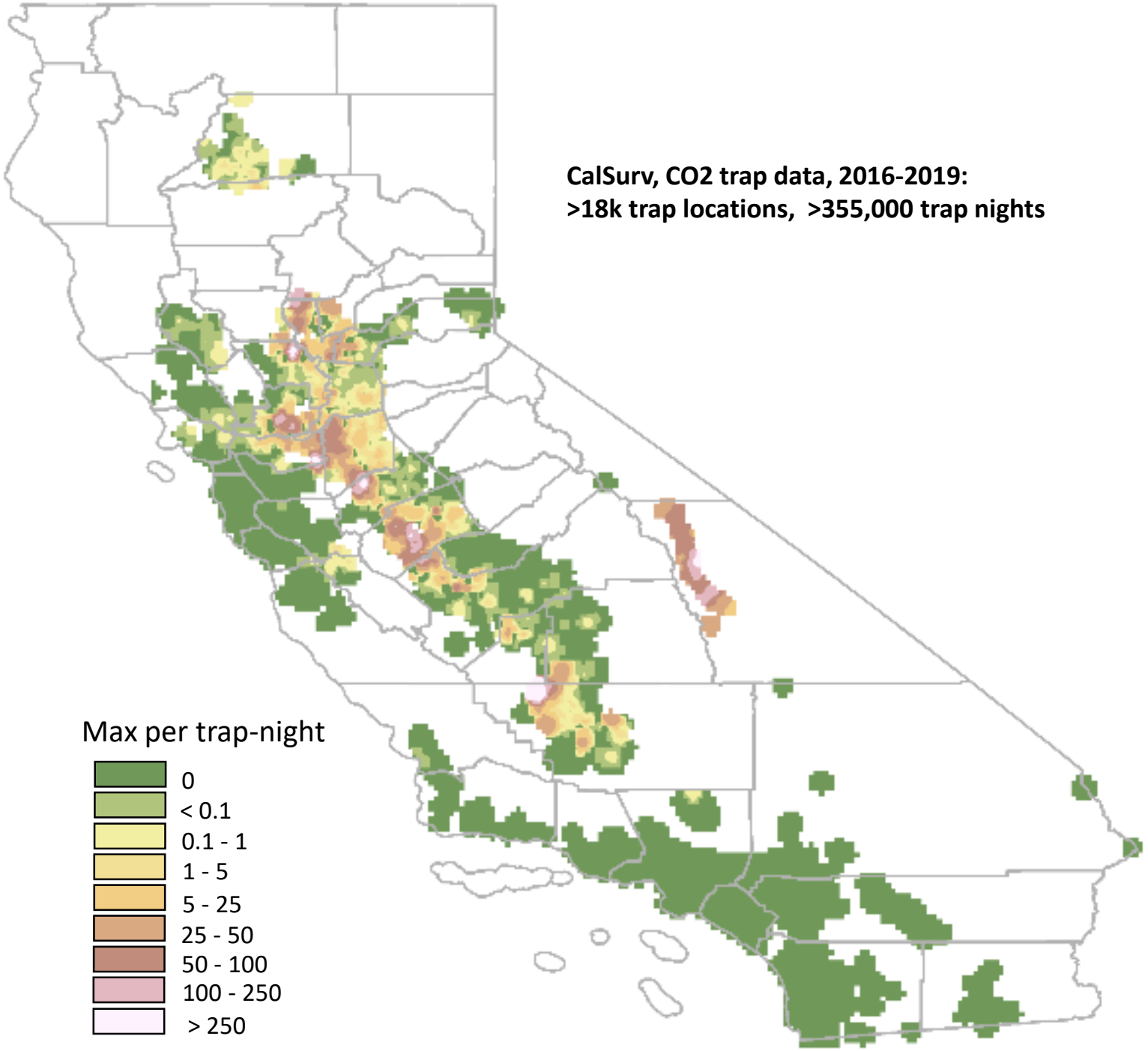
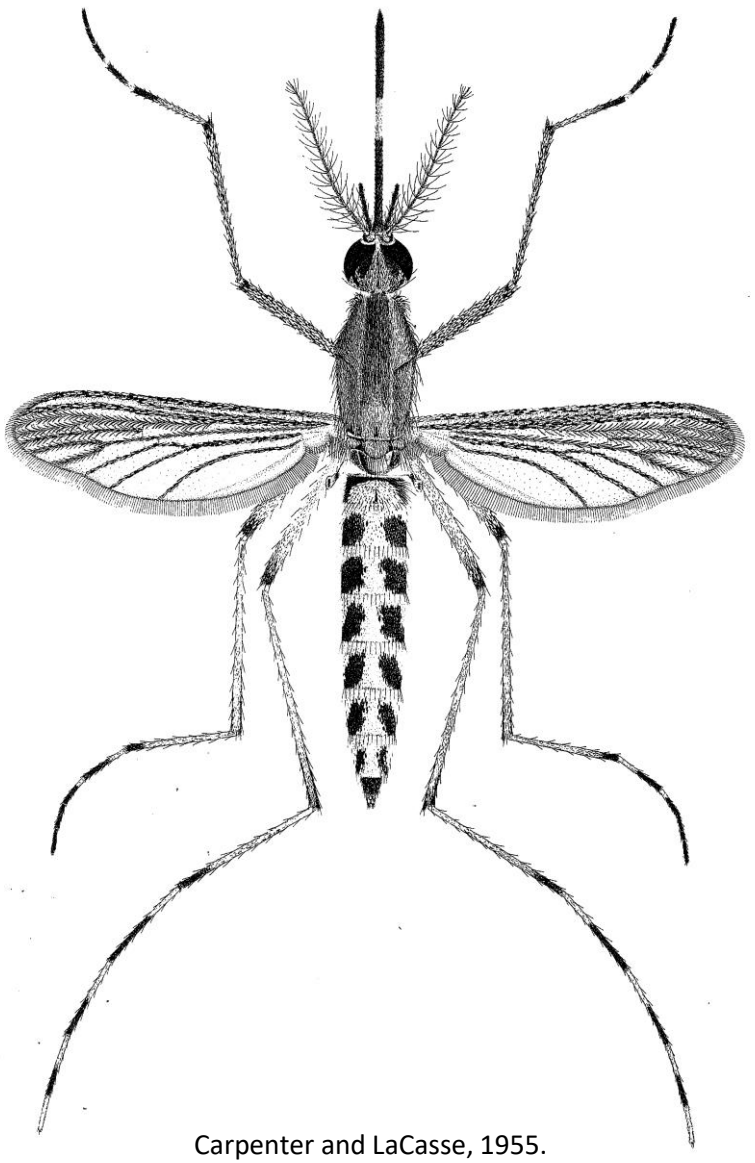


Aedes nigromaculis

- The “irrigated pasture mosquito”
- First found in California in 1937
- Very abundant in Central Valley in 1950s-60s
- Often with *Ae. melanimon*
- Less tolerant of salt content than *Ae. melanimon* and *dorsalis*
- Rapid larval development
- Adults peak in hot summer months
- Vicious day and dusk biters



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Mosquitoes of North America

Aedes nigromaculis

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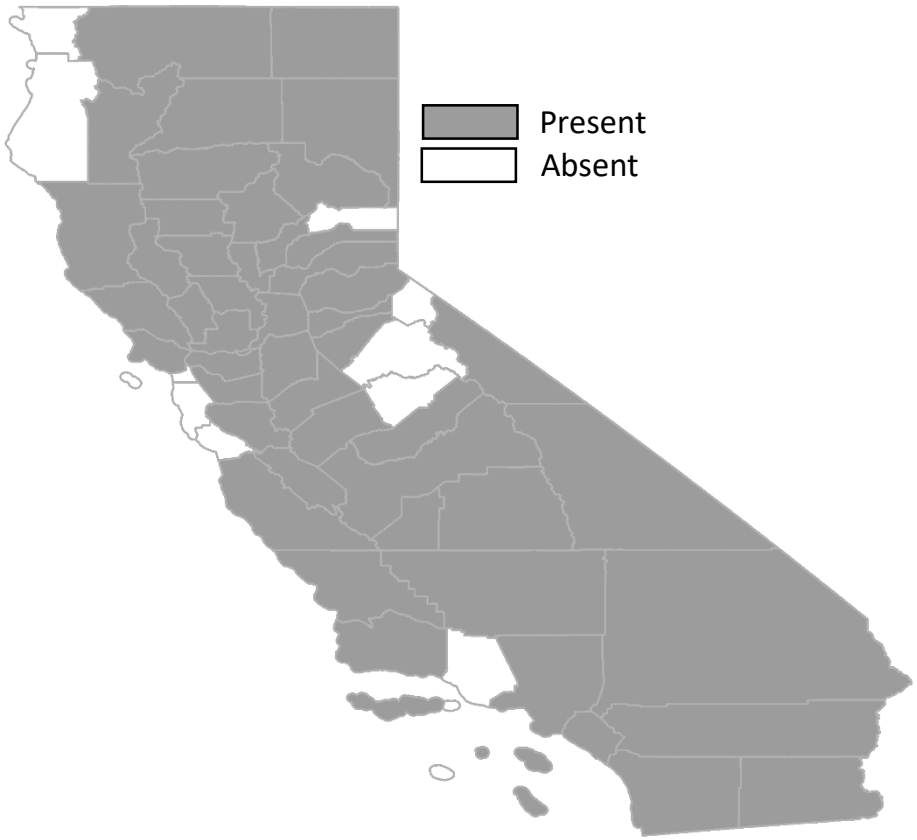

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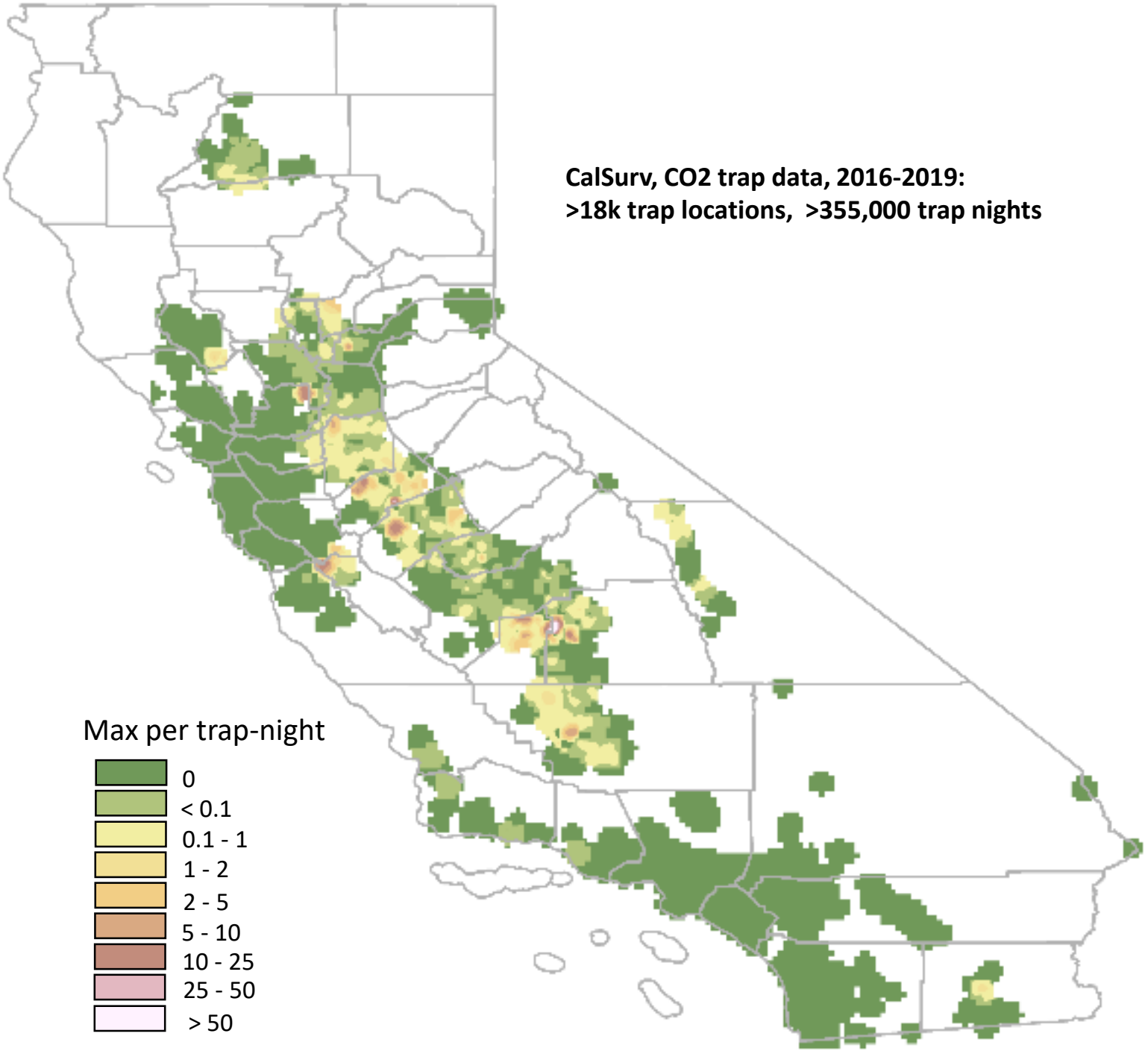
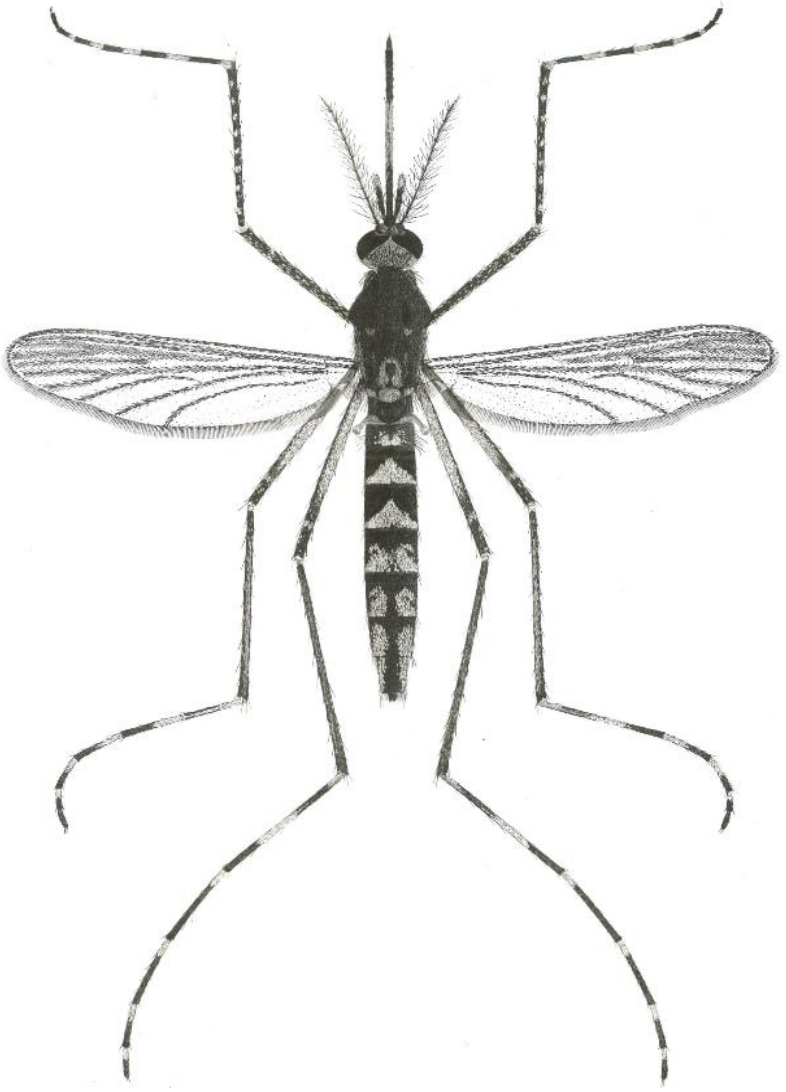


Psorophora columbiae

- The “dark rice-field mosquito”
- Limited distribution in CA: Riverside, San Bernardino, Imperial counties
- Rapid larval development
- Can be locally abundant: Date Palm irrigation



Carpenter and LaCasse, 1955.
Mosquitoes of North America

Psorophora columbiae

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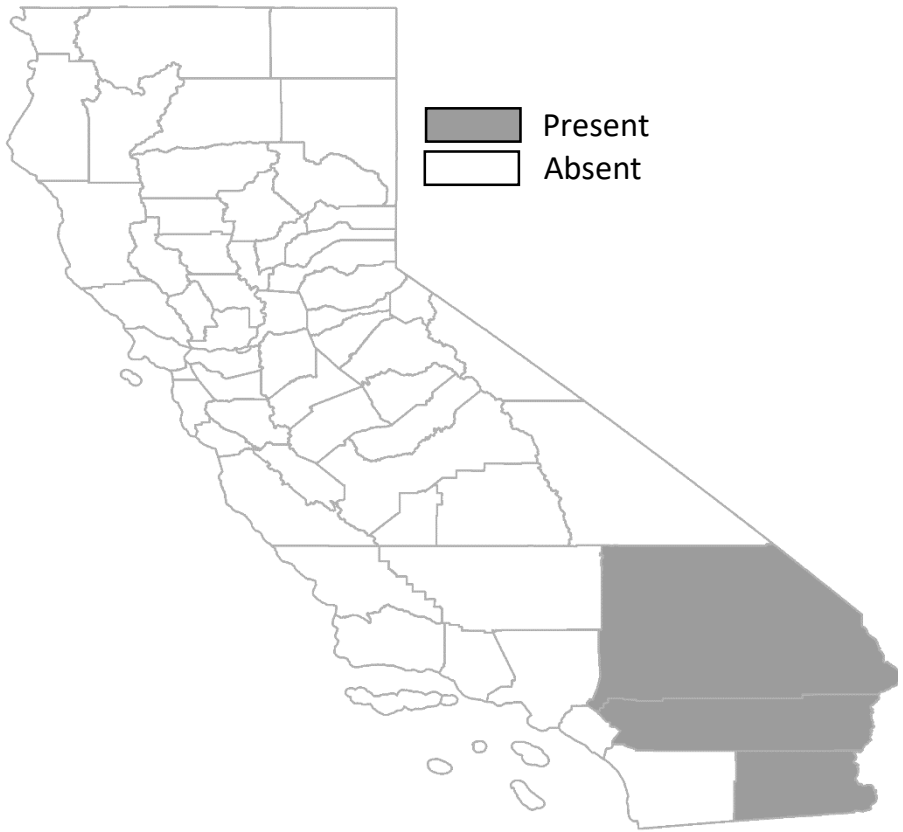

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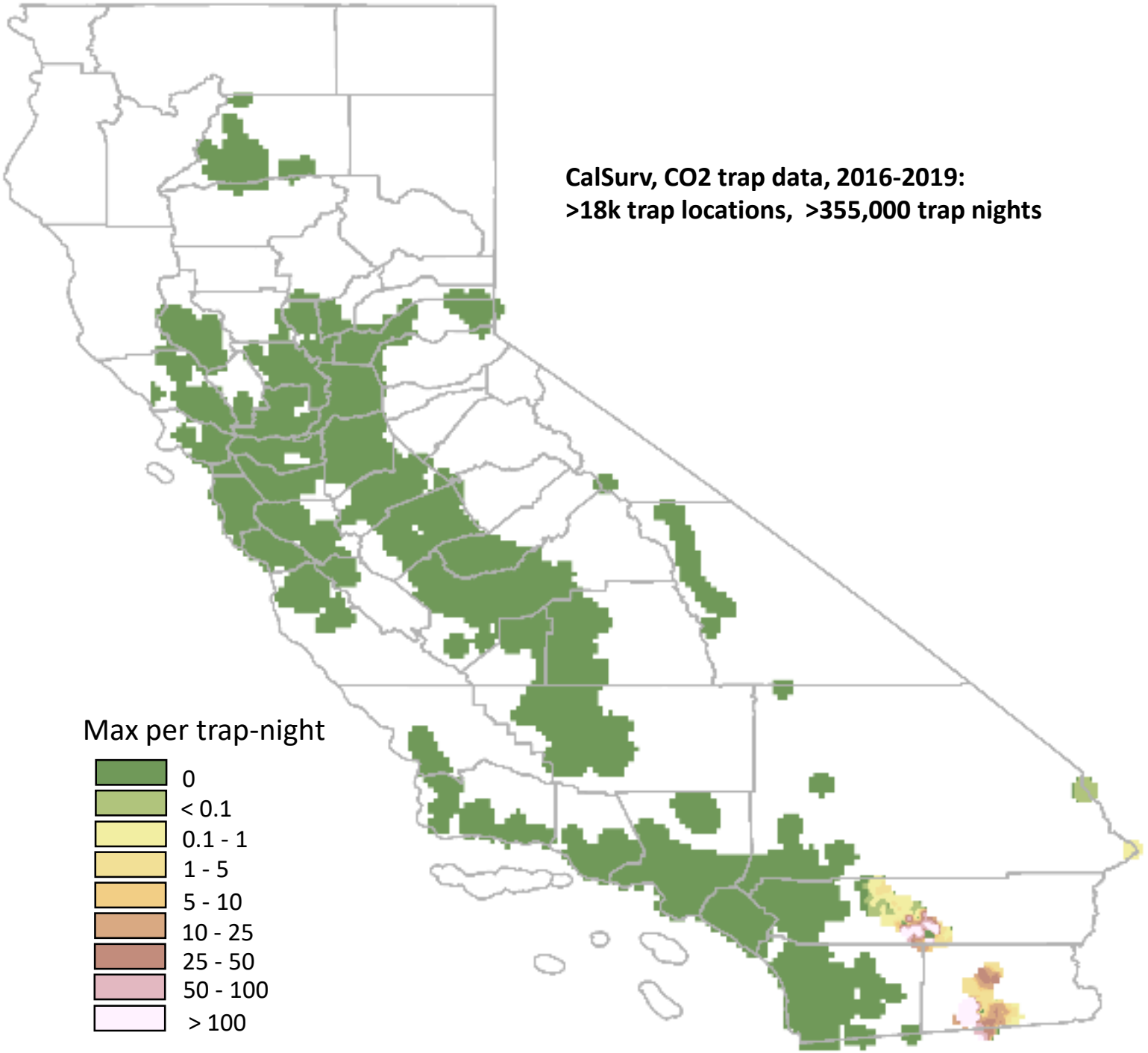
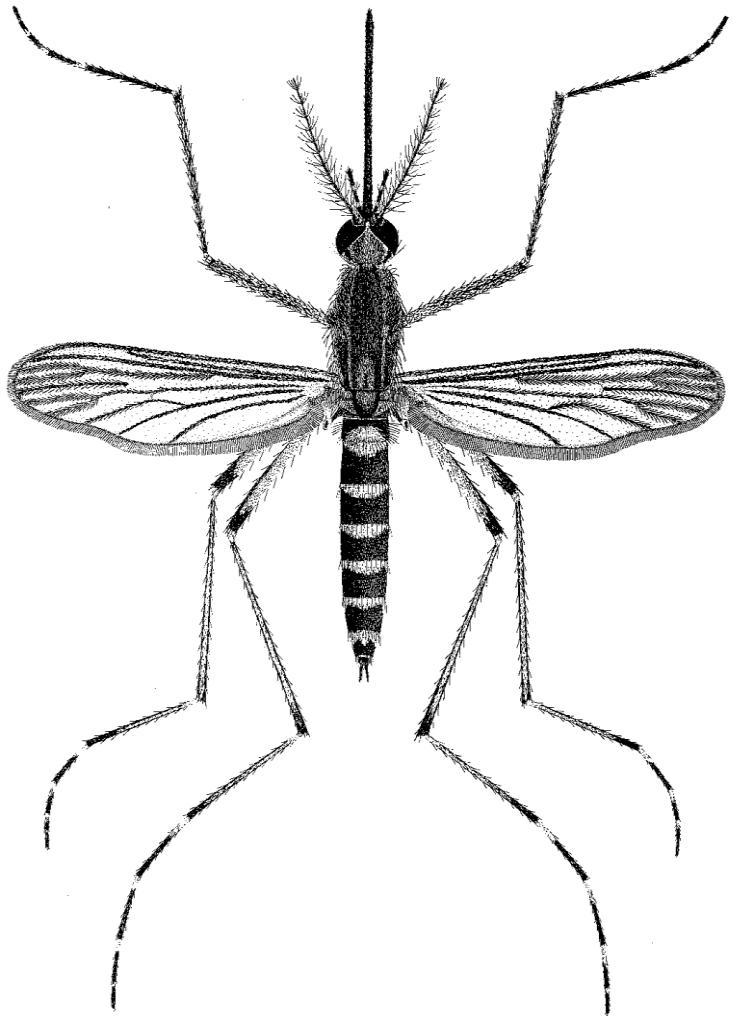


Floodwater biotypes

- ***Woodland / snow pool***
- General description: Woodland pool mosquitoes commonly develop during winter and early spring. Larvae can be found in pools in forested areas following spring snowmelt or rains.
- Common woodland / snow pool mosquitoes:
  - *Aedes cataphylla*
  - *Aedes fitchii*
  - *Aedes hexodontus*
  - *Aedes increpitus* complex
  - *Aedes tahoensis*
  - *Aedes ventrovittus*

Aedes increpitus

- Complex of 3 species: *increpitus, clivis, washinoi*
- Adults are morphologically indistinguishable
- *Ae. washinoi:* coastal and inland
- *Ae. clivis:* west slope of Sierras & Cascades
- *Ae. increpitus:* east side of Sierras & Cascades
- Univoltine/*washinoi* may be multivoltine



Carpenter and LaCasse, 1955. Mosquitoes of North America

Aedes increpitus complex
(*increpitus, clivis* and *washinoi*)

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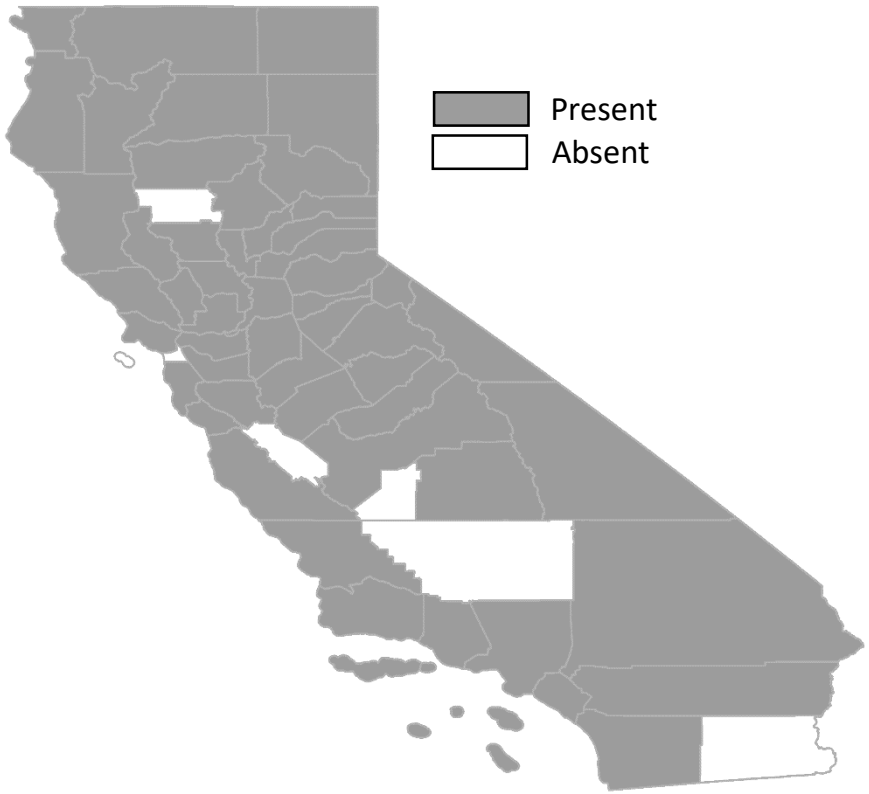
MVCAC Identification of the Mosquitoes of California, 1998



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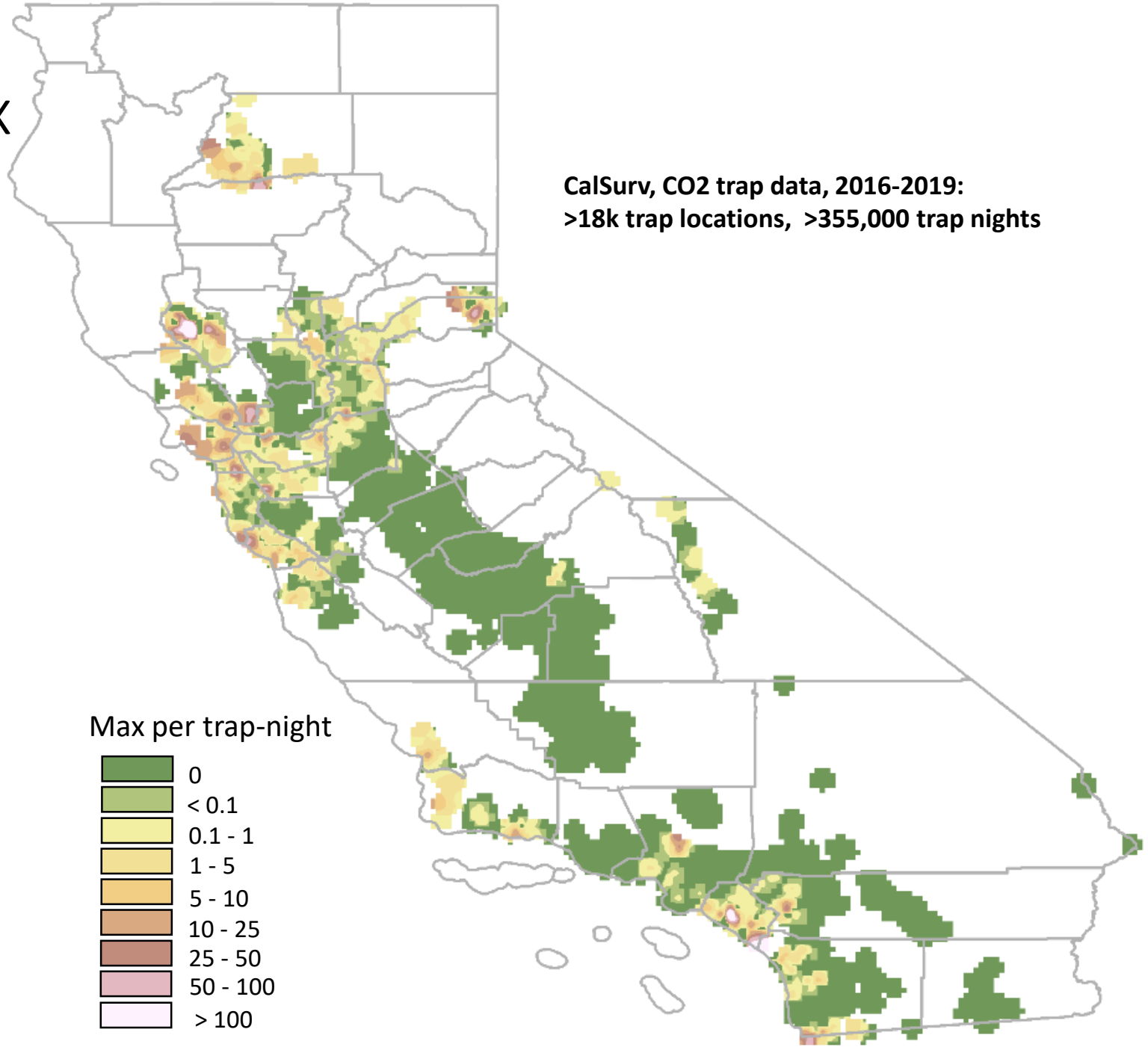

Floodwater mosquito control:

- Reduce/eliminate flood irrigation or other floodwater habitats
- Design/modify seasonal wetlands to reduce mosquito production and increase predators
- Manage vegetation
- Delay or phase flooding in coordination with vector control agencies
- Flood fast / drain fast
- Maintain water levels and depth
- Inspect and maintain water conveyances
- Larvicides and adulticides

Thank you to:

- Tony Kovach, CDPH VBDS

- Butte County MVCD
- Coachella Valley MVCD
- Colusa MAD
- County of San Diego Vector Control Program
- Greater LA County VCD
- Lake County VCD
- MVMD of Santa Barbara County
- Orange County MVCD
- Owens Valley MAP
- Sacramento-Yolo MVCD
- San Joaquin County MVCD
- Shasta MVCD