



# **West Nile Virus in**

# **Ft. Collins, Colorado 2003**

# **Surveillance and Vector Control**

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Fort Collins, CO**



# Collaborators

- **Larimer County Dept. of Health and Environment**
- **City of Fort Collins**
- **Colorado Dept. of Public Health and Environment**
- **Colorado Mosquito Control**
- **Dynamic Aviation**
- **Colorado State University: Dept. of Forest, Rangeland, and Watershed Stewardship**
- **CDC-DVBID**
  - **Arbovirus Ecology Laboratory**
  - **Arbovirus Epidemiology Activity – ArboNET**

# Project Goals

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- **Identify primary vector species and infection rates associated with the epidemic.**
- **Evaluate mosquito-based surveillance indices as predictors.**
- **Evaluate mosquito control effects.**
  - **Mosquito density**
  - **Human cases**

# Fort Collins, Colorado



- **5,000 feet above sea level**
- **High plains / agriculture to East**
- **Rocky Mountain Foothills to West**
- **126,848 residents**
- **51,236 housing units**
- **49.43 square miles**
- **436 street miles**

# **The West Nile Virus Epidemic**

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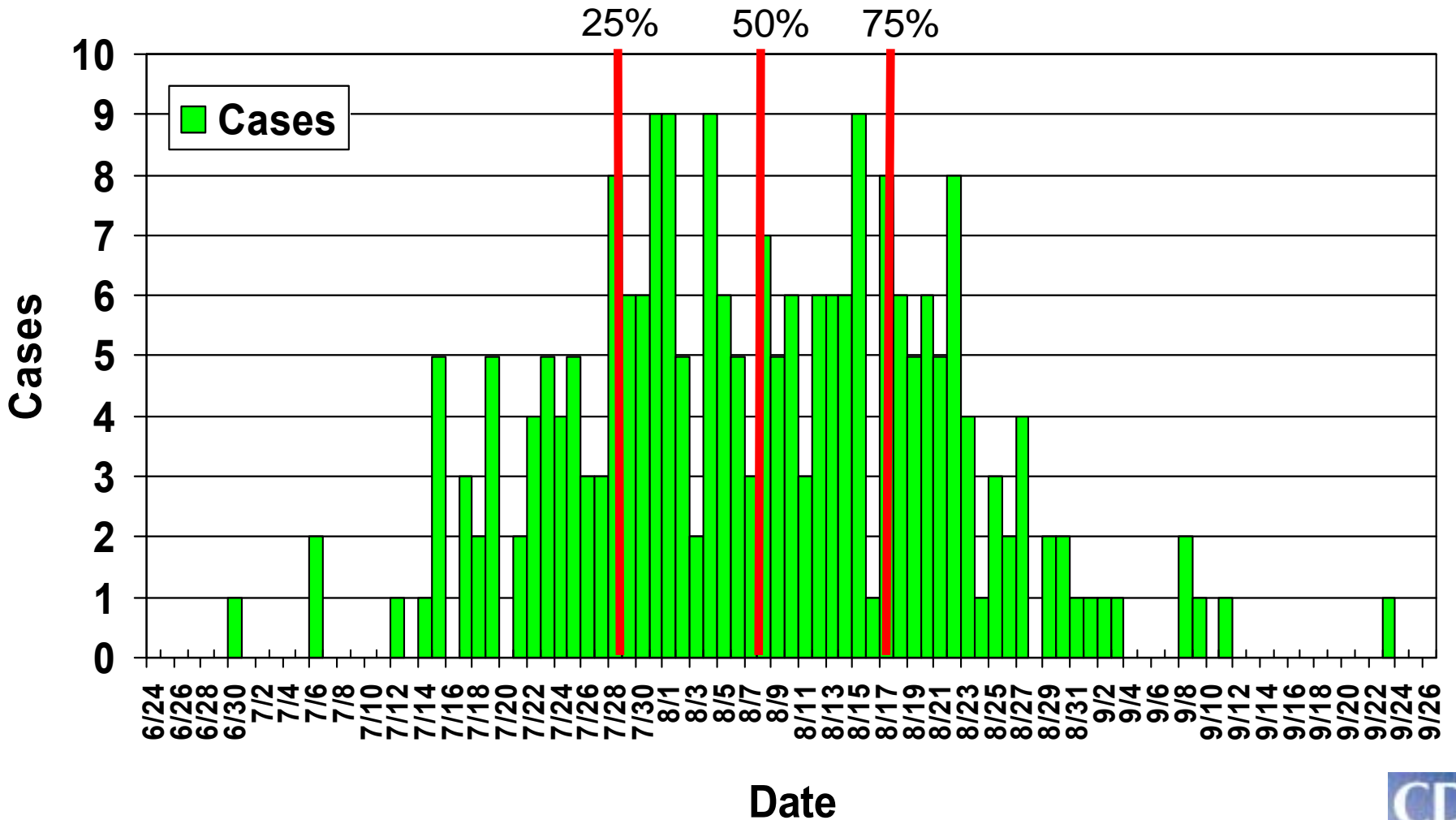
**Fort Collins, Colorado  
2003**

# 2003 Fort Collins Cases used in analyses

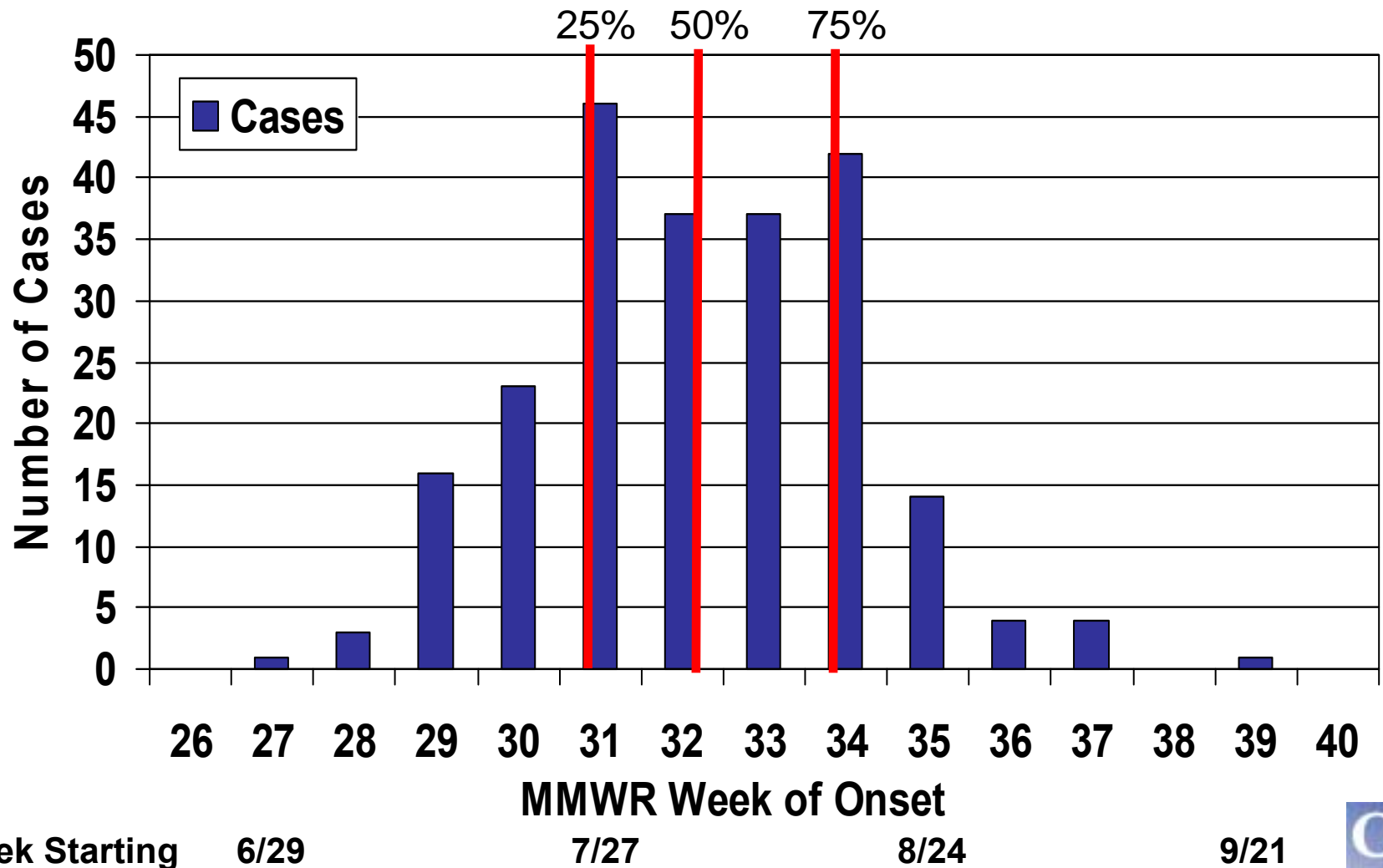
Location	Onset date type	Number
	<b>Total</b>	<b>228</b>
<b>Within City</b>	<b>Known</b>	<b>183</b>
<b>≤1 mile from city</b>	<b>Known</b>	<b>45</b>

Diagnosis	Number	Percent
<b>WN Encephalitis</b>	<b>4</b>	<b>1.8%</b>
<b>WN Meningitis</b>	<b>11</b>	<b>4.8%</b>
<b>WN Fever</b>	<b>213</b>	<b>93.4%</b>

# Onset date of 228 cases In Fort Collins or $\leq 1$ mile outside



# Onset date of 228 cases In Fort Collins or $\leq 1$ mile outside





# Geographic Distribution of Ft. Collins WN Cases

2003 WNV Cases  
Fort Collins, CO

## Legend

- WNV Cases
- Roads
- City Limits



0 0.375 0.75 1.5 2.25 3 Miles

Source Data:  
Case information from the Larimer County Health Department  
Spray Route and map layers from City of Fort Collins  
Map Created by Karin Ekshoff  
1/2004

# **Mosquito Surveillance and Control**

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**Fort Collins, Colorado  
2003**

## Colorado Mosquito Control (CMC) Ft. Collins Trap Sites

32 trap locations; Sampled June 24 – Sept 28

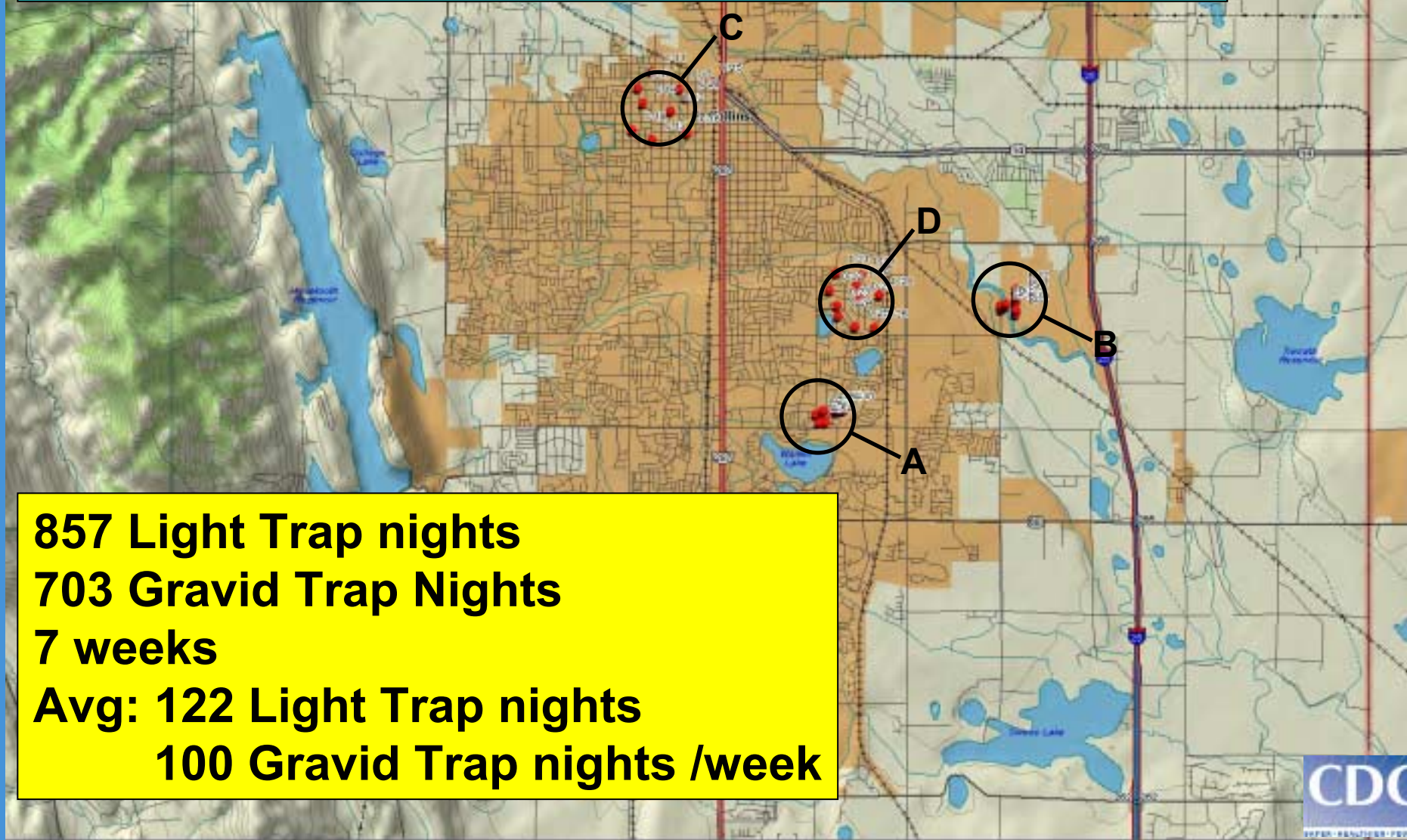
Light traps in ~ 20 sites/week so each site is sampled ~ twice/month

**304 Light Trap nights**

**14 weeks**

**Avg: 21 Light Trap nights/week**

**Centers for Disease Control (CDC) Ft. Collins Trap Sites**  
**4 areas; Sampled Aug 13 – Sept 29**  
**10-12 Light traps and 6-10 gravid traps per night in each area**  
**4 nights/week**



**857 Light Trap nights**  
**703 Gravid Trap Nights**  
**7 weeks**  
**Avg: 122 Light Trap nights**  
**100 Gravid Trap nights /week**

# Ft. Collins Adulticide locations

~13 sq miles

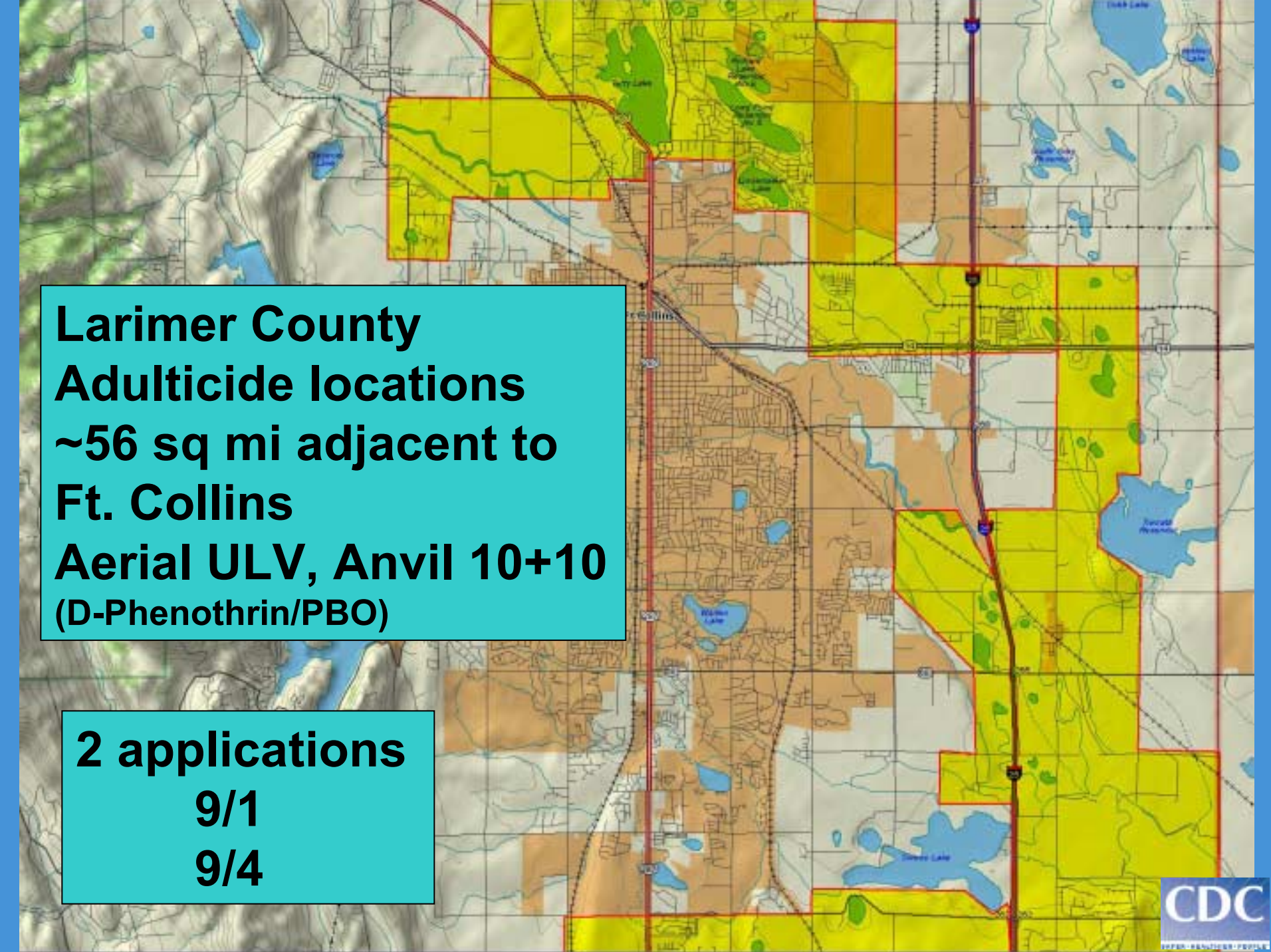
Truck-based ULV, Biomist 3+15 (Permethrin/PBO)

3 applications

8/20-23

8/23-26

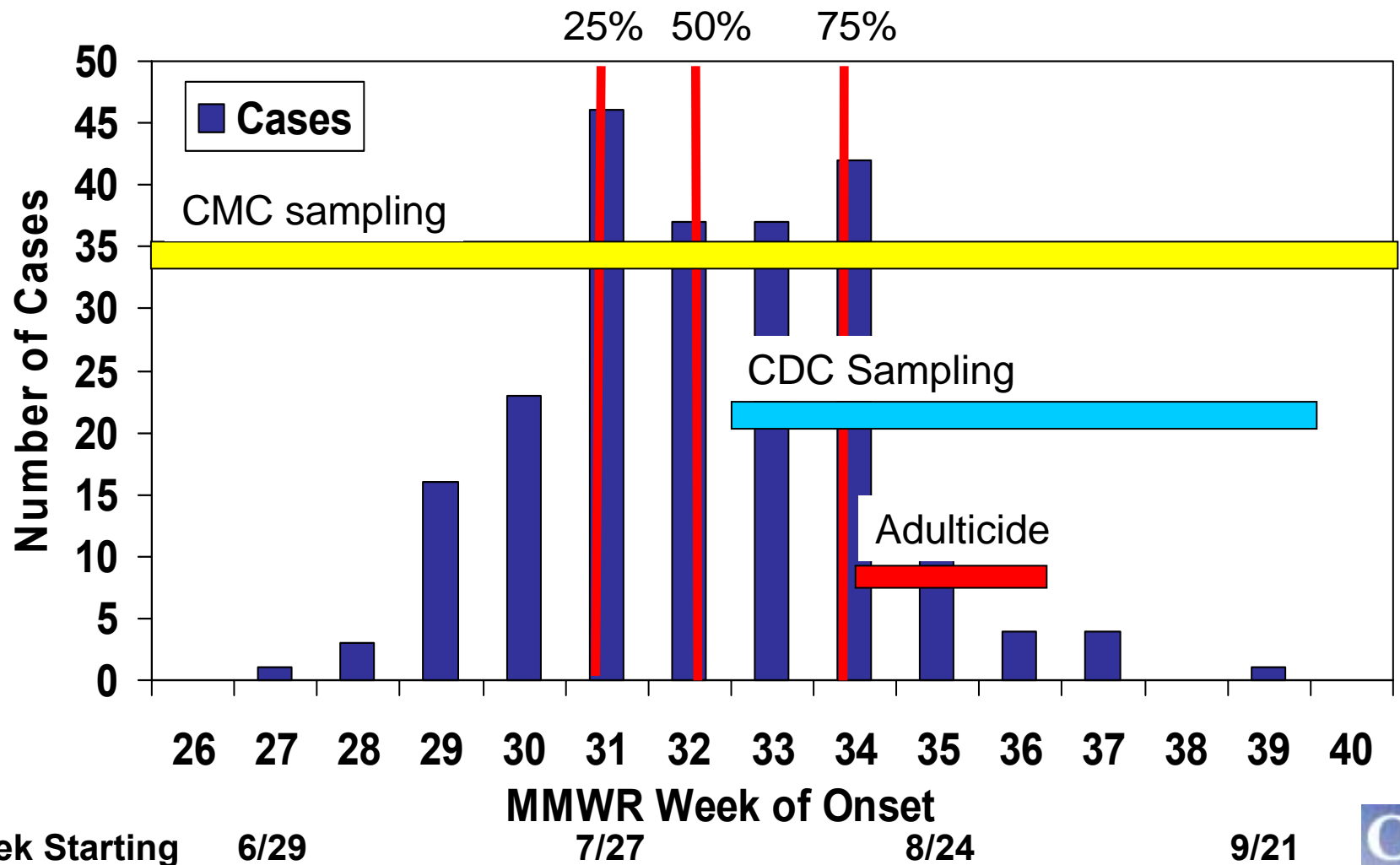
9/3-5



**Larimer County  
Adulticide locations  
~56 sq mi adjacent to  
Ft. Collins  
Aerial ULV, Anvil 10+10  
(D-Phenothrin/PBO)**

**2 applications  
9/1  
9/4**

# Onset date of 228 cases In Fort Collins or $\leq 1$ mile outside (Onset known + assigned)



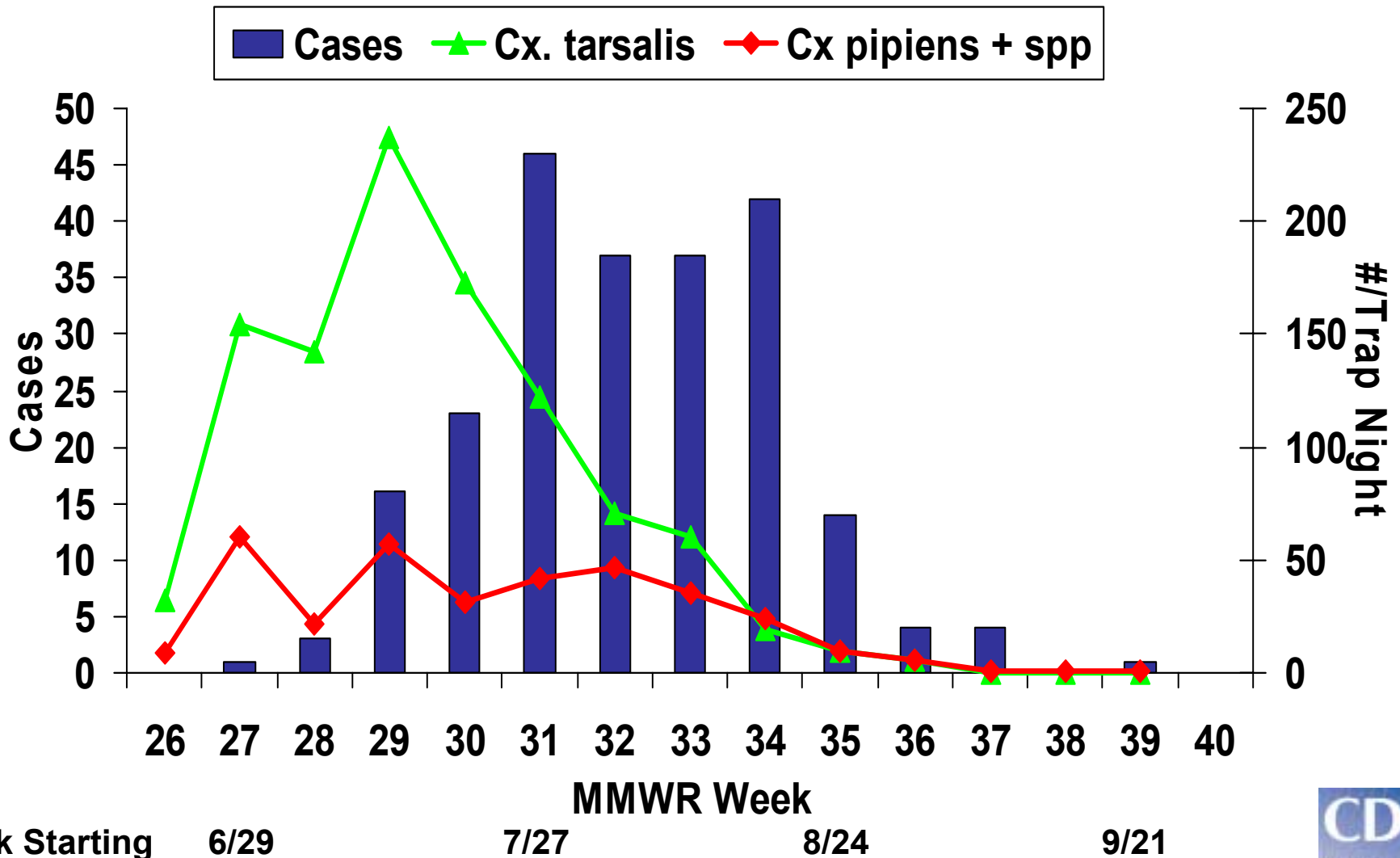
- **Vector species**
- **Infection rates**
- **Mosquito-based surveillance indices**



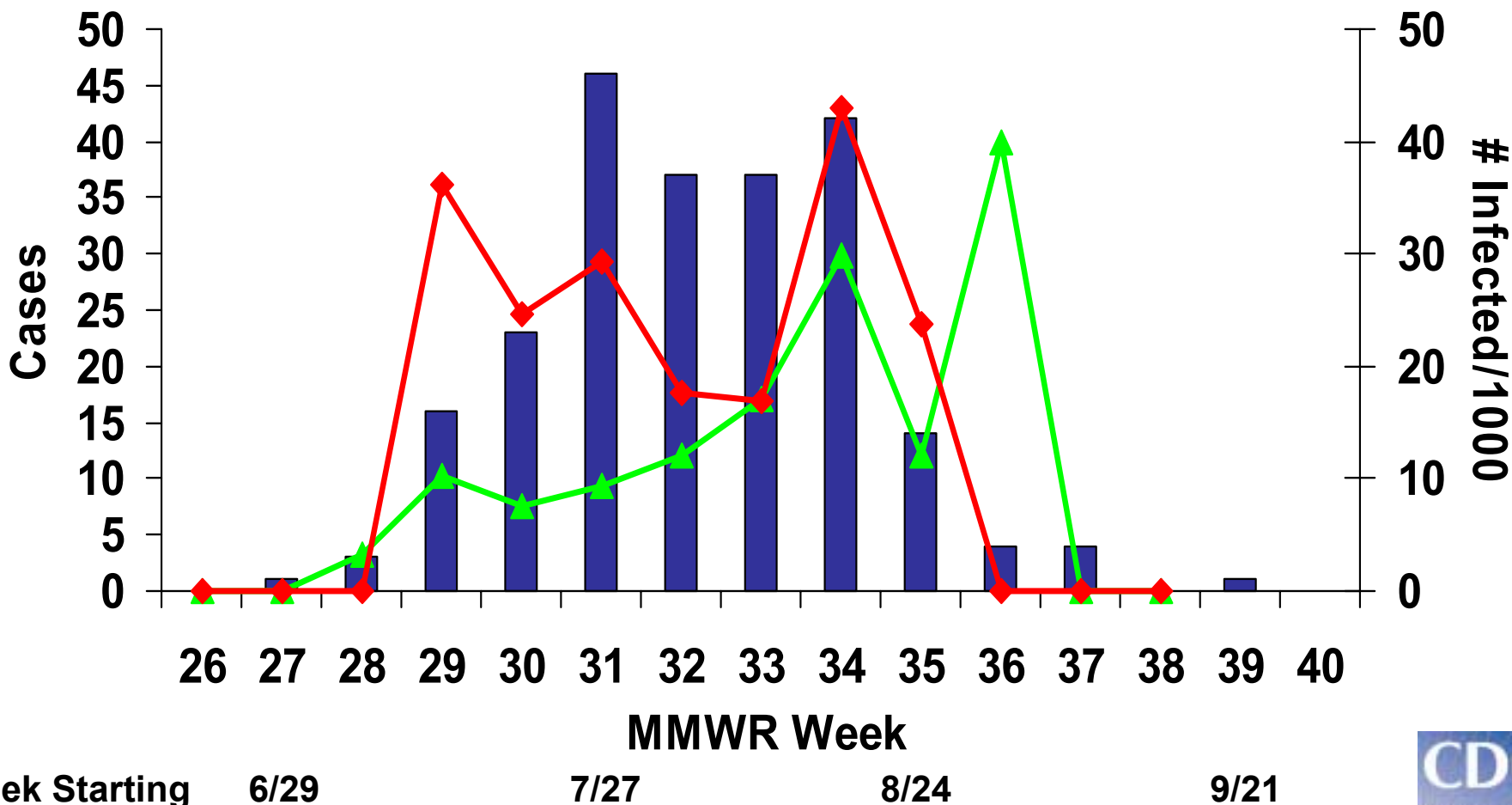
# CMC Light Trap collections

Species (females)	Specimens Collected	Specimens submitted for testing	Isolates
<b><i>Cx. tarsalis</i></b>	<b>24118</b>	<b>6369</b>	<b>45</b>
<b><i>Ae. vexans</i></b>	<b>12810</b>		
<b><i>Cx. species</i></b>	<b>5906</b>	<b>1401</b>	<b>24</b>
<b><i>Cx. restuans</i></b>	<b>2708</b>	<b>38</b>	<b>2</b>
<b><i>Cx. pipiens</i></b>	<b>2242</b>	<b>311</b>	<b>7</b>
<b><i>Cs. inornata</i></b>	<b>1727</b>		
<b><i>Oc. dorsalis</i></b>	<b>1467</b>		
<b><i>Oc. melanimon</i></b>	<b>1109</b>		
<b><i>Cx. salinarius</i></b>	<b>90</b>		
<b><i>Ae. - Oc. species</i></b>	<b>65</b>		
<b><i>Other species</i></b>	<b>29</b>		
<b><i>Oc. trivitattus</i></b>	<b>10</b>		
<b><i>Cs. species</i></b>	<b>6</b>		
<b>Total</b>	<b>52287</b>	<b>8119</b>	<b>78</b>

# CMC Sites: Density and 228 cases in Ft. Collins

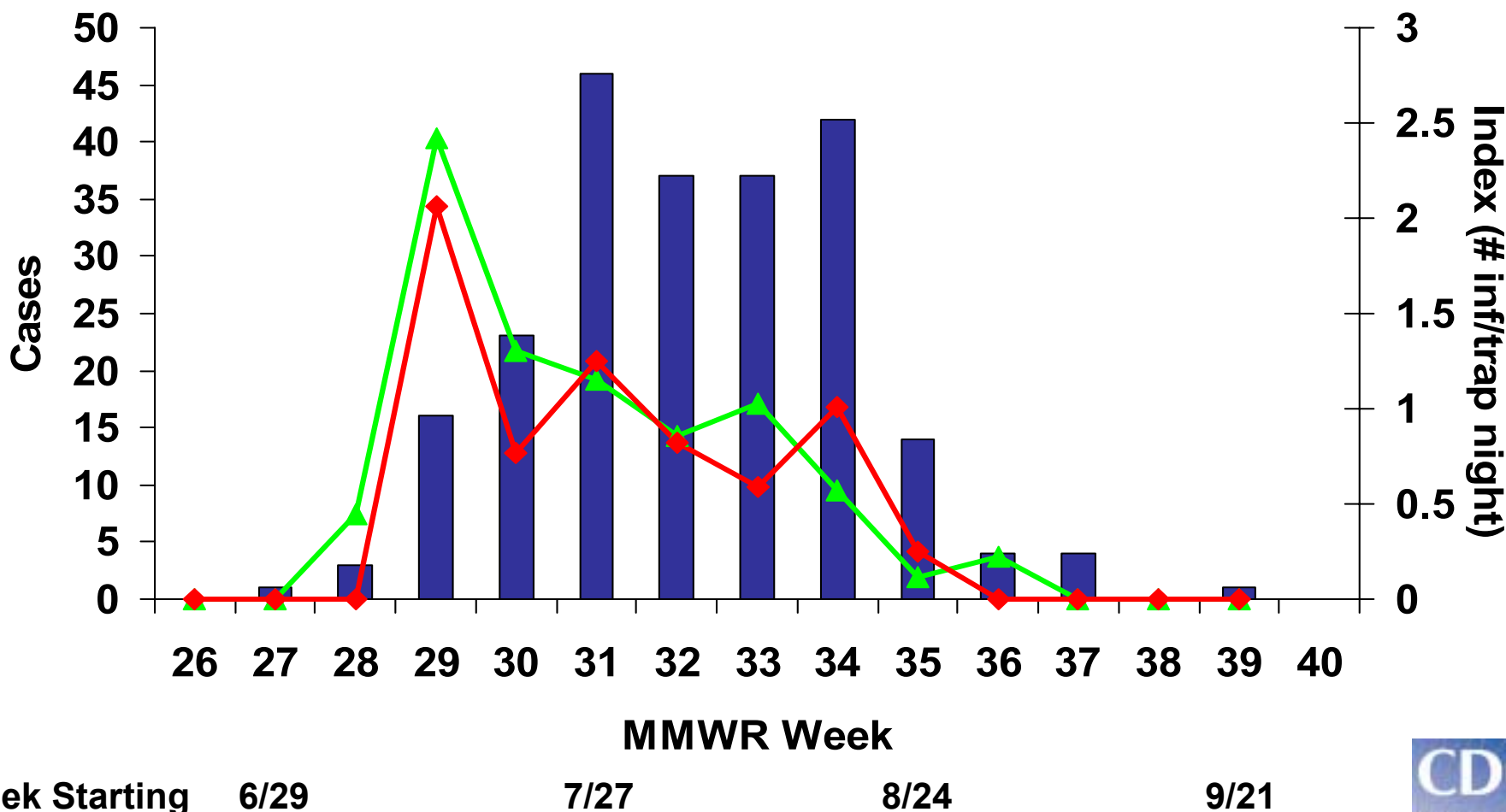


# CMC Sites: Infection rate and 228 cases in Ft. Collins



# CMC Sites: Index (prop infected x density) and 228 cases in Ft. Collins

■ Cases ▲ *Cx. tarsalis* ◆ *Cx. pipiens* + spp



# CDC Light and Gravid Trap Collections

<b>Females</b>	<b>Light Trap</b>		<b>Gravid Trap</b>	
<b>Species</b>	<b>Specimens</b>	<b>Isolates</b>	<b>Specimens</b>	<b>Isolates</b>
<b><i>Ae. vexans</i></b>	<b>10644</b>		<b>121</b>	
<b><i>Cx. tarsalis</i></b>	<b>4795</b>	<b>63</b>	<b>176</b>	<b>3</b>
<b><i>Cx. pipiens</i></b>	<b>1399</b>	<b>33</b>	<b>1158</b>	<b>35</b>
<b><i>An. earlei</i></b>	<b>294</b>		<b>27</b>	
<b><i>Cx. erythrothorax</i></b>	<b>279</b>	<b>2</b>	<b>4</b>	<b>2</b>
<b><i>Cx. spp</i></b>	<b>187</b>	<b>8</b>	<b>251</b>	<b>4</b>
<b><i>Oc. hendersoni</i></b>	<b>172</b>		<b>11</b>	
<b><i>Cs. inornata</i></b>	<b>118</b>		<b>18</b>	
<b><i>Oc. melanimon</i></b>	<b>103</b>	<b>2</b>	<b>3</b>	
<b><i>Oc. spp</i></b>	<b>103</b>		<b>2</b>	
<b><i>Oc. dorsalis</i></b>	<b>67</b>		<b>2</b>	

## CDC Light and Gravid Trap Collections cont.

<b>Females</b>	<b>Light Trap</b>		<b>Gravid Trap</b>	
<b>Species</b>	<b>Specimens</b>	<b>Isolates</b>	<b>Specimens</b>	<b>Isolates</b>
<i>Oc. trivittatus</i>	66		1	
<i>Oc. increpitus</i>	30			
<i>Ae. spp</i>	9		1	
<i>Cs. incidens</i>	8		5	
<i>Cx. salinarius</i>	5		4	
<i>Cx. restuans</i>	2			
<i>Oc. titillans</i>	2			
<i>Oc. intrudens</i>	1			
<i>Oc. nigromaculis</i>	1			
<i>Ps. spp</i>	1			
<i>Cx. territans</i>			1	
<b>Total</b>	<b>18286</b>	<b>108</b>	<b>1785</b>	<b>42</b>

# CDC Light and Gravid Trap Collections cont.

Males	Light Trap		Gravid Trap	
Species	Specimens	Isolates	Specimens	Isolates
<b><i>Cx. tarsalis</i></b>	<b>418</b>	<b>4</b>	<b>114</b>	<b>0</b>
<i>Cx. spp</i>	207		249	0
<i>Cx. pipiens</i>	150		177	0
<i>Ae. vexans</i>	36		5	0
<b><i>An. earlei</i></b>	<b>9</b>	<b>1</b>	<b>2</b>	<b>0</b>
<i>Cs. inornata</i>	8		2	0
<i>Oc. spp</i>	5			0
<i>Ae. spp</i>	3			0
<i>Oc. melanimon</i>	3			0
<i>Cs. incidens</i>	2			0
<i>Oc. increpitus</i>	2			0
<i>Oc. dorsalis</i>	1		1	0
<i>Oc. hendersoni</i>	1			0
<i>Cx. restuans</i>			1	0
<b>Total</b>	<b>845</b>	<b>5</b>	<b>551</b>	<b>0</b>

# CDC Light and Gravid Trap Summary

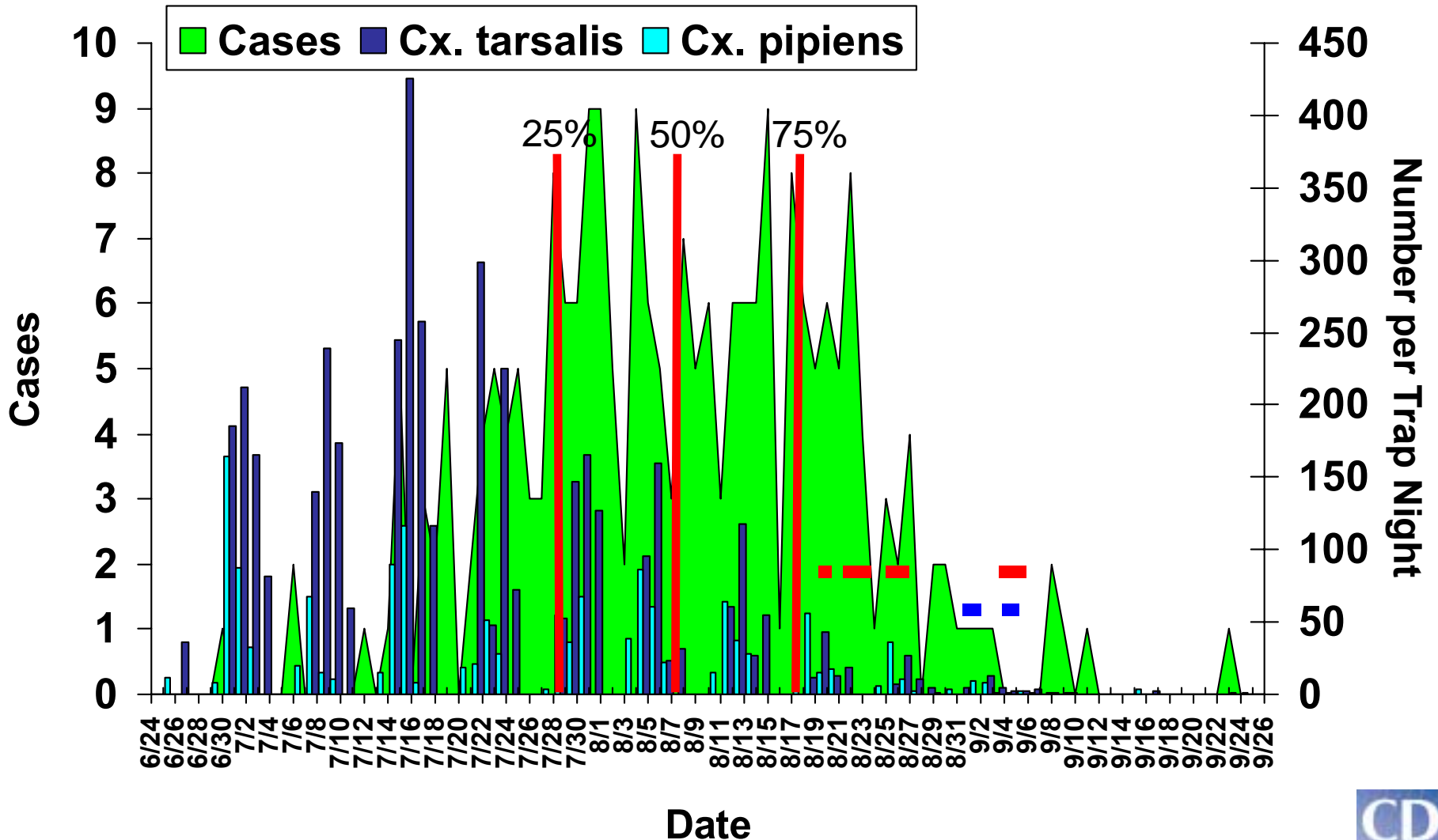
## All Ft. Collins sites combined

- Light trap densities similar to CMC light trap results for both *Cx. tarsalis* and *Cx. pipiens*
- Gravid traps useless for *Cx. tarsalis*
- Unexpectedly large numbers of *Cx. pipiens* in light traps
- Infection rates similar to those found in CMC collections
- IR of 133/1000 (95% CI 66.5 – 261.2) in *Cx. pipiens* collected from gravid traps week 33.



- **Evaluate mosquito control effects.**
  - **Mosquito density**

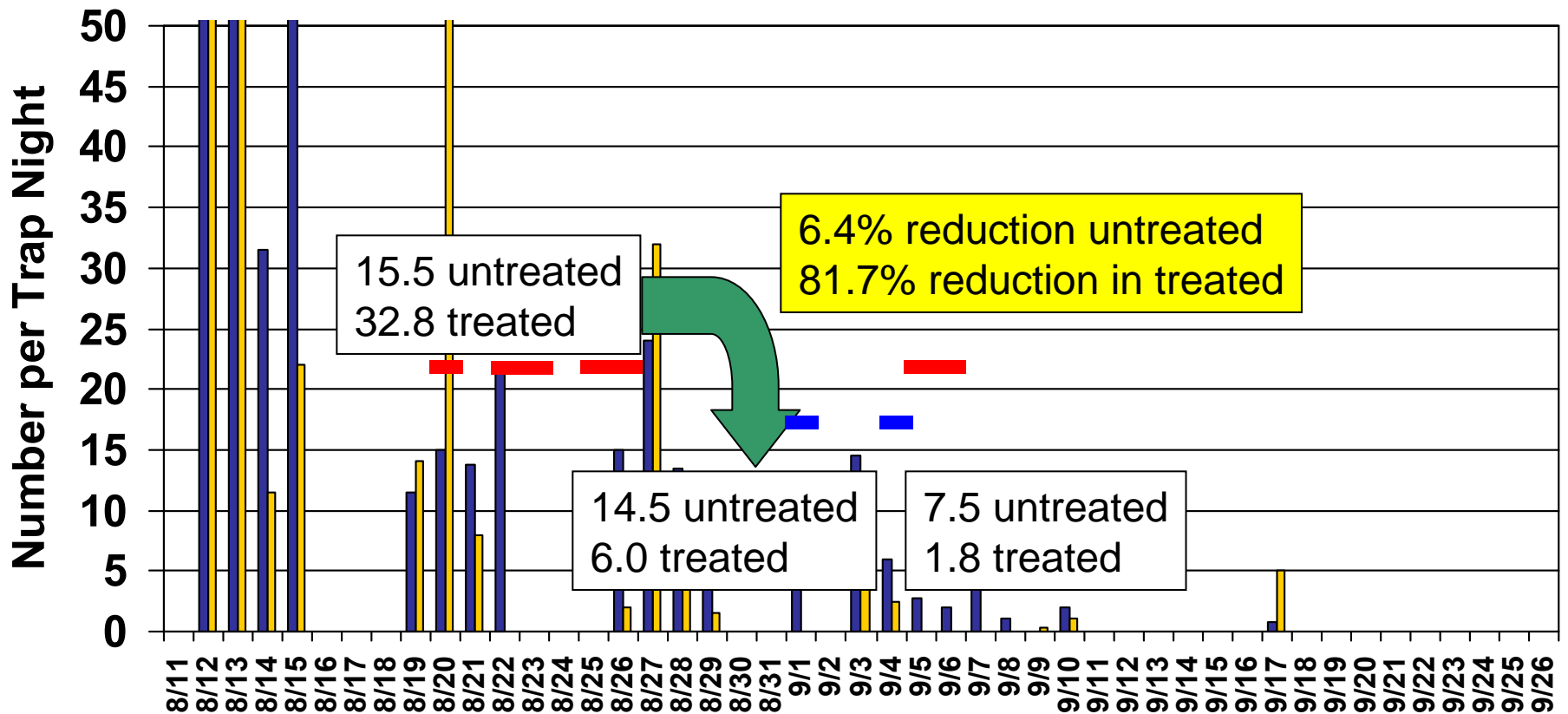
# Onset date of 228 cases In Fort Collins or $\leq 1$ mile outside



# CMC collections Ft. Collins City

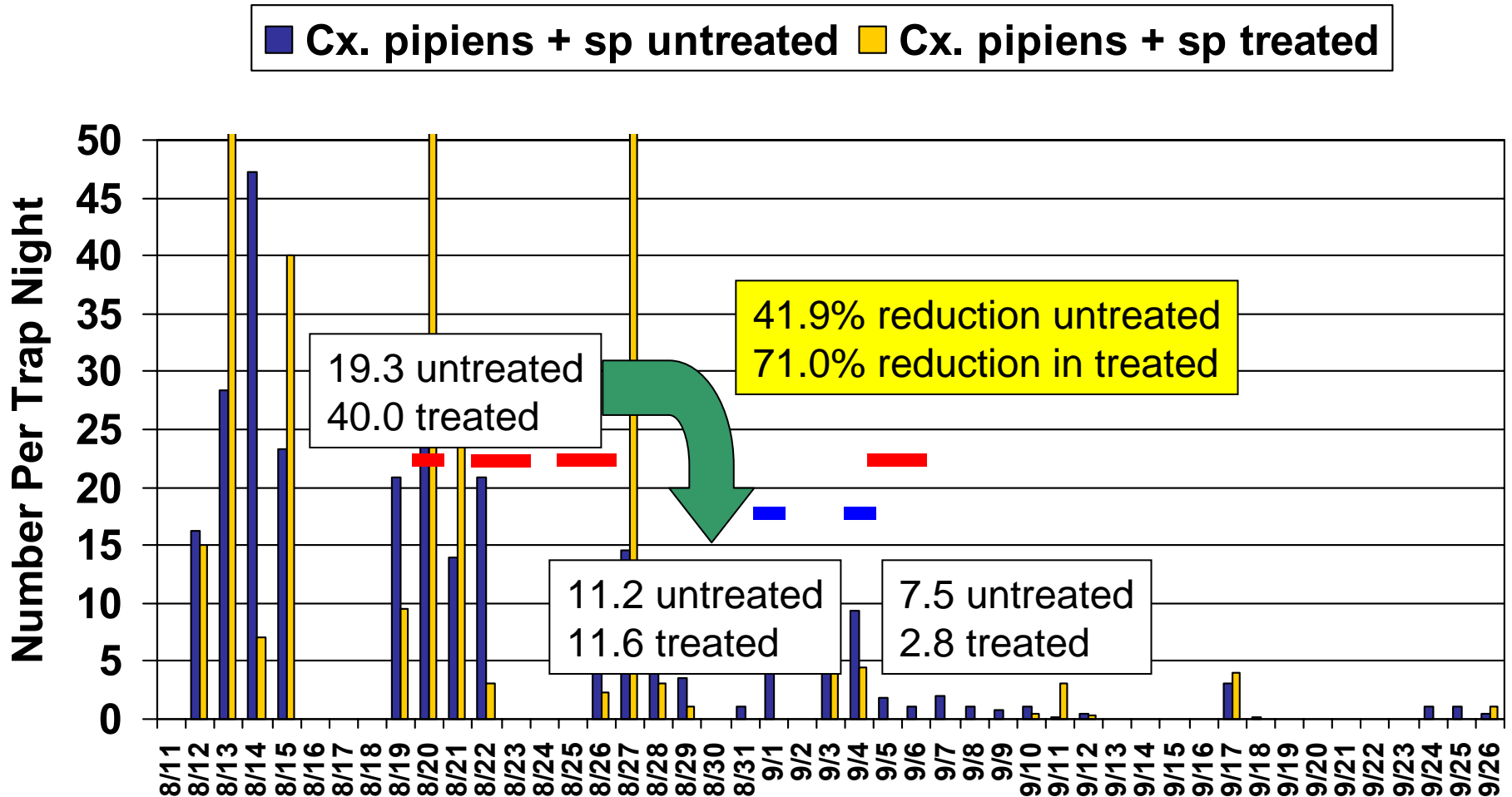
## Limits - *Cx. tarsalis* per trap night

■ *Cx. tarsalis* untreated    ■ *Cx. tarsalis* treated



# CMC trap counts Ft. Collins City

## Limits - Cx. pipiens per trap night

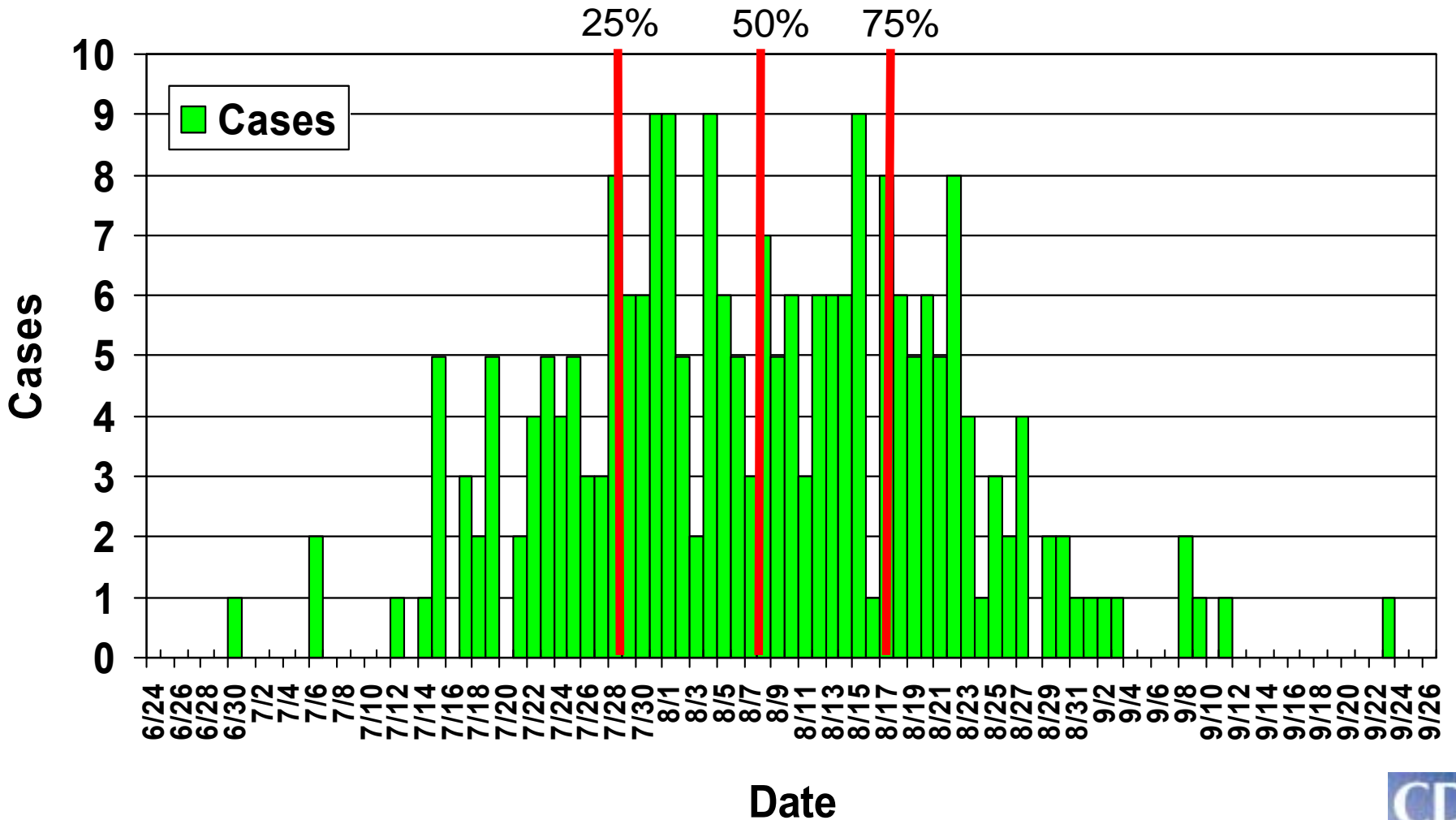


Population density changes from pre to post spray  
 CDC surveillance – light traps and gravid traps

	Percent Change in number per trap night	
	Treated Area	Untreated Area
<i>Cx. tarsalis</i>	57% - 83% decrease	Unchanged to 43% decrease
<i>Cx. pipiens</i>	73% - 89% decrease	50% decrease – unchanged – 50% increase

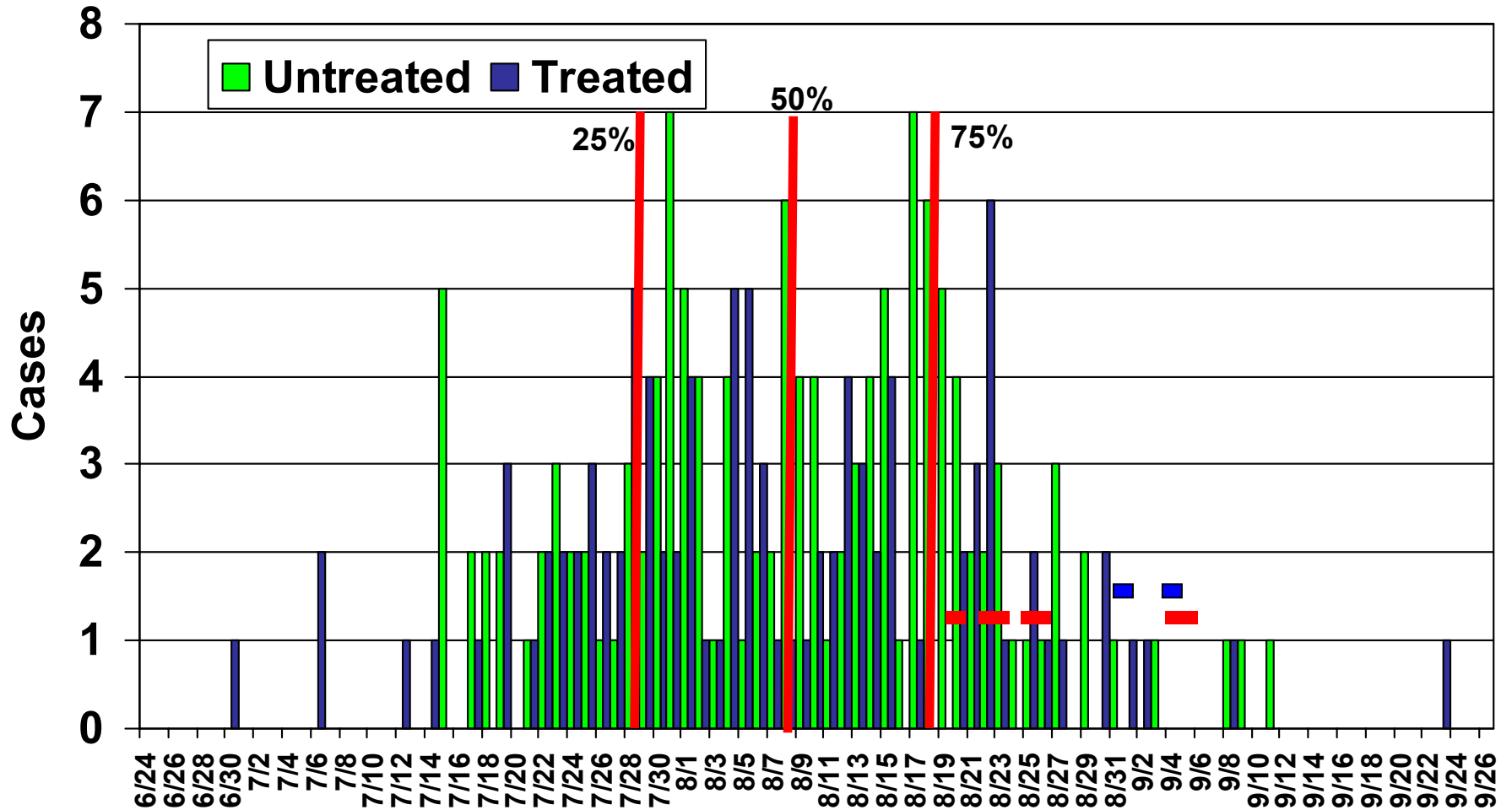
- **Evaluate mosquito control effects.**
  - **Human cases**

# Onset date of 228 cases In Fort Collins or $\leq 1$ mile outside



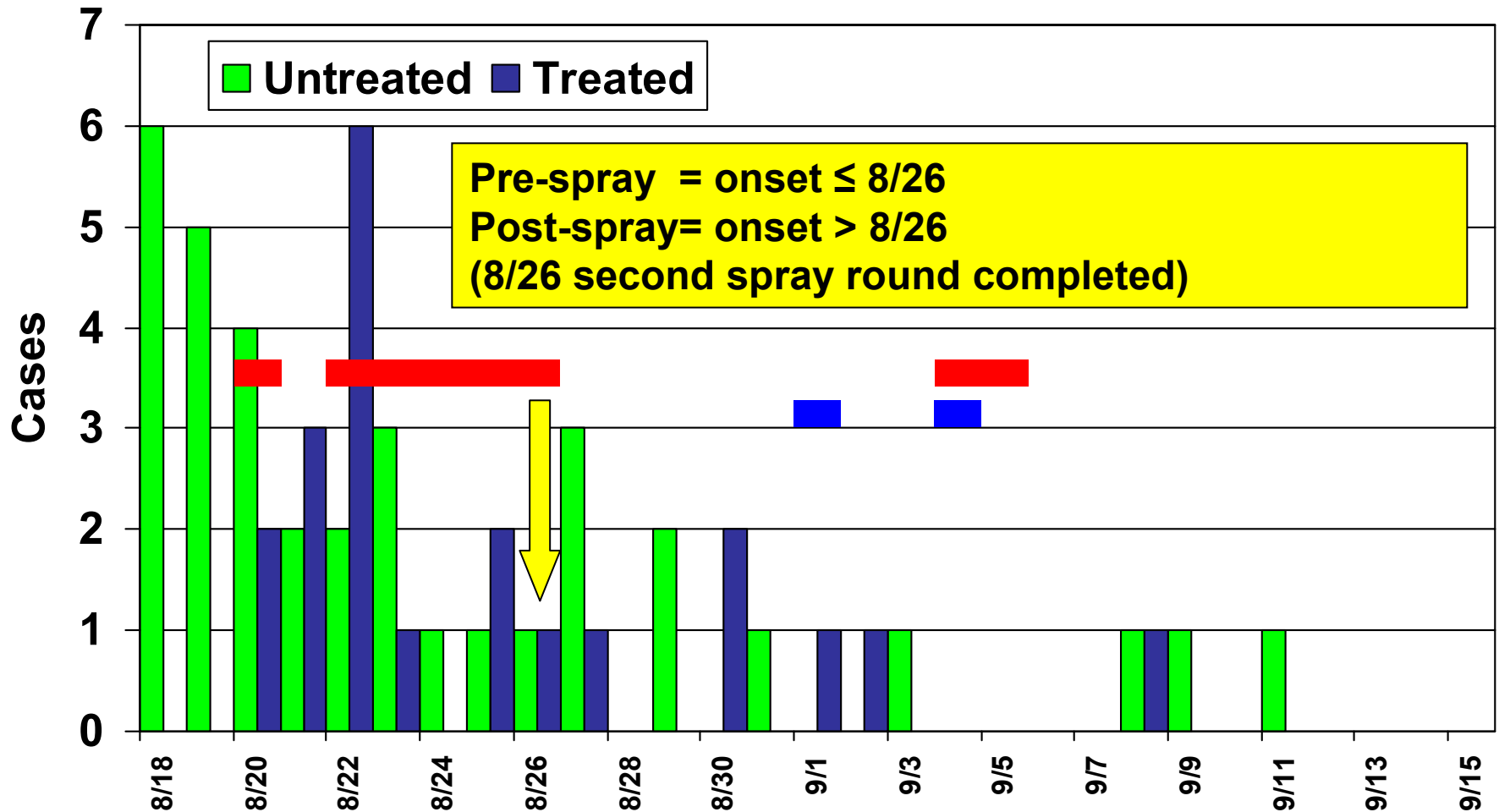
# Ft. Collins

## 228 cases by onset date





# Ft. Collins cases by onset date, late August – early September



# Cases pre- and post-adulticide:

Known onset, in city and within 1 mile of city.

Total cases pre spray	211	92.5%
Total cases post spray	17	7.5%
Total Ft. Collins cases	228	

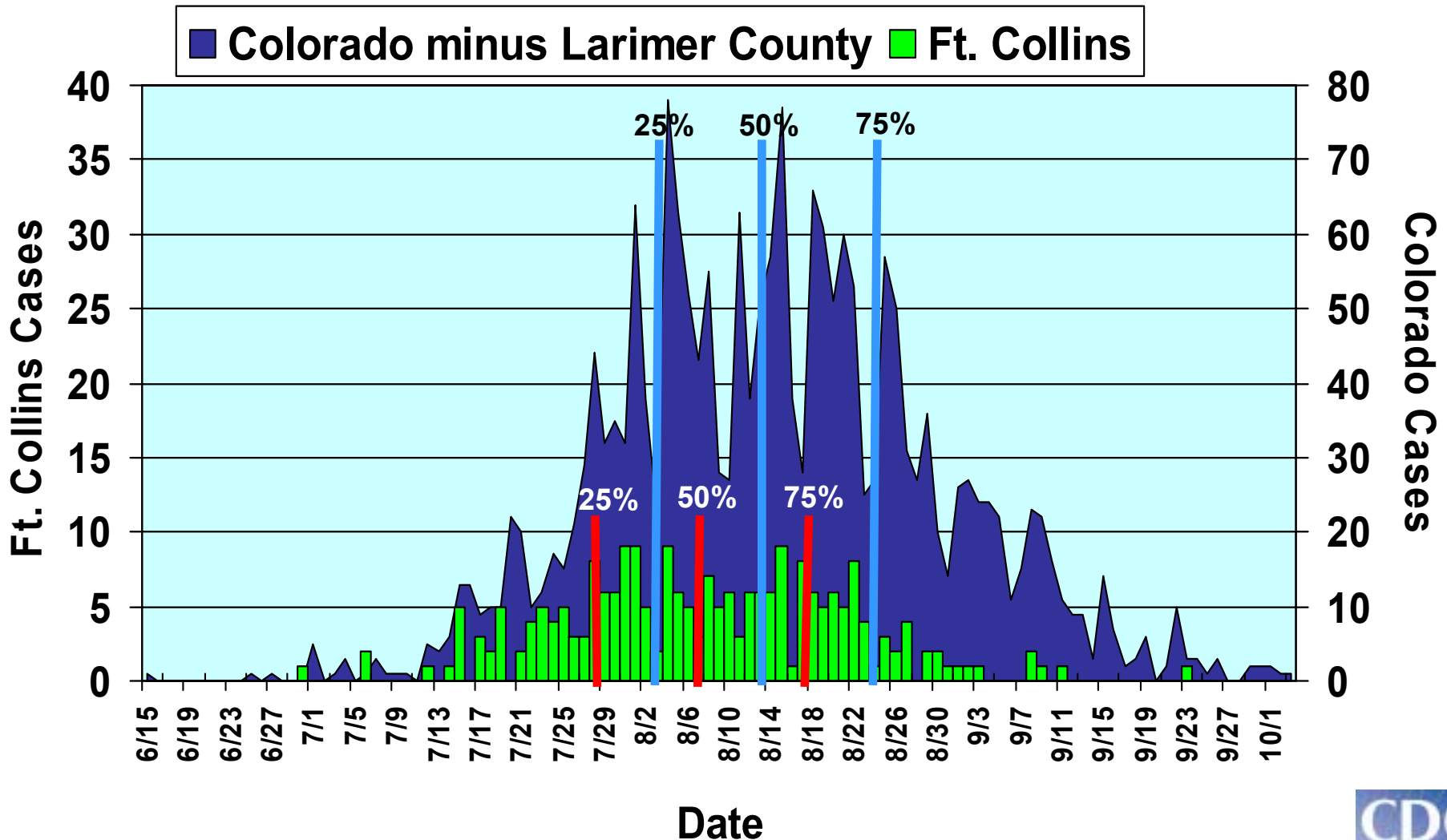
	Adulticide	No adulticide
Pre spray	91	120
Post spray	7	10

$\chi^2=0.024$   
**P=0.8**

**Pre spray defined as onset prior to 8/26  
(day of completion of the second spray round)**

- **Shape of epidemic curve**
- **Duration of epidemic**

# Onset date of 228 cases In Fort Collins or $\leq 1$ mile outside



# Comparison of case numbers Pre and post 8/26

	Number (%) Of Cases			
	Fort Collins	Boulder County	Weld County	Colorado minus Larimer Co.
Pre spray	211 (93%)	276 (74%)	309 (82%)	1739 (77%)
Post spray	17 (7%) <sup>a</sup>	97 (26%) <sup>b</sup>	67 (18%) <sup>b</sup>	510 (23%) <sup>b</sup>
Total	228	373	376	2249

<sup>a</sup> Cases occurring after 8/26/03 significantly lower in Ft. Collins than in Boulder, Weld, or Colorado (minus Ft. Collins cases), ( $\chi^2$  P<0.001).

<sup>b</sup> Cases after 8/26: Boulder>Weld=Colorado



# Summary

- ***Culex tarsalis* and *Culex pipiens* population densities and infection rates suggest both species involved in Ft. Collins epidemic.**
- **High surveillance indices preceded epidemic peak.**
- **Adulticide caused a measurable decline in vector mosquito density.**
- **The number of new human cases in Ft. Collins with onsets after adulticide applications declined relative to other communities in the region.**