

Dust and Valley Fever: Facts, Fiction, & Speculation

Joe Tabor, PhD

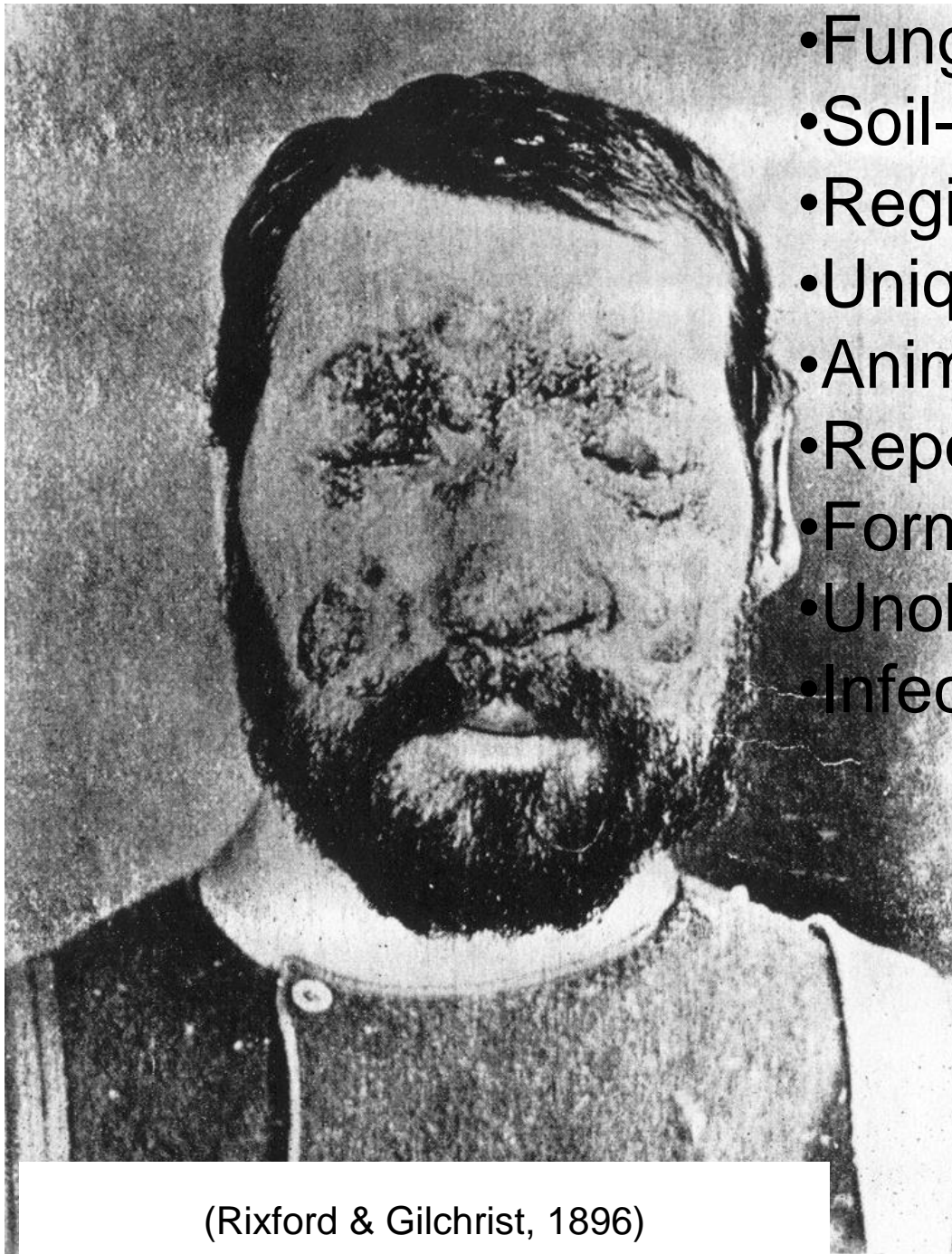
Community, Environment and Policy Division
College of Public Health

&

School of Natural Resources and the Environment
College of Agriculture and Life Sciences

The University of Arizona, Tucson





- Fungus *Coccidioides* spp.
- Soil-borne, air-dispersed
- Regional disease
- Unique to the Americas
- Animals are incidental hosts?
- Reportable disease in AZ
- Former-select agent, BSL-3
- Unobserved sexual phase
- Infection \approx lifelong immunity

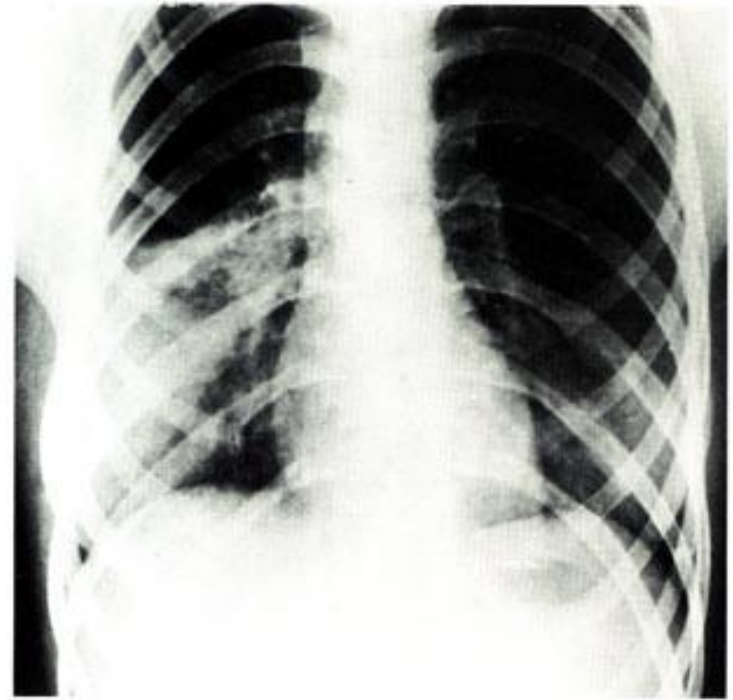
(Rixford & Gilchrist, 1896)

BIOHAZARD





erythema nodosum



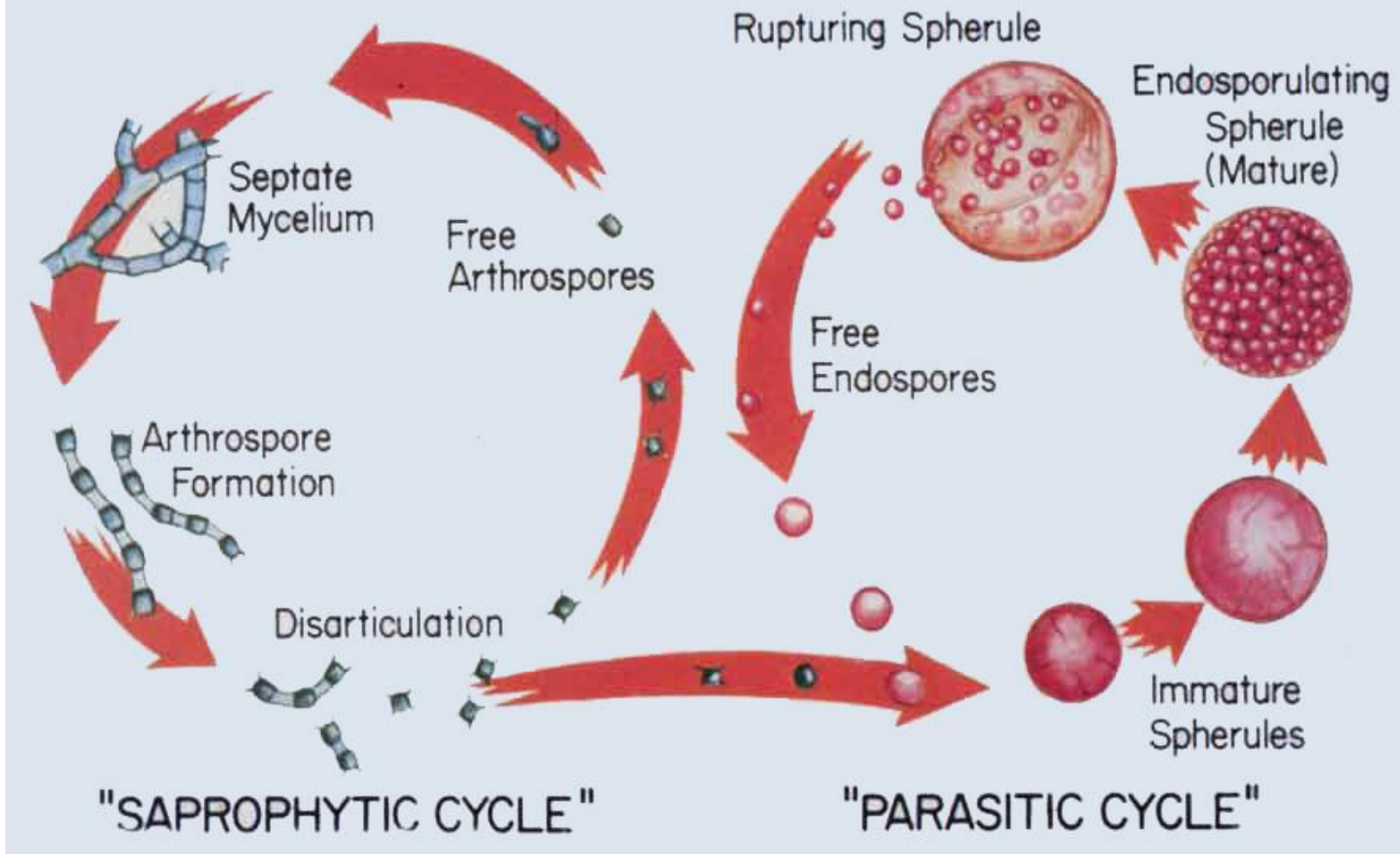
pneumonia-like infiltration



Image Courtesy of C. Halde
Copyright © 2000 Doctorfungus Corporation

desseminated infections

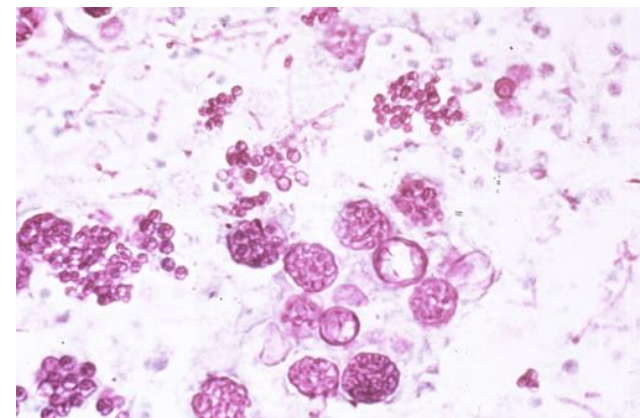
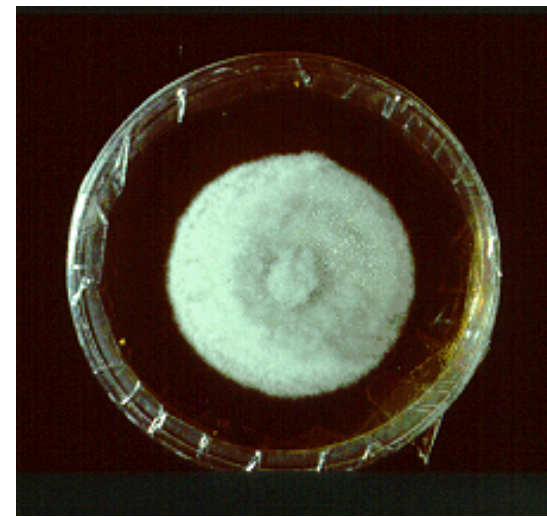
The Morphology of Coccidioides immitis



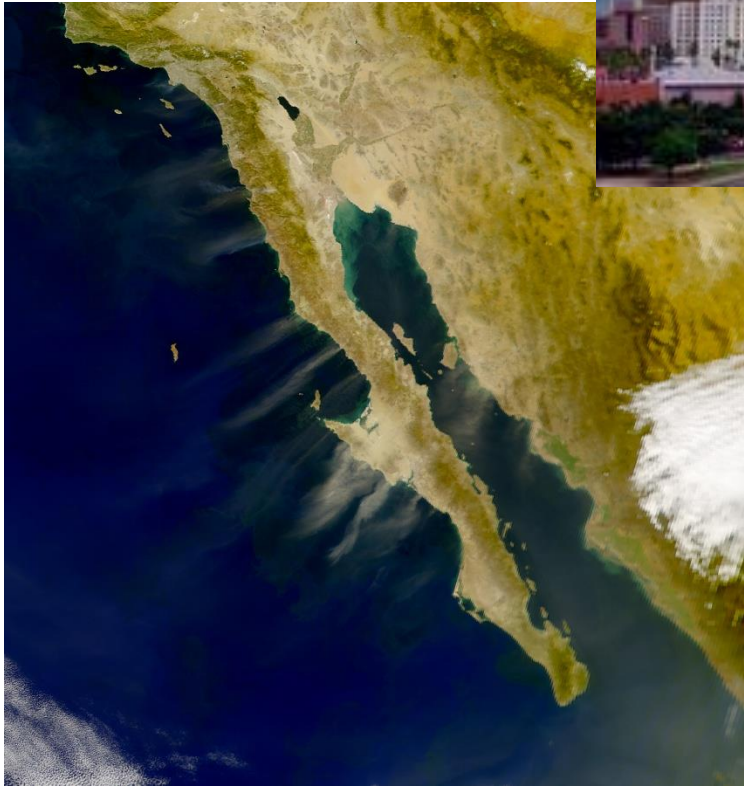
Life cycle of *Coccidioides* spp. (© H.B. Levine)

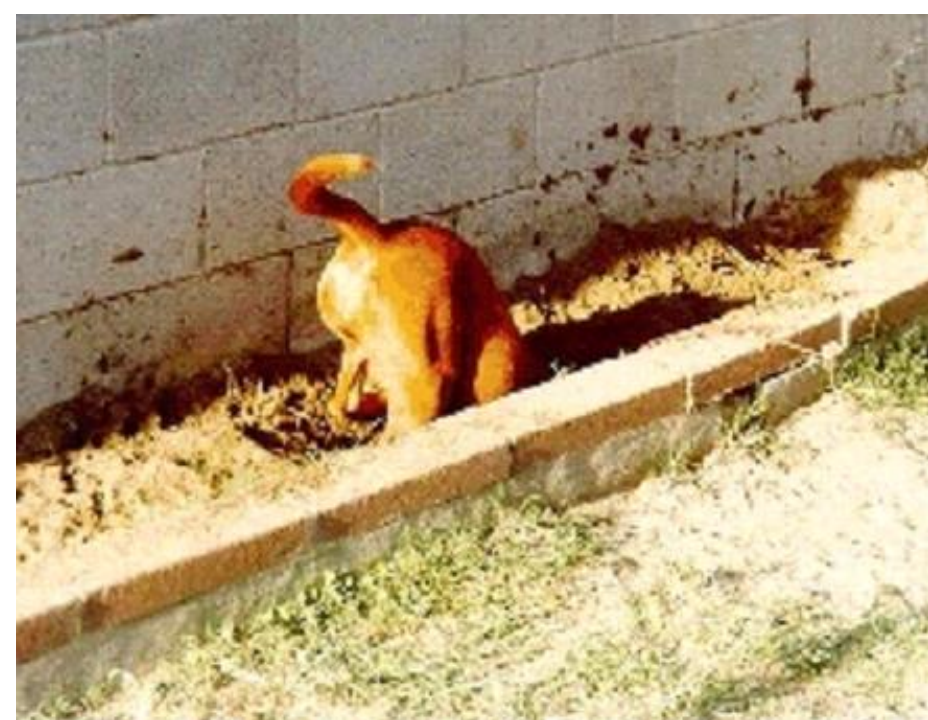


order Onygenales
Coccidioides immitis and *C. posadasii*









"We appreciate your continued advocacy for public awareness"
-Julie Louise Gerberding, MD, MPH, Director CDC

Valley Fever Epidemic

*Everything tourists, residents and YOU need to know
about this incurable, debilitating and deadly disease*



"The authors have filled the need for a detailed understanding of San Joaquin Valley Fever... This volume is complete, up to date, and accurate in describing this illness..."

- Hans Einstein, MD, FACP
Legendary Valley Fever Pioneer & Expert

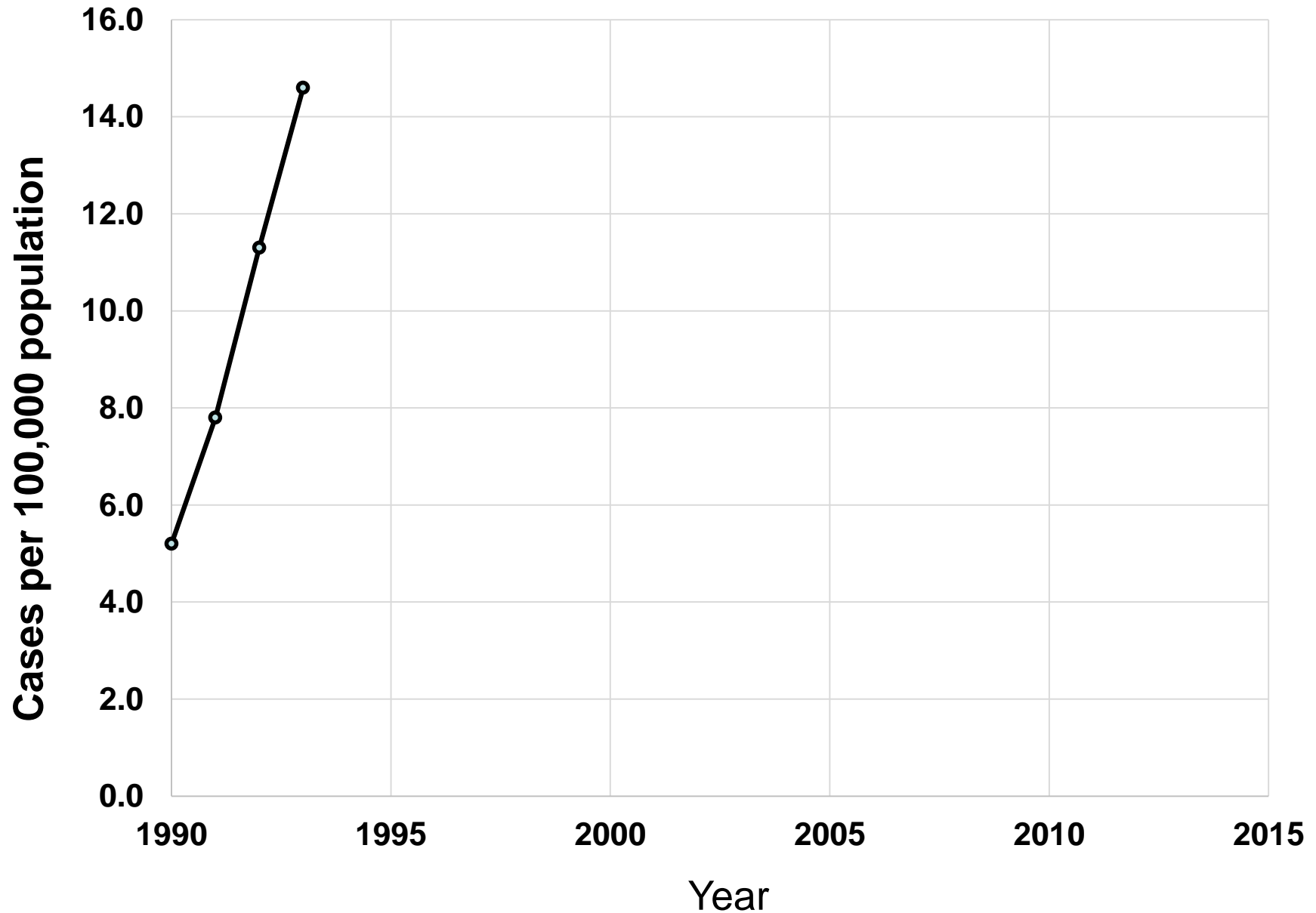
"This is a disease that many would just as soon sweep under the rug - you've laid the dust out where all can see!"

- Sandra Larson, Executive Director,
Valley Fever Vaccine Project of the Americas

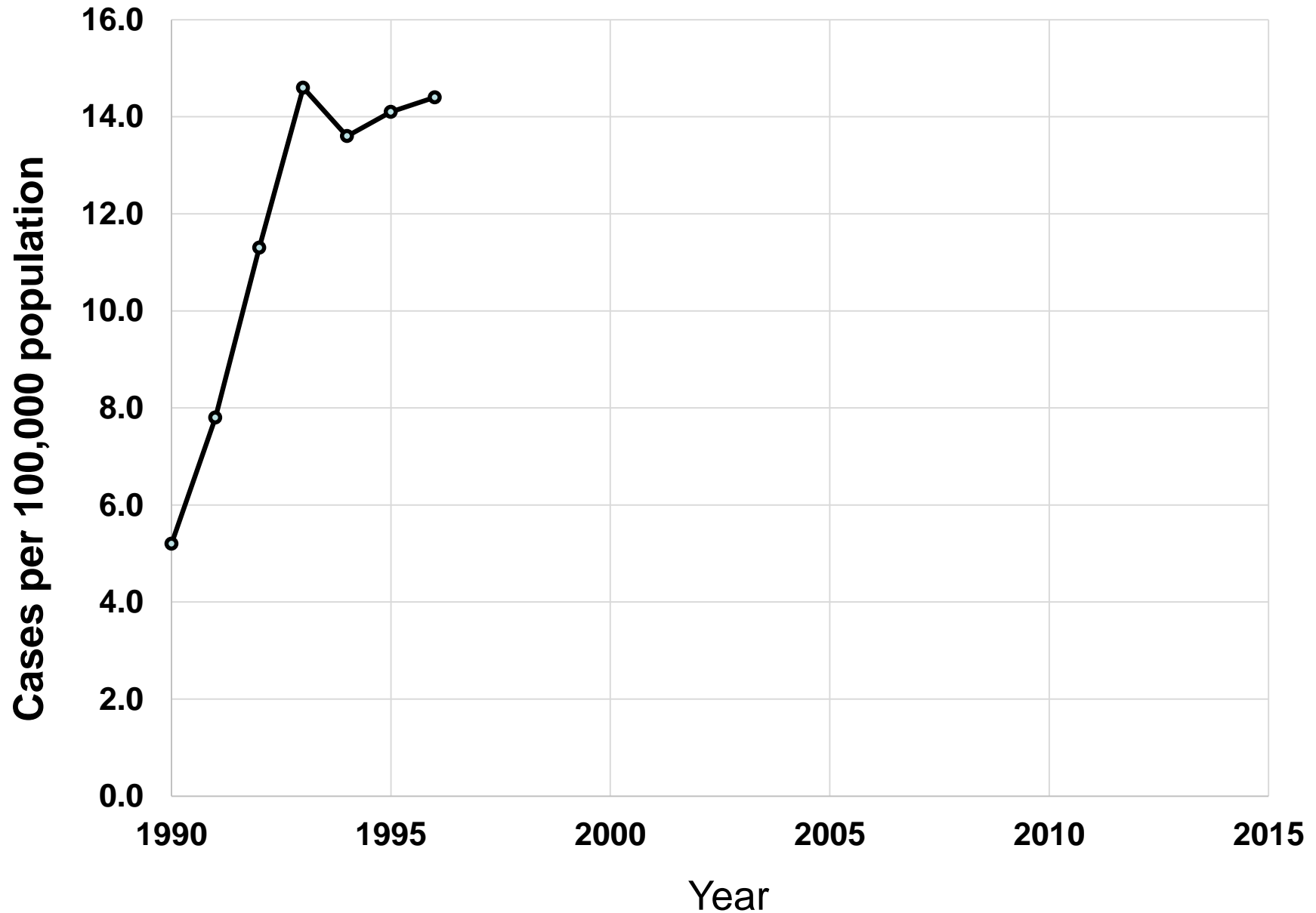
"...if you breathe here, you can catch it."
- Jose Miguel, KOCV-15 Phoenix, Arizona

David Filip and Sharon Filip

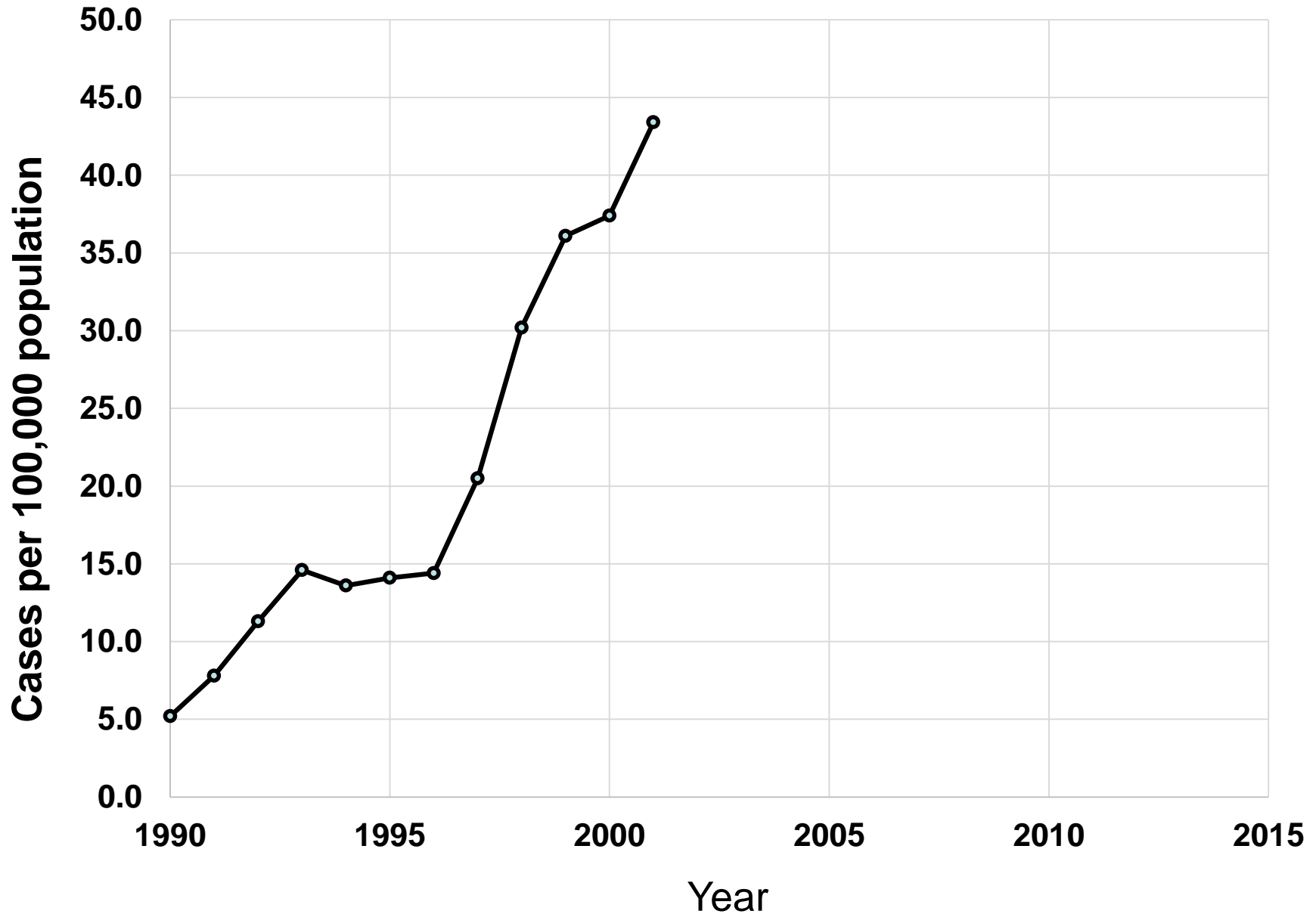
Reported valley fever cases in Arizona



Reported valley fever cases in Arizona



Reported valley fever cases in Arizona



An Epidemic of Coccidioidomycosis in Arizona Associated with Climatic Changes, 1998–2001

**Benjamin J. Park,¹ Keith Sigel,^{1,a} Victorio Vaz,³ Ken Komatsu,³ Cheryl McRill,³ Maureen Phelan,^{2,a} Timothy Colman,³
Andrew C. Comrie,⁴ David W. Warnock,¹ John N. Galgiani,^{5,6} and Rana A. Hajjeh¹**

¹Mycotic Diseases Branch and ²Biostatistics and Information Management Branch, Division of Bacterial and Mycotic Diseases, National Center for Infectious Diseases, Centers for Disease Control and Prevention, Atlanta, Georgia; ³Arizona Department of Health Services, Phoenix, and ⁴University of Arizona Department of Geography and Regional Development, ⁵University of Arizona Valley Fever Center for Excellence, and ⁶Southern Arizona VA Health Care System, Tucson

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2% incident rate (0.4% to 24% per year)

0.02

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40% symptomatic (misdiagnosis as pneumonia)

0.02 X 0.30

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40% symptomatic (misdiagnosis as pneumonia)

40% immune (non-Hispanic)

$$0.02 \times 0.30 \times 0.5$$

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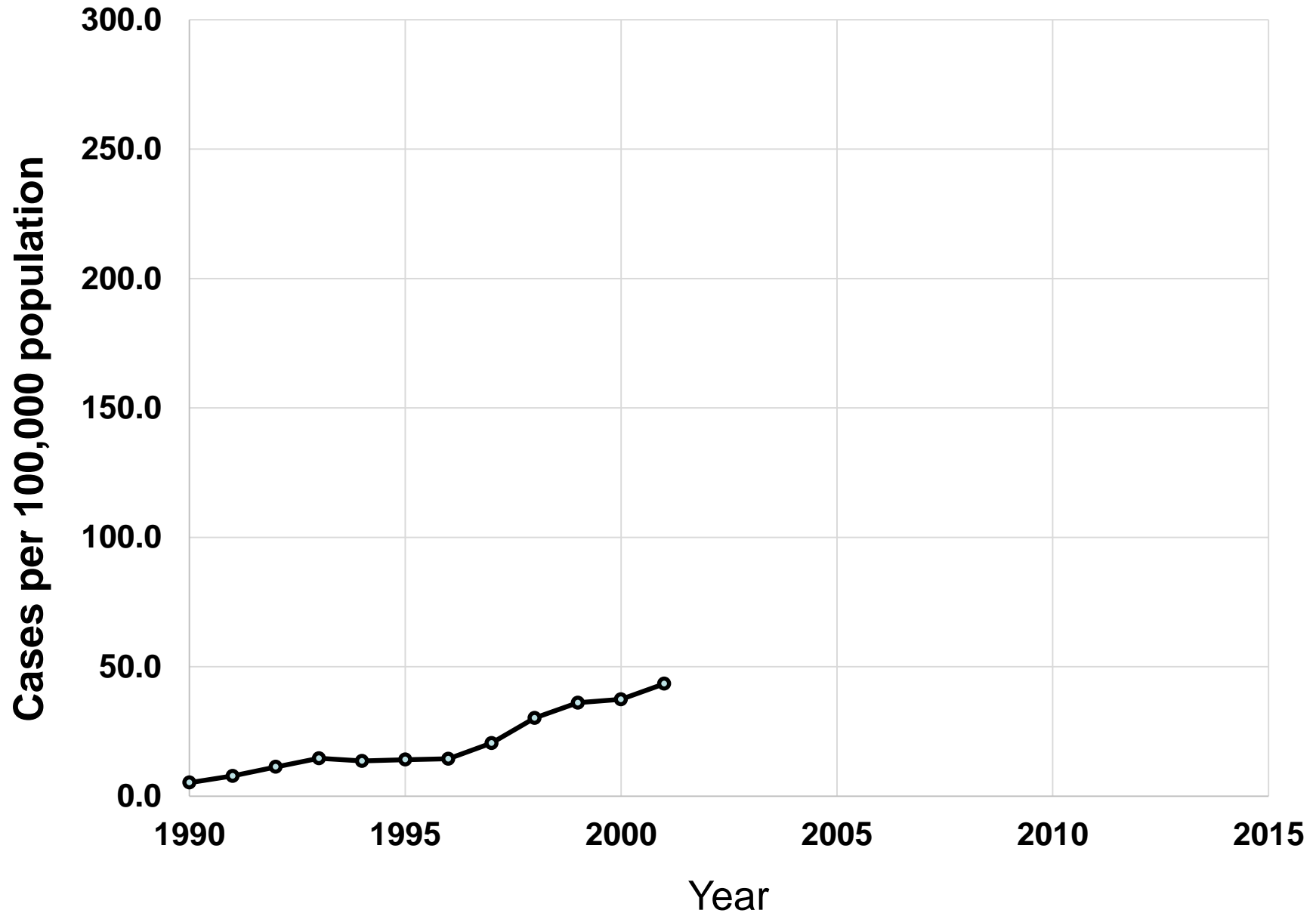
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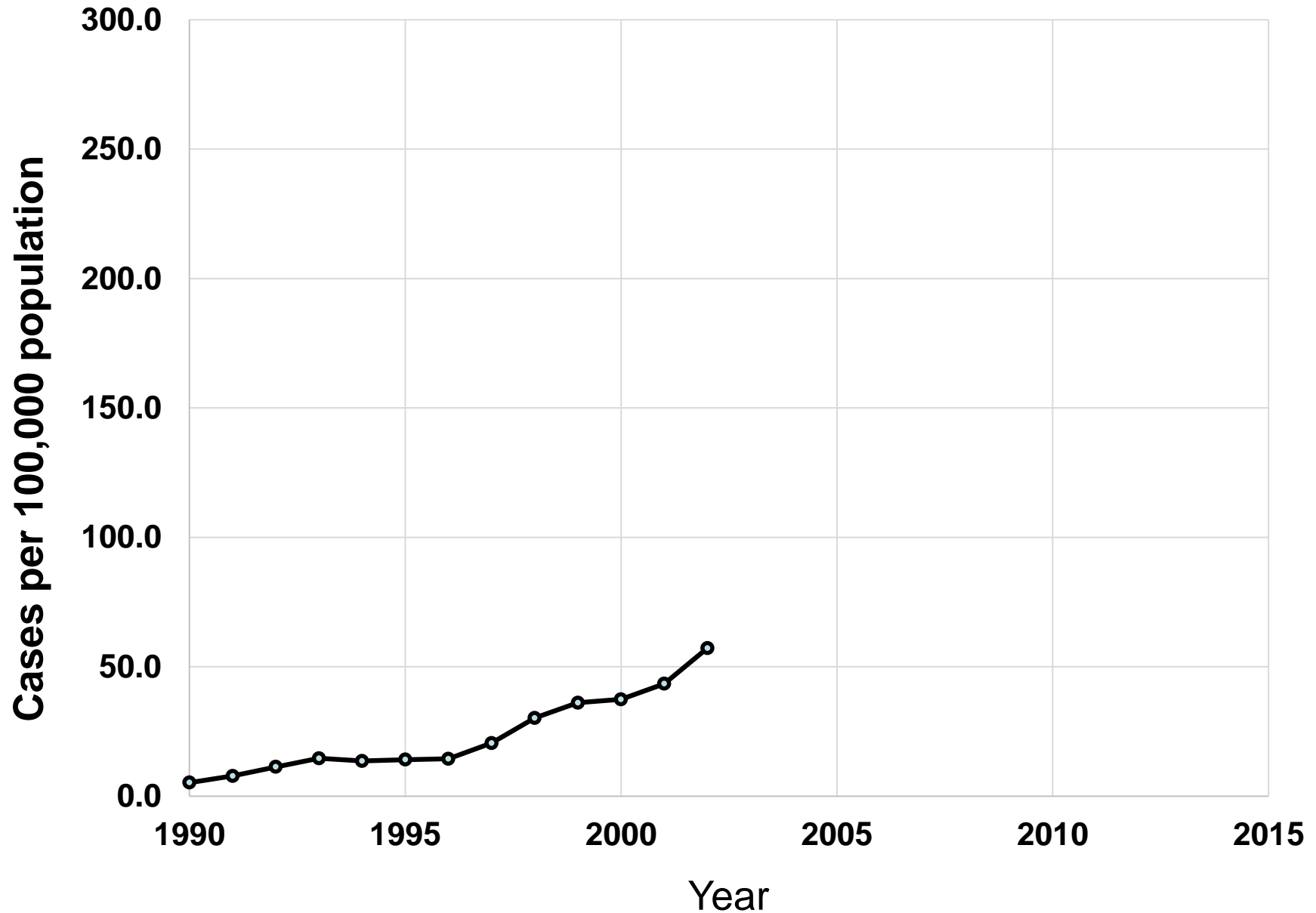
40% immune (non-Hispanic)

$$0.02 \times 0.30 \times 0.5 \times 100,000 = \underline{\underline{300 \text{ per } 100,000}}$$

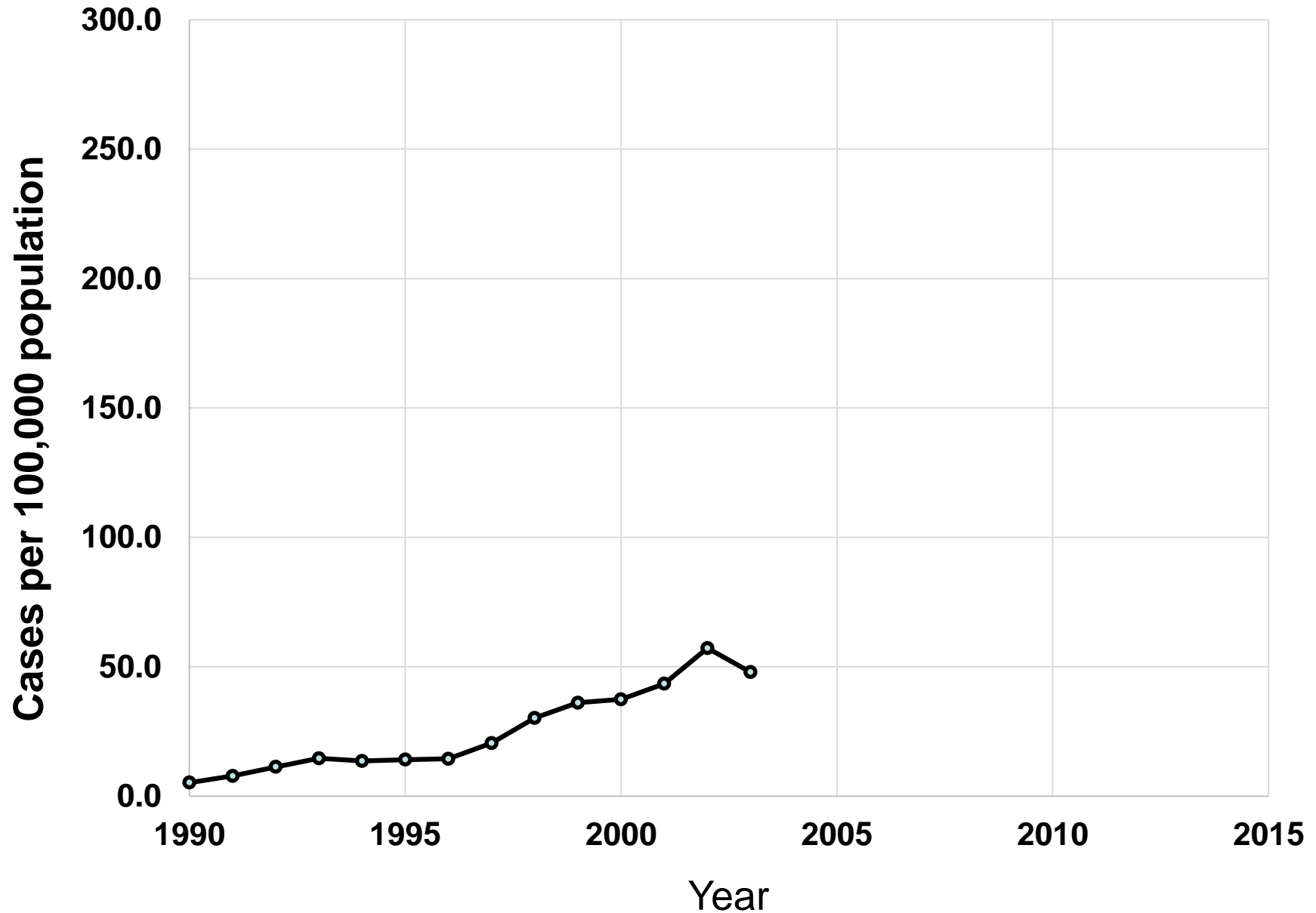
Reported valley fever cases in Arizona



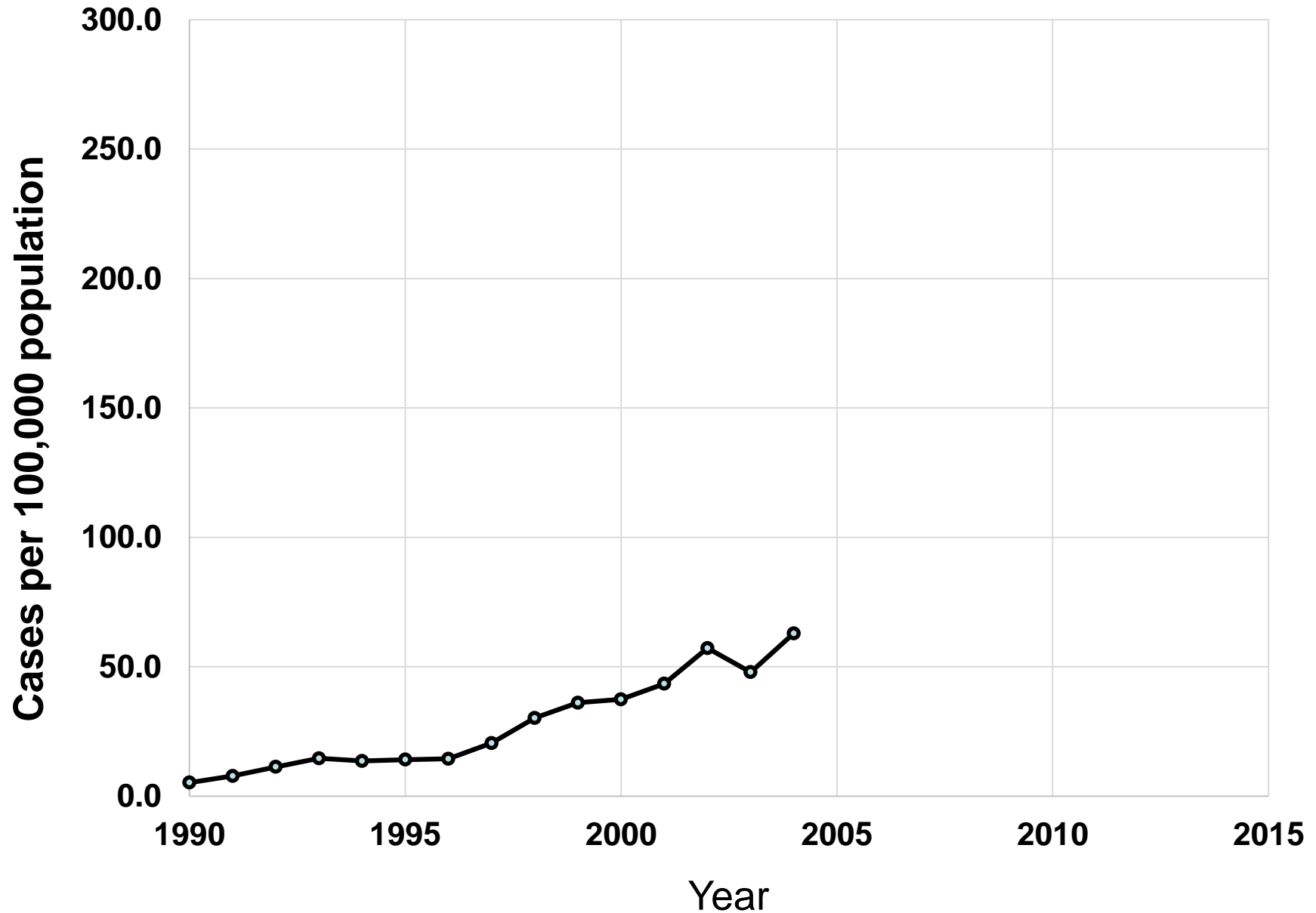
Reported valley fever cases in Arizona



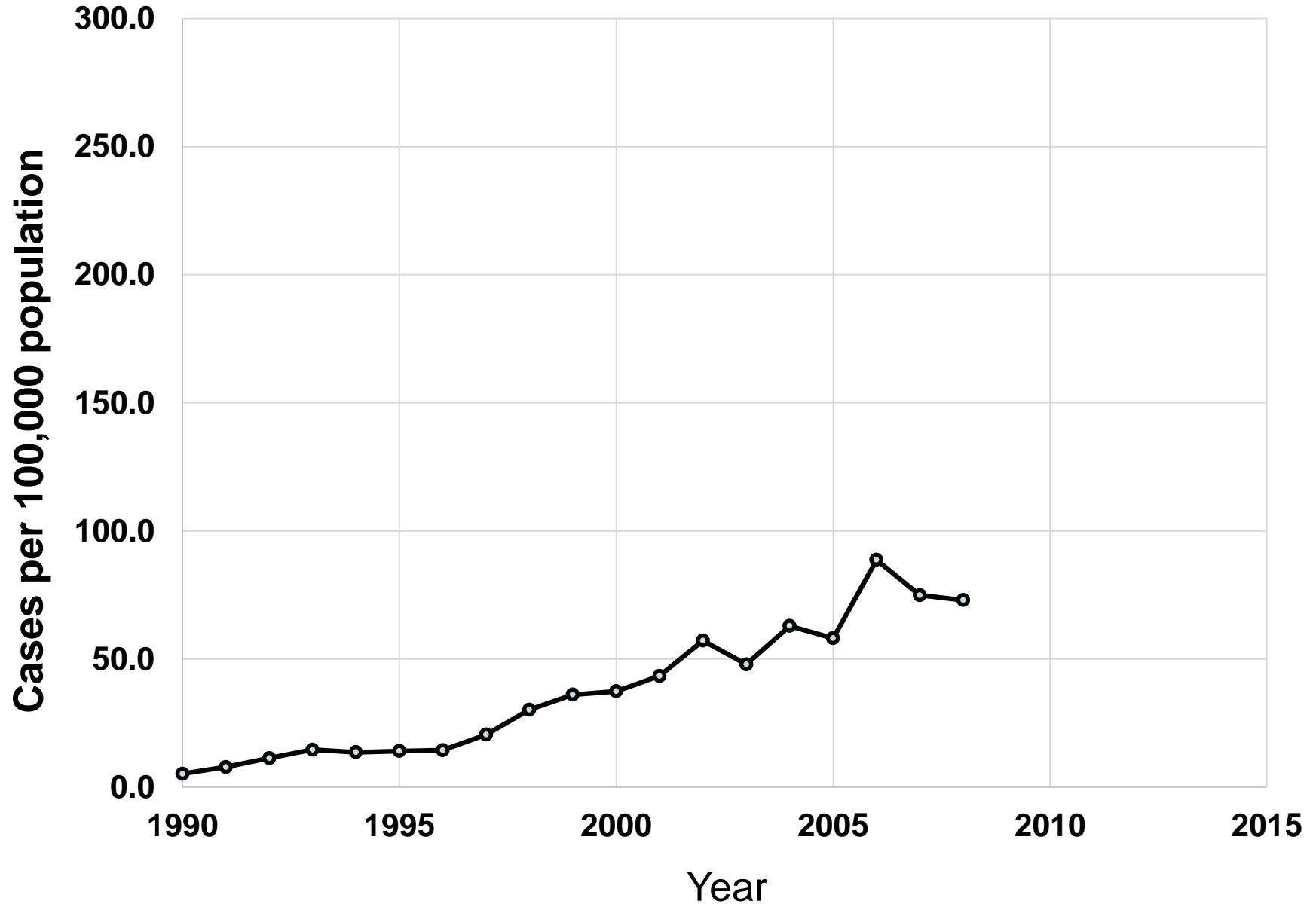
Reported valley fever cases in Arizona



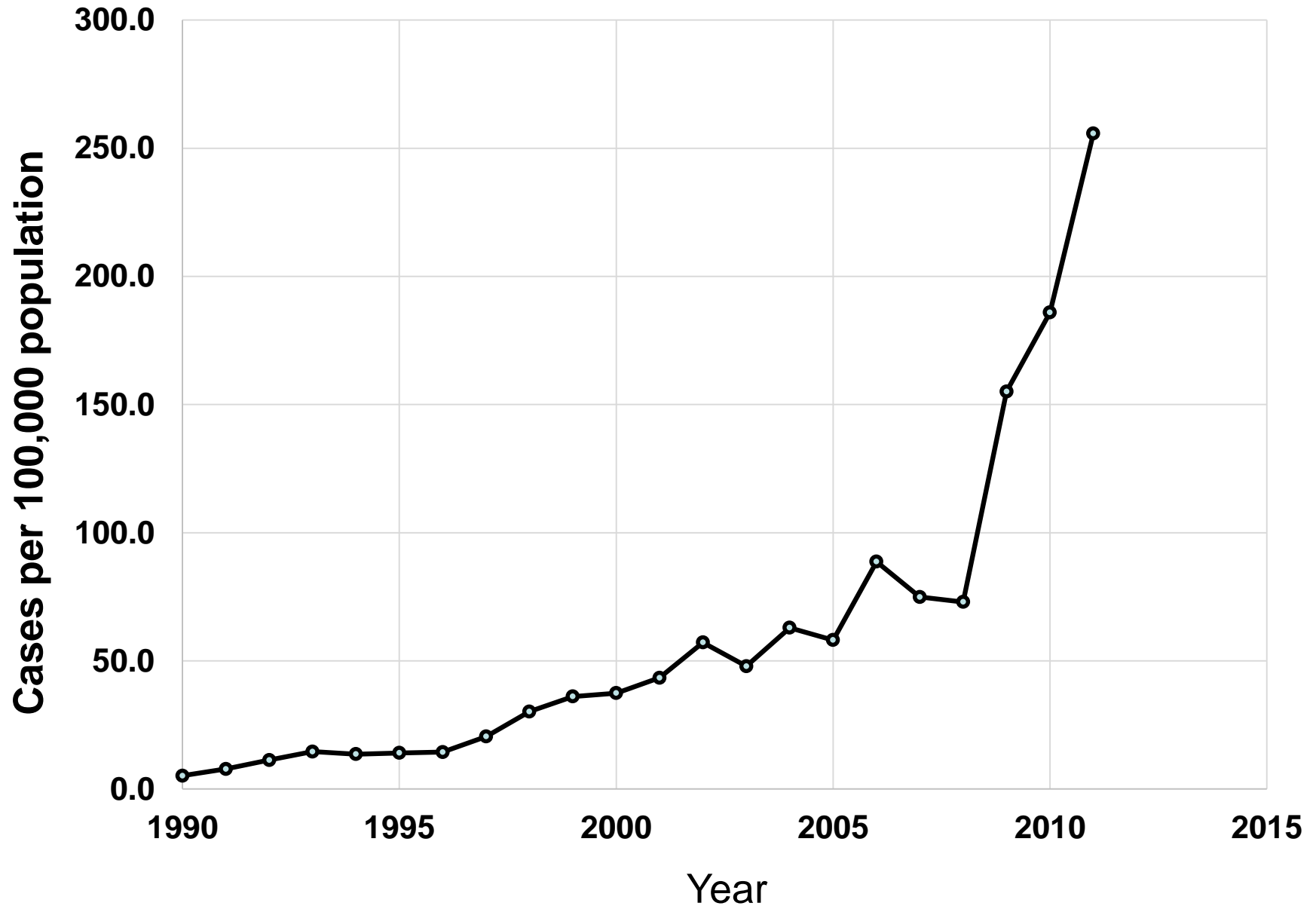
Reported valley fever cases in Arizona



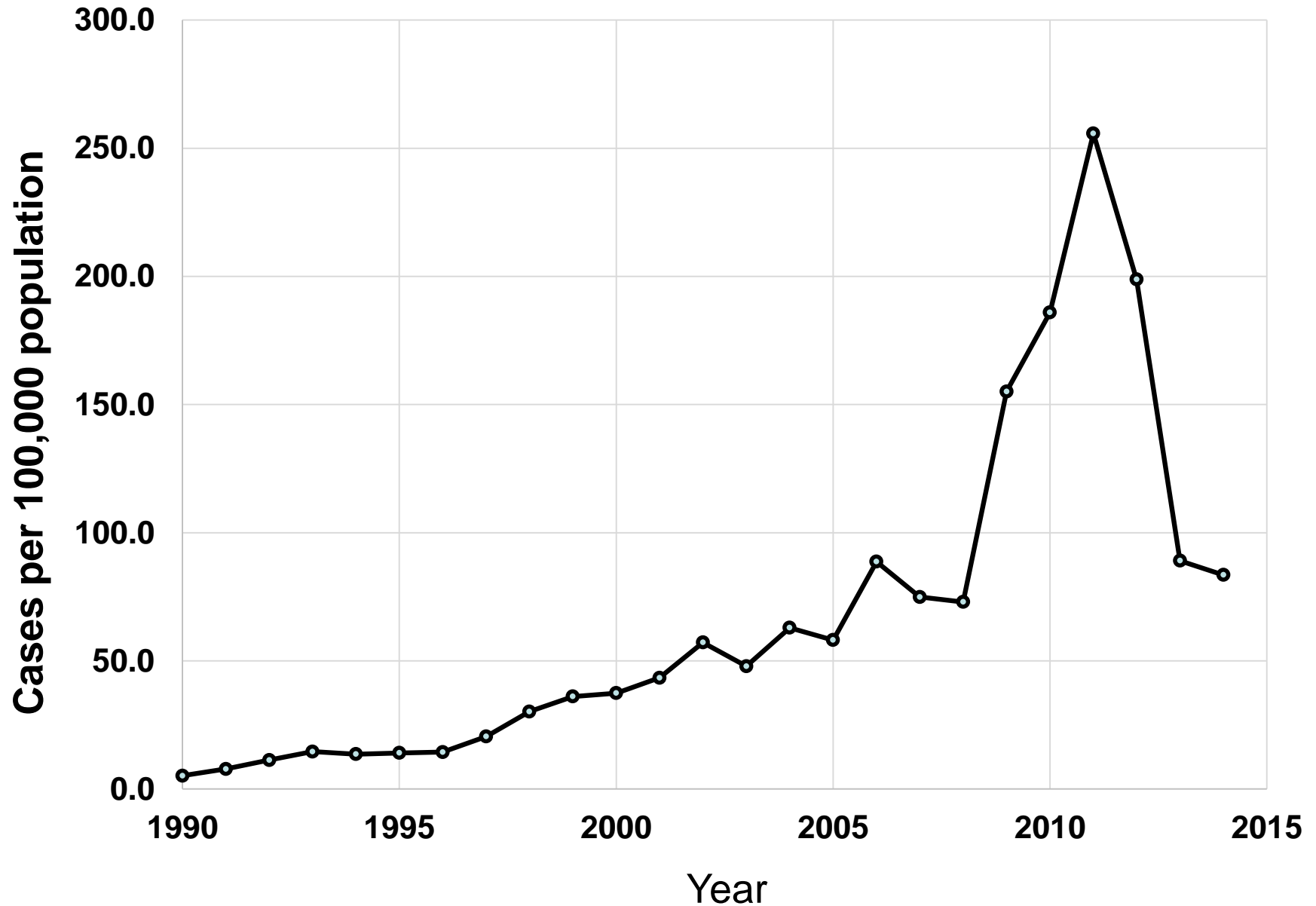
Reported valley fever cases in Arizona



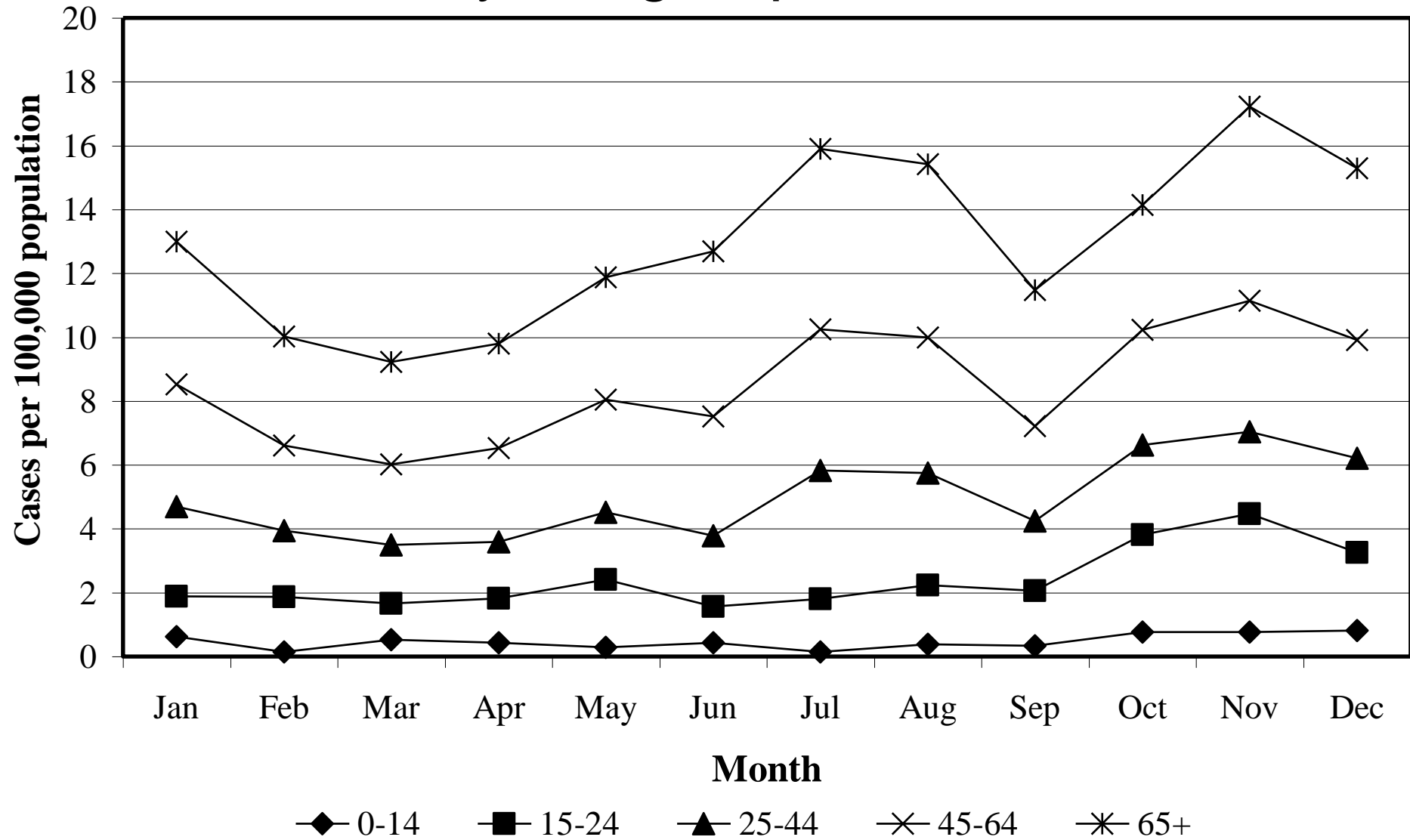
Reported valley fever cases in Arizona



Reported valley fever cases in Arizona

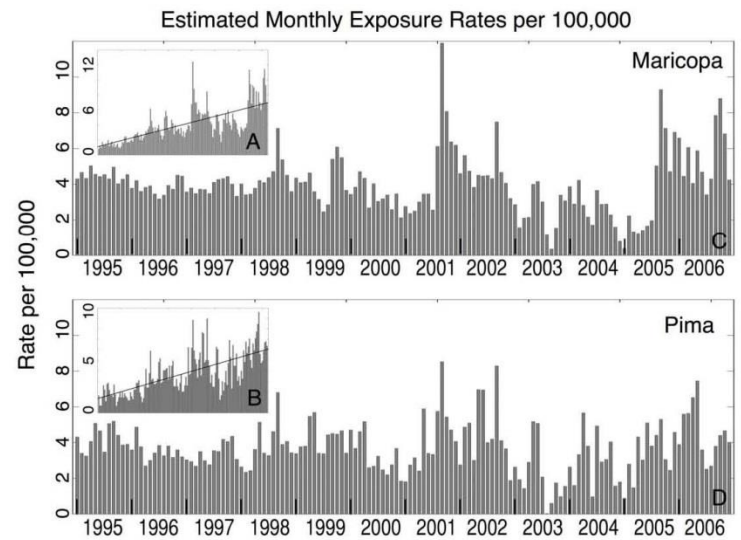
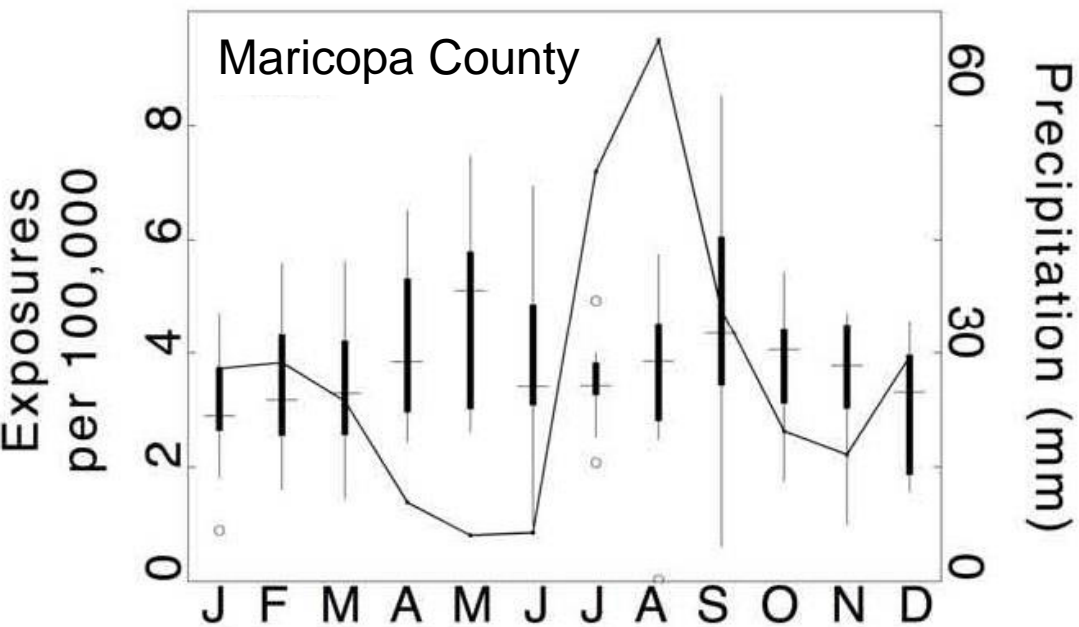
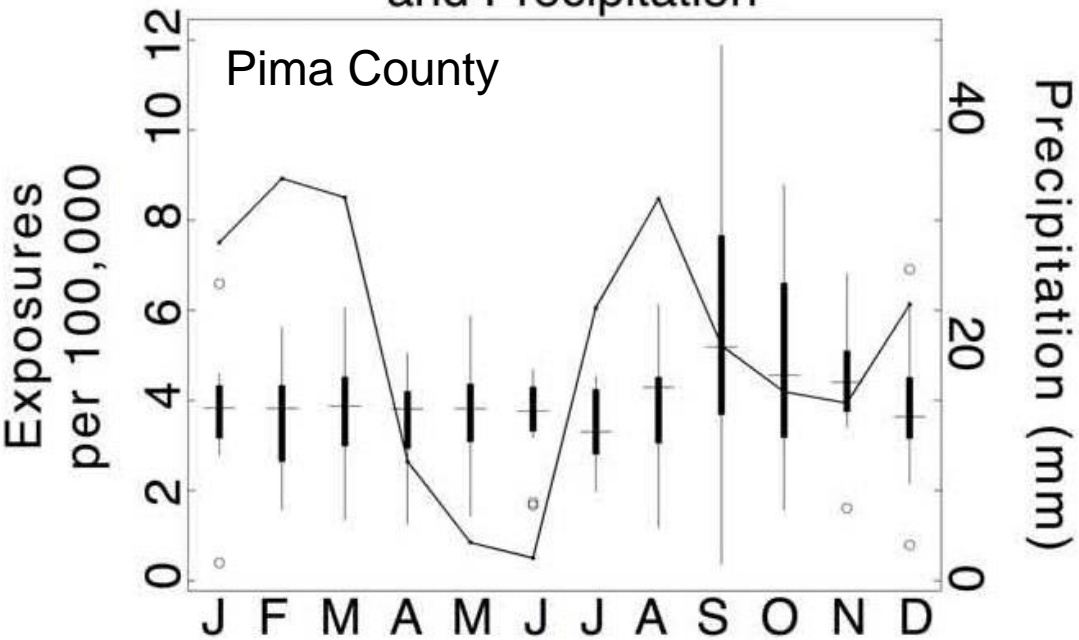


Seasonality of Age Specific Incidence



Age-specific monthly case frequency averaged from 1992 to 2003 notifiable coccidioidomycosis case data for Pima County, Arizona.

Average Monthly Exposure Rates and Precipitation



Fluctuation in reported cases are influenced by normal inter-annual changes in climate
 Not "climate change"

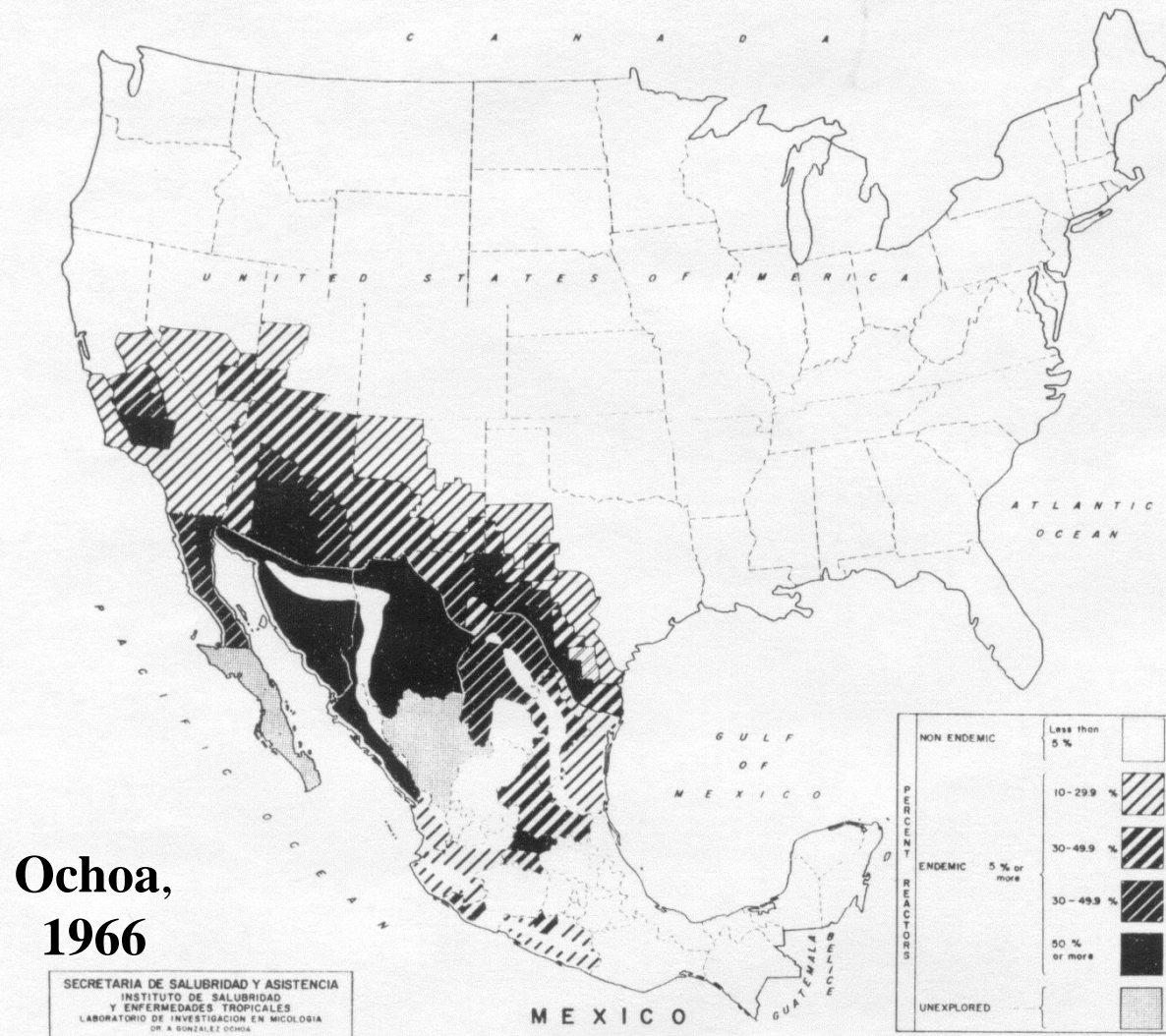
Fore-summer rainfall with a 1-1.5 year time lag
 PM₁₀ not associated

"Exposures" based on reported cases and assumes an average 2 month lag until reported

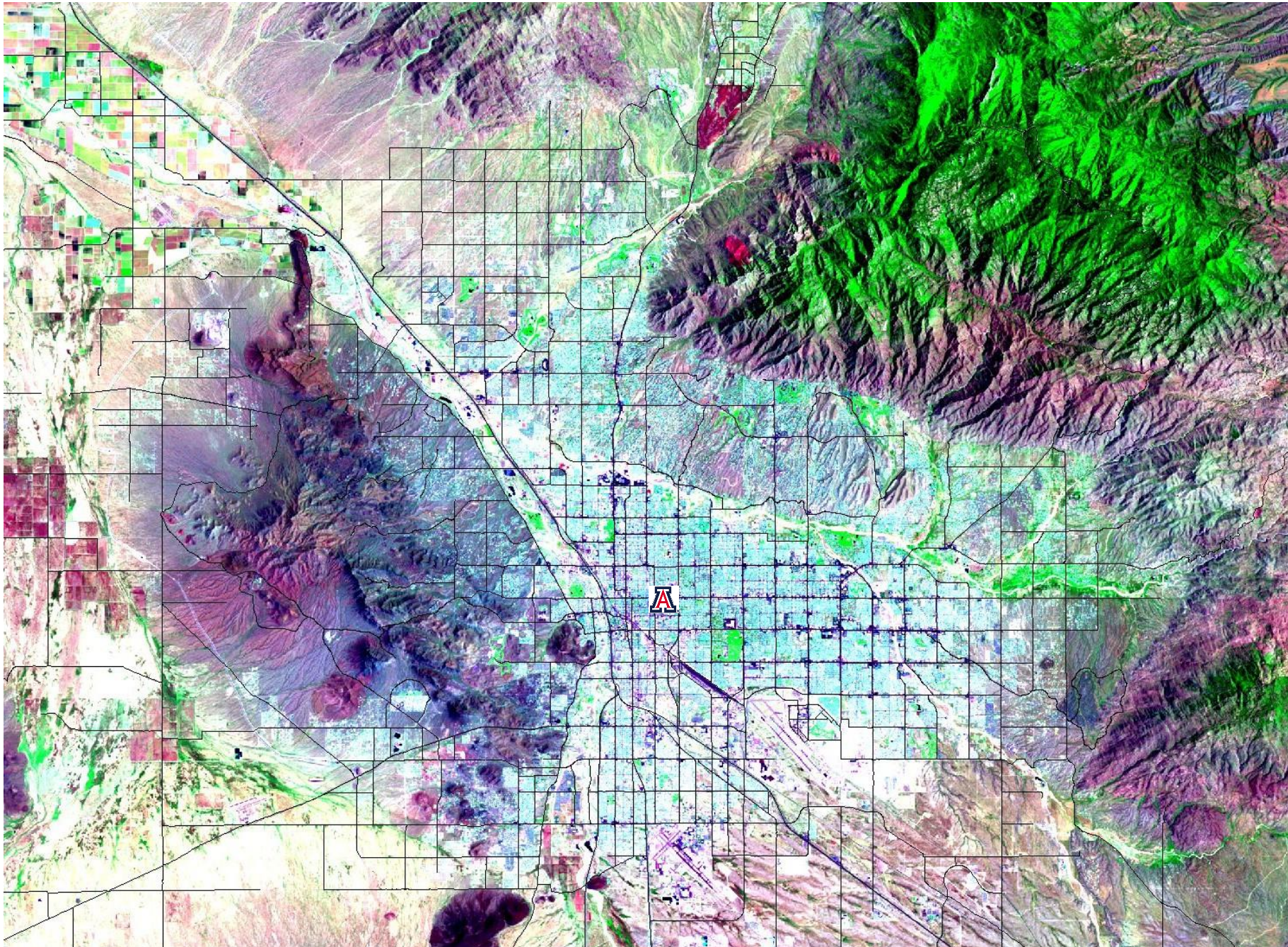
Tamerius & Comrie, 2011

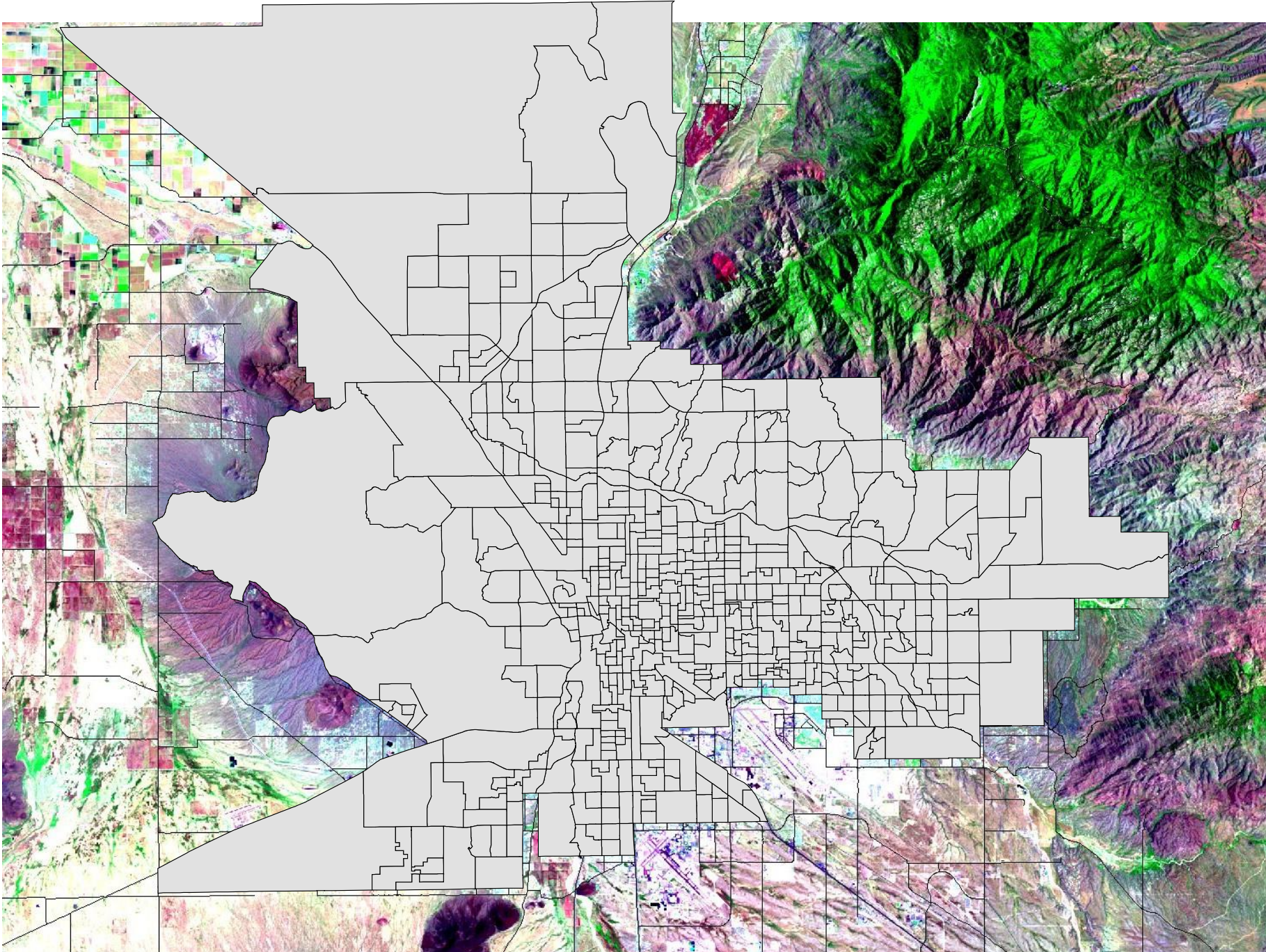
Ecology & Exposure

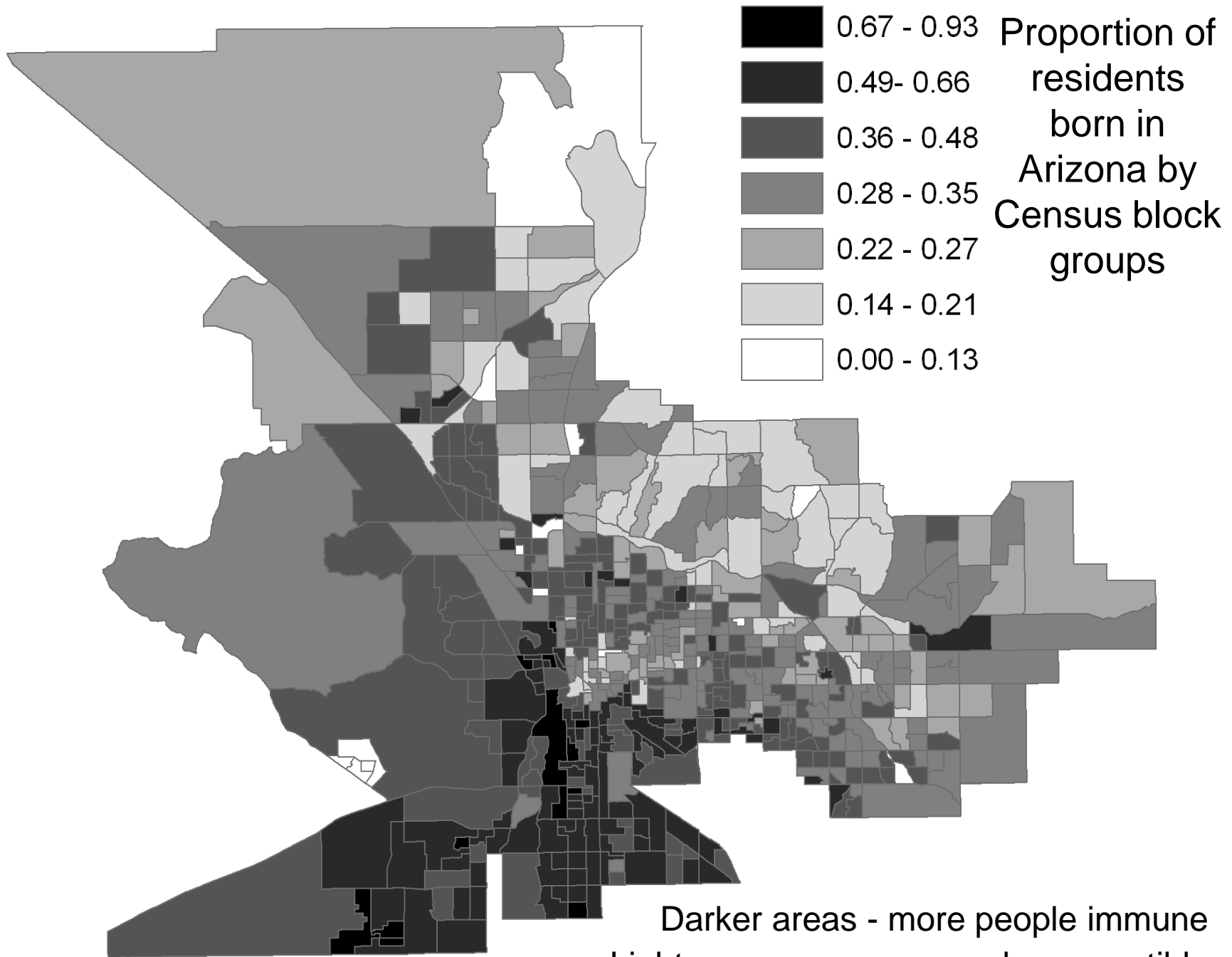




- 37M in endemic areas of US;
- 6.4M highly endemic areas of US, 4.7M in AZ
- 62% of 2006 US reported cases in Arizona (n=5,535)
- 5,624 reported Arizona cases in 2014 (3,937 in Maricopa Co.)

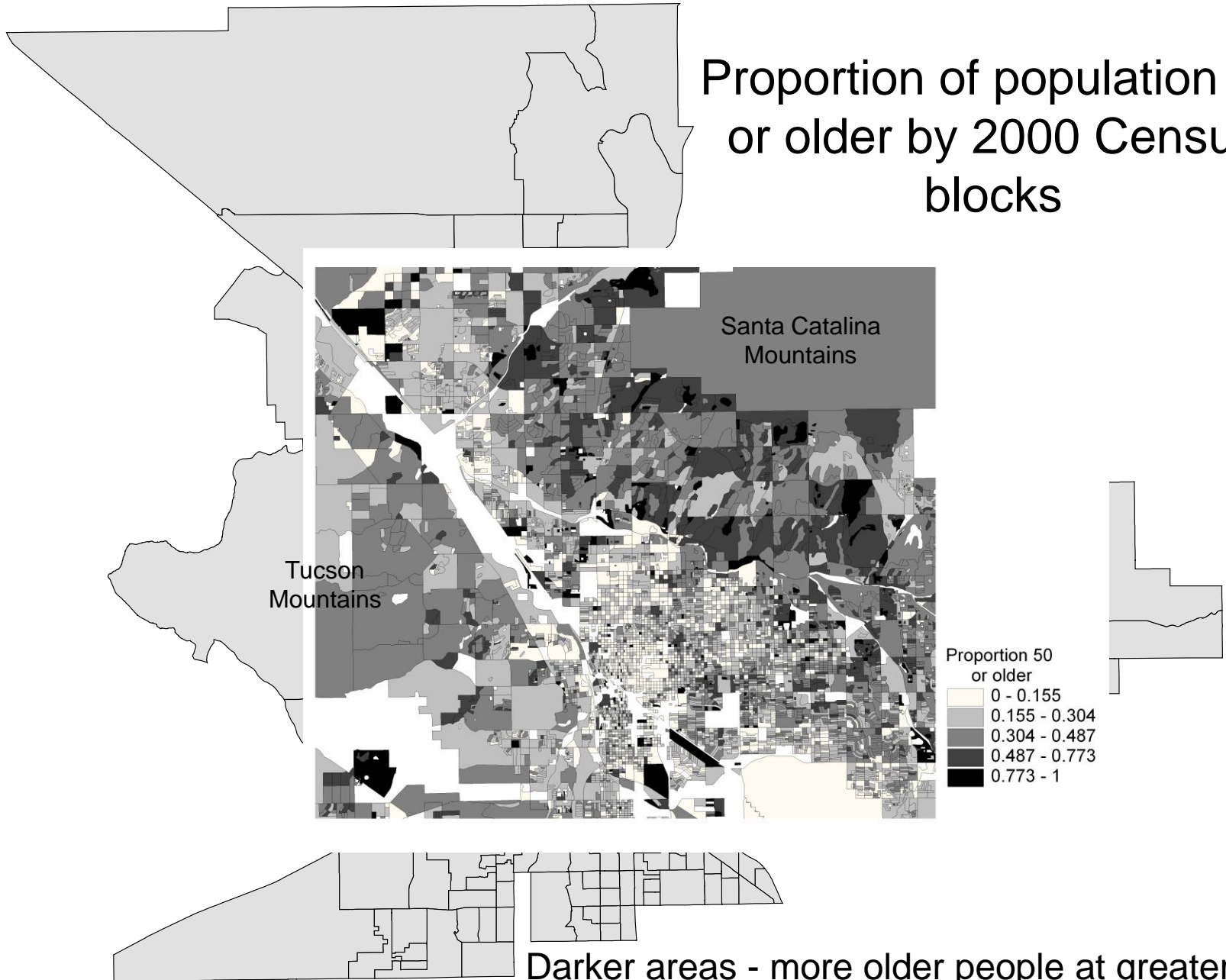






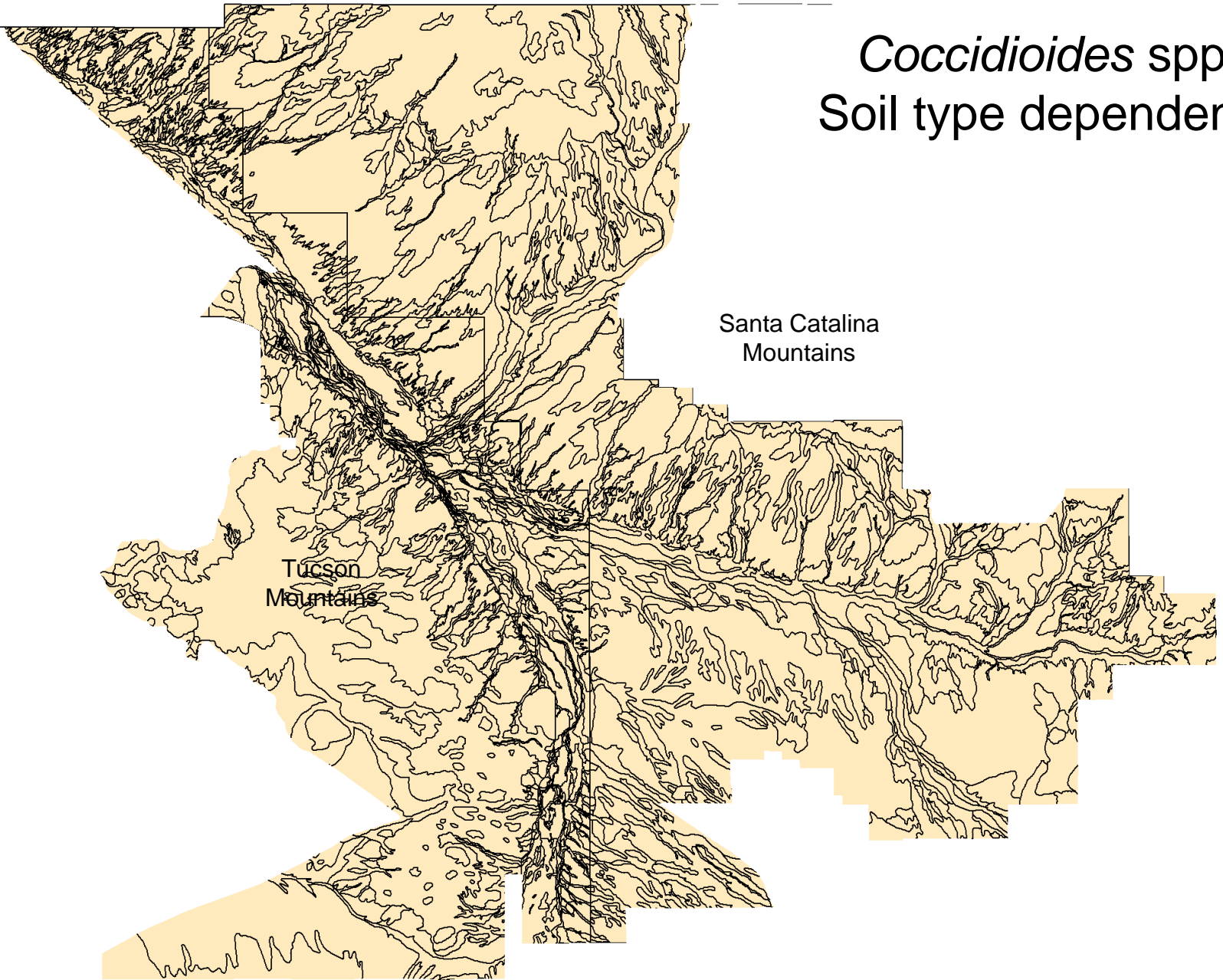
Darker areas - more people immune
Lighter areas - more people susceptible

Proportion of population 50 or older by 2000 Census blocks

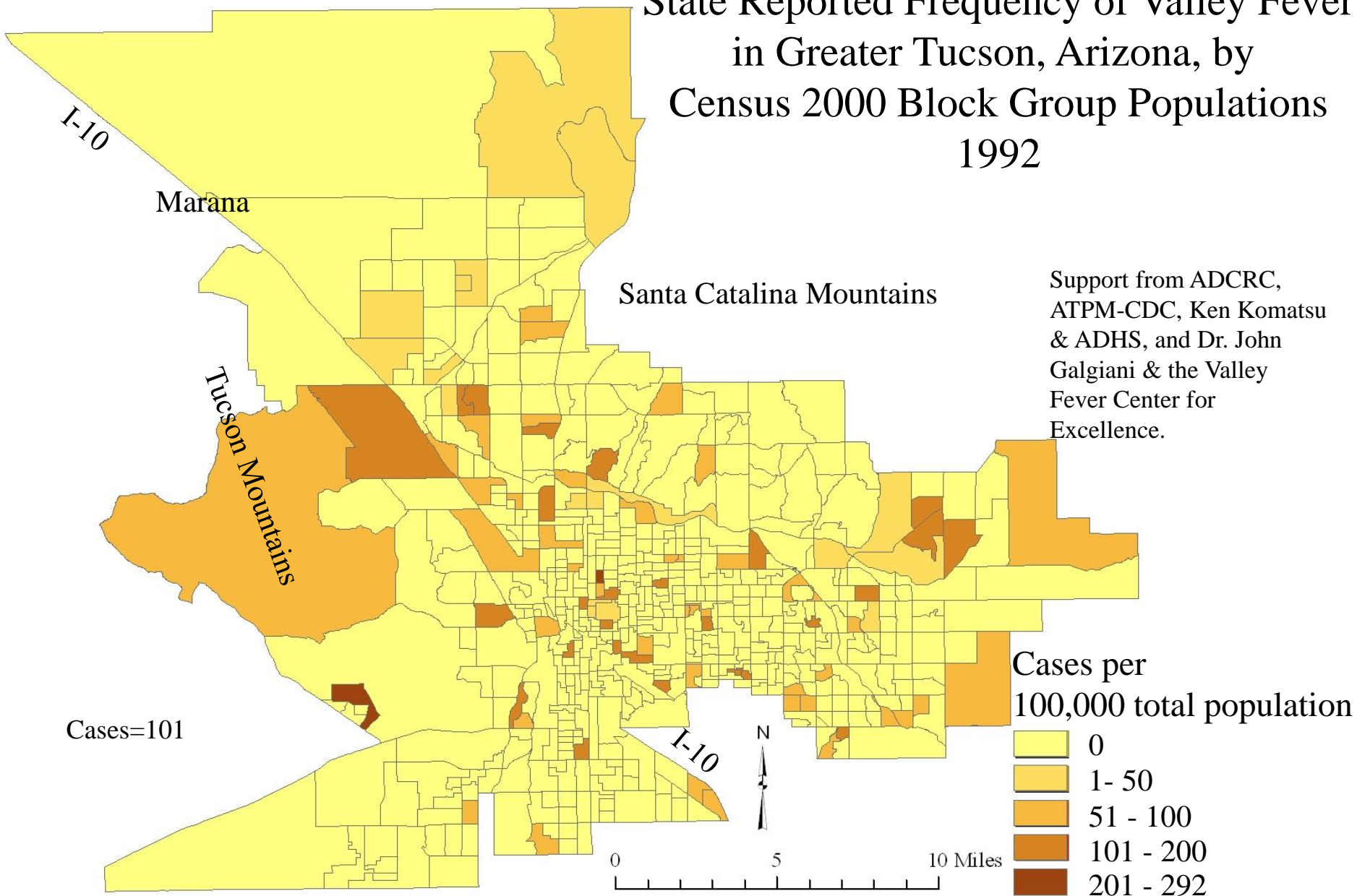


Darker areas - more older people at greater risk
Lighter areas - more younger people at less risk

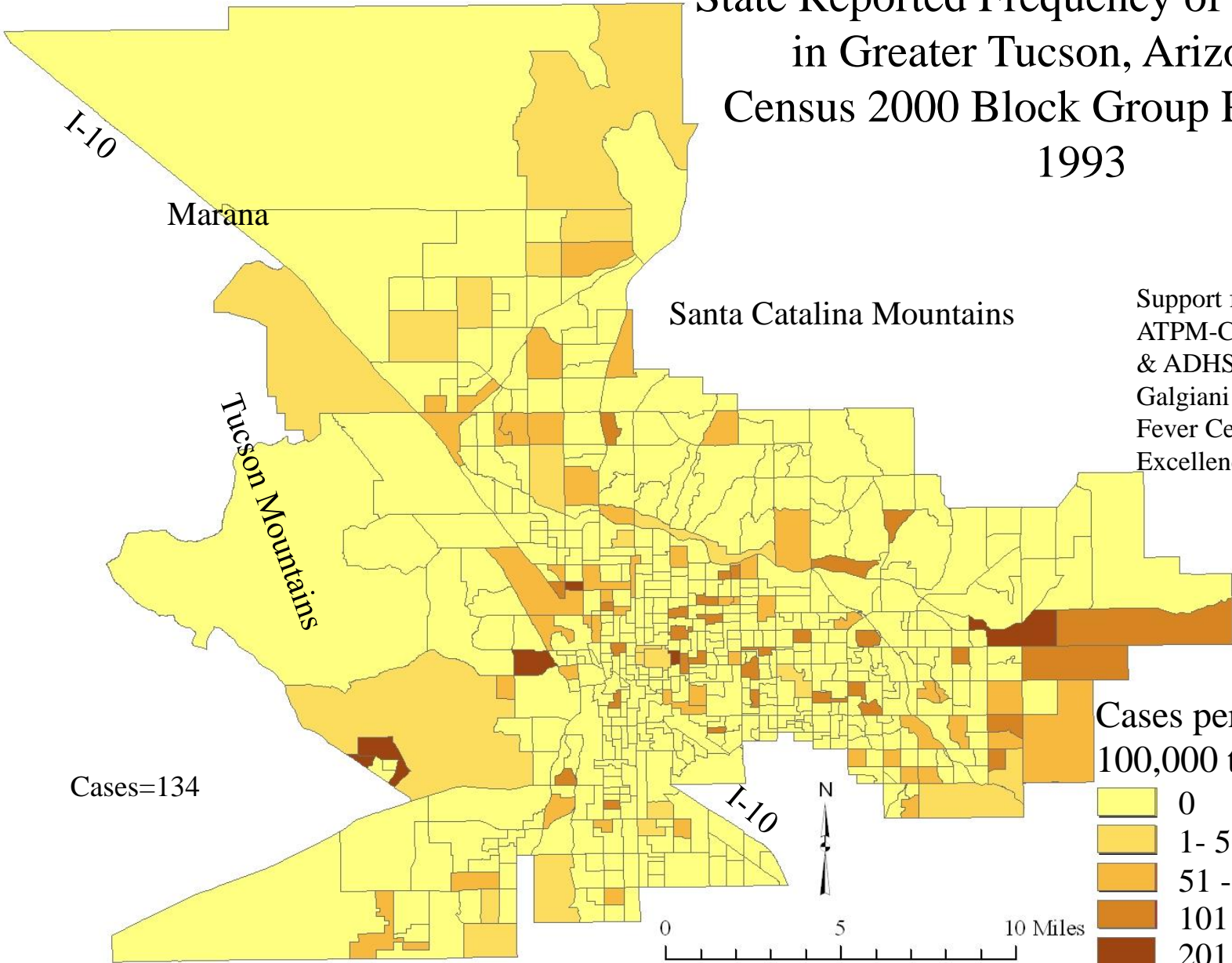
Coccidioides spp.
Soil type dependent?



State Reported Frequency of Valley Fever in Greater Tucson, Arizona, by Census 2000 Block Group Populations 1992



State Reported Frequency of Valley Fever in Greater Tucson, Arizona, by Census 2000 Block Group Populations 1993



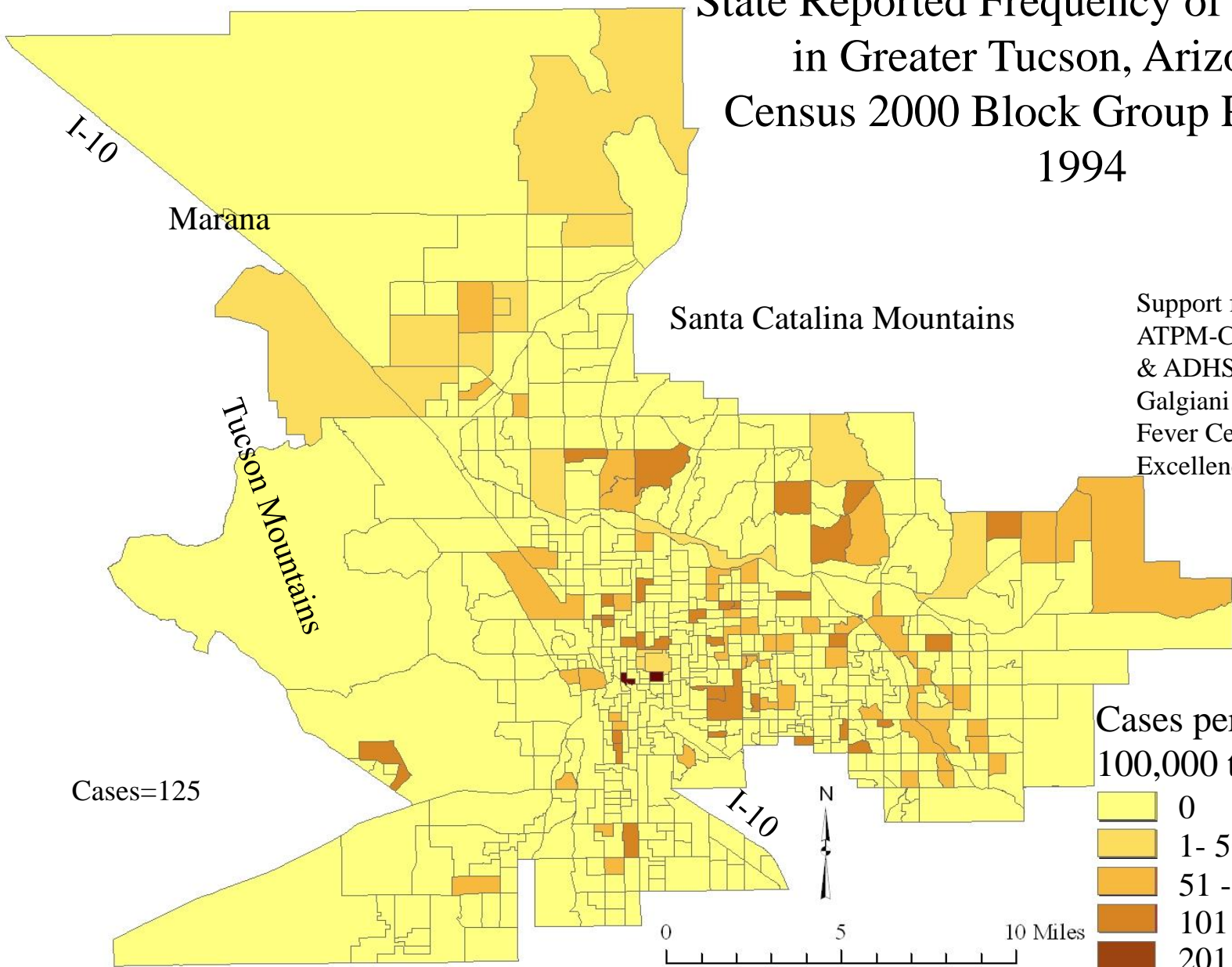
Support from ADCRC,
ATPM-CDC, Ken Komatsu
& ADHS, and Dr. John
Galgiani & the Valley
Fever Center for
Excellence.

Cases per
100,000 total population

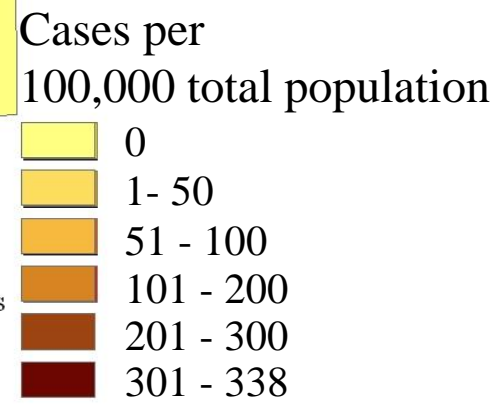
0
1 - 50
51 - 100
101 - 200
201 - 240

Cases=134

State Reported Frequency of Valley Fever in Greater Tucson, Arizona, by Census 2000 Block Group Populations 1994

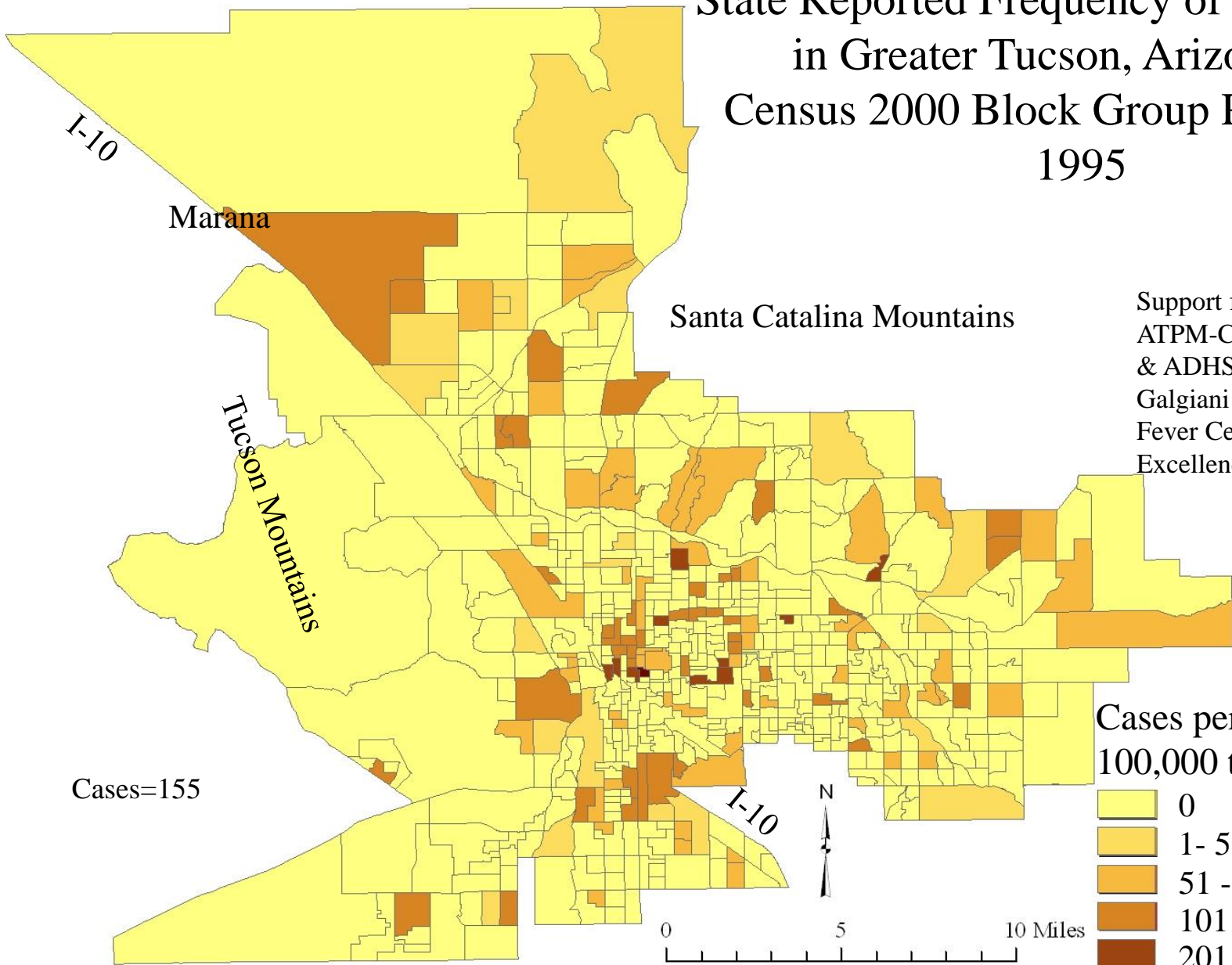


Support from ADCRC,
ATPM-CDC, Ken Komatsu
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Cases=125

State Reported Frequency of Valley Fever in Greater Tucson, Arizona, by Census 2000 Block Group Populations 1995



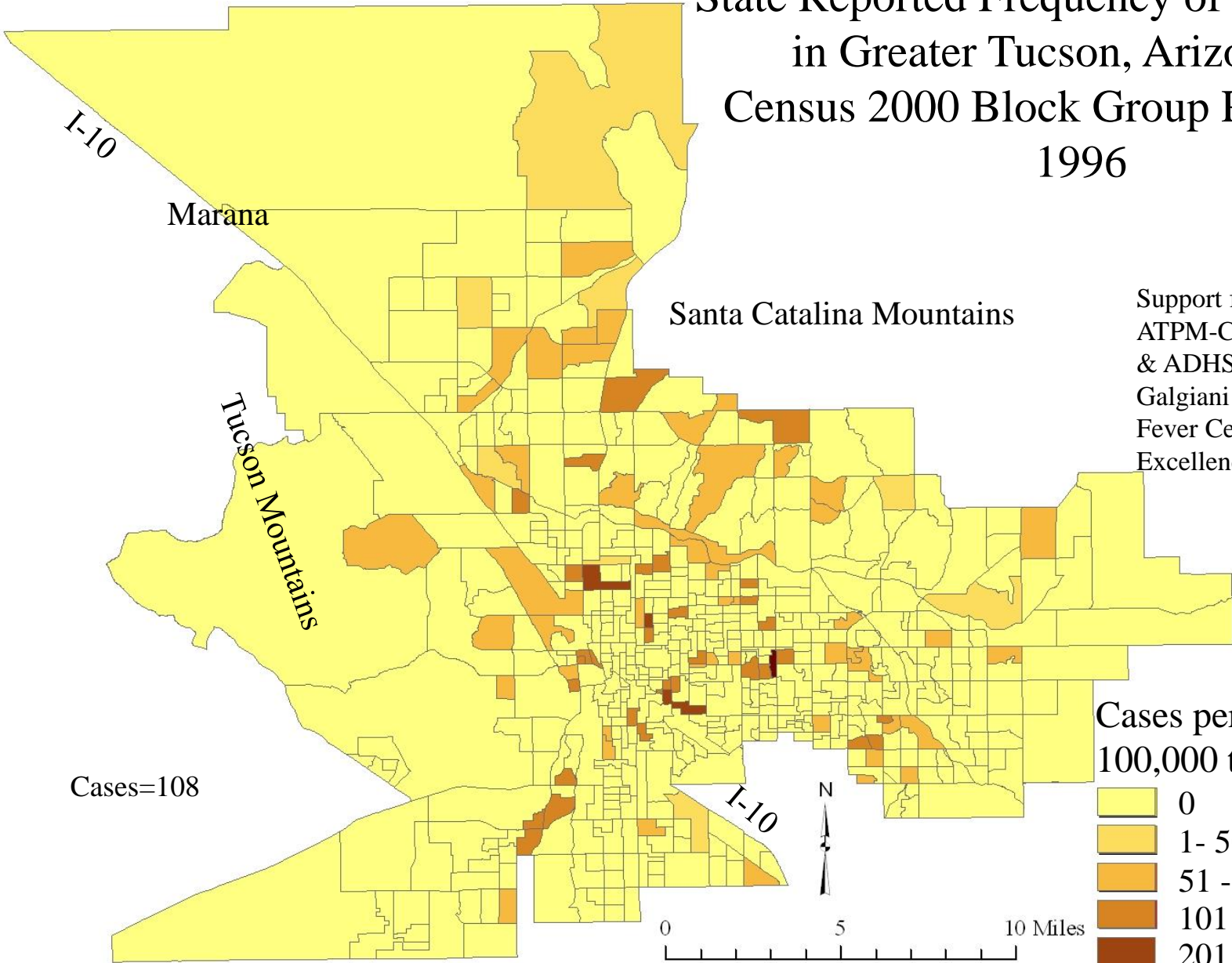
Support from ADCRC,
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Cases=155

Cases per
100,000 total population

- 0
- 1 - 50
- 51 - 100
- 101 - 200
- 201 - 300
- 301 - 463

State Reported Frequency of Valley Fever in Greater Tucson, Arizona, by Census 2000 Block Group Populations 1996



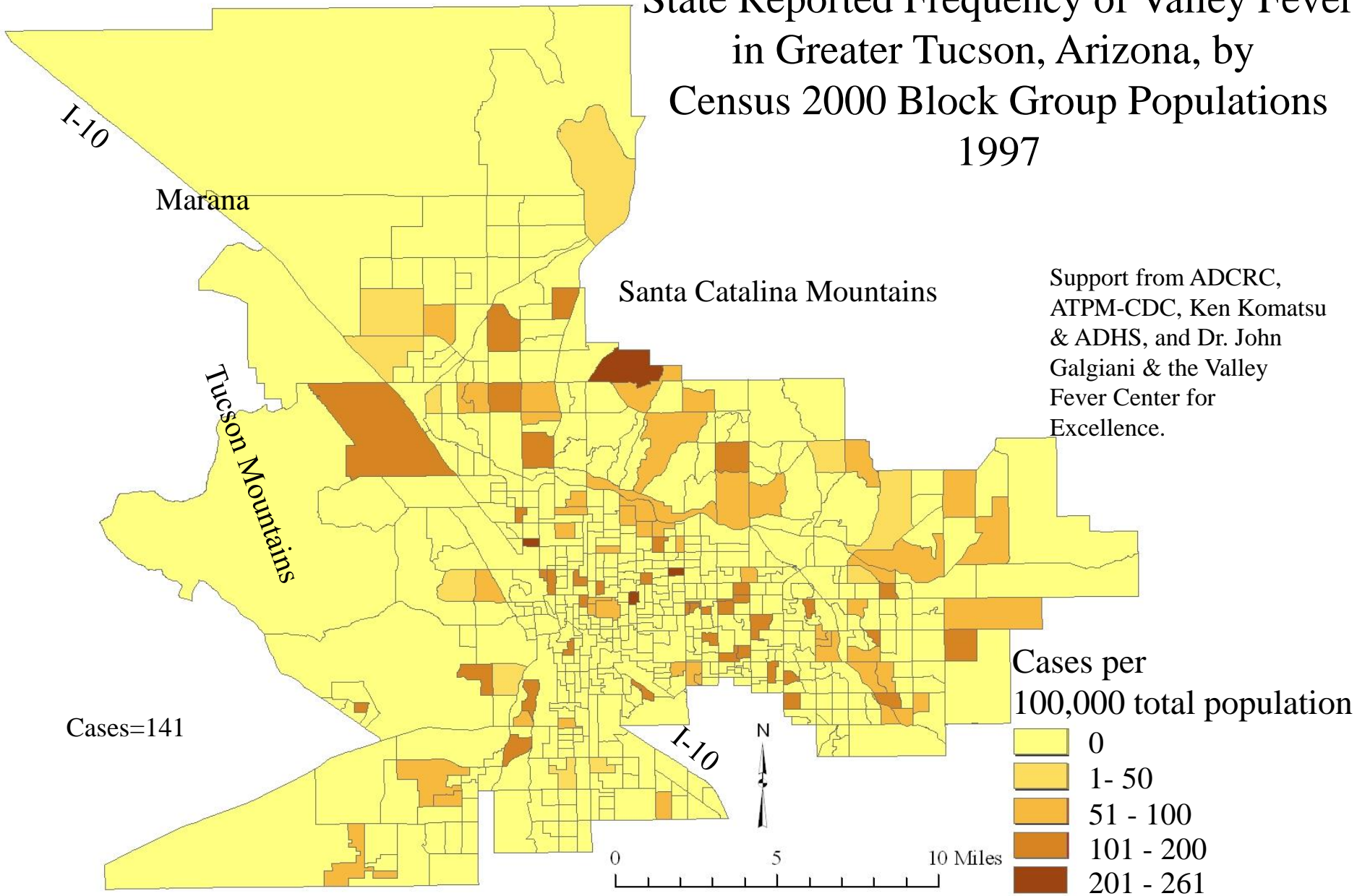
Support from ADCRC,
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Cases=108

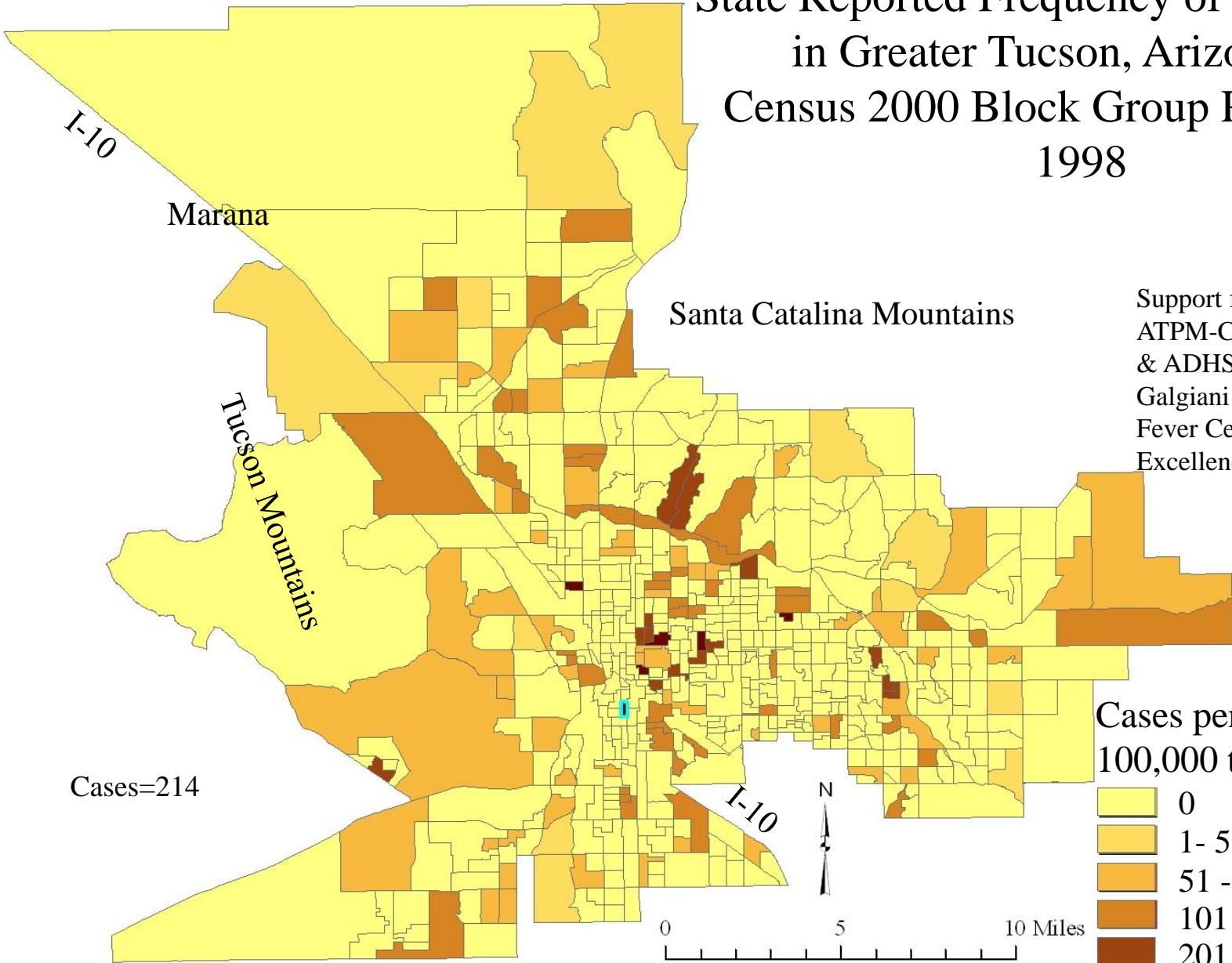
Cases per
100,000 total population

0
1 - 50
51 - 100
101 - 200
201 - 300
301 - 307

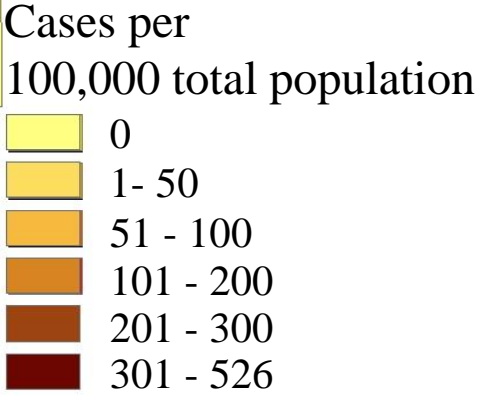
State Reported Frequency of Valley Fever in Greater Tucson, Arizona, by Census 2000 Block Group Populations 1997



State Reported Frequency of Valley Fever in Greater Tucson, Arizona, by Census 2000 Block Group Populations 1998

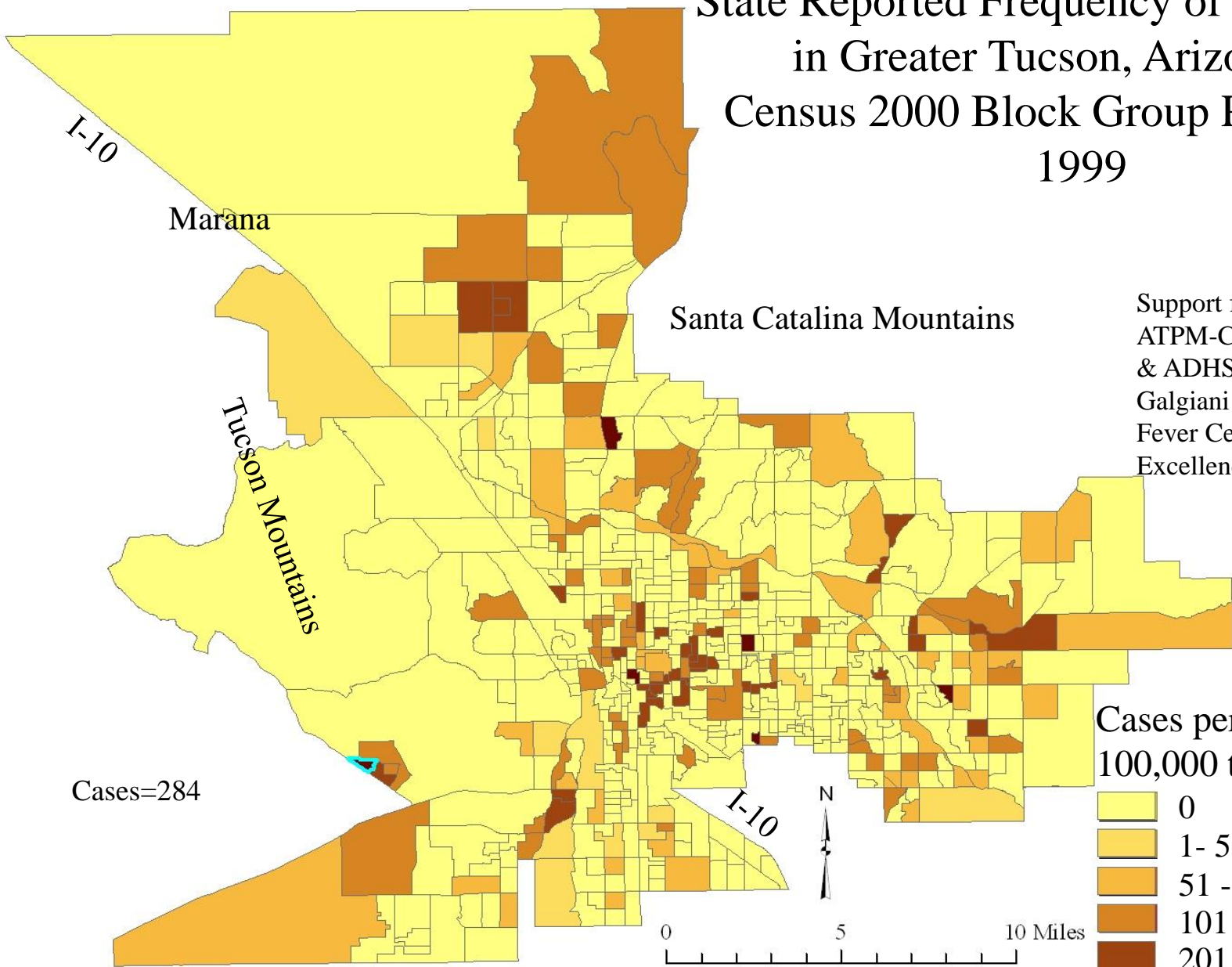


Support from ADCRC,
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Cases=214

State Reported Frequency of Valley Fever in Greater Tucson, Arizona, by Census 2000 Block Group Populations 1999



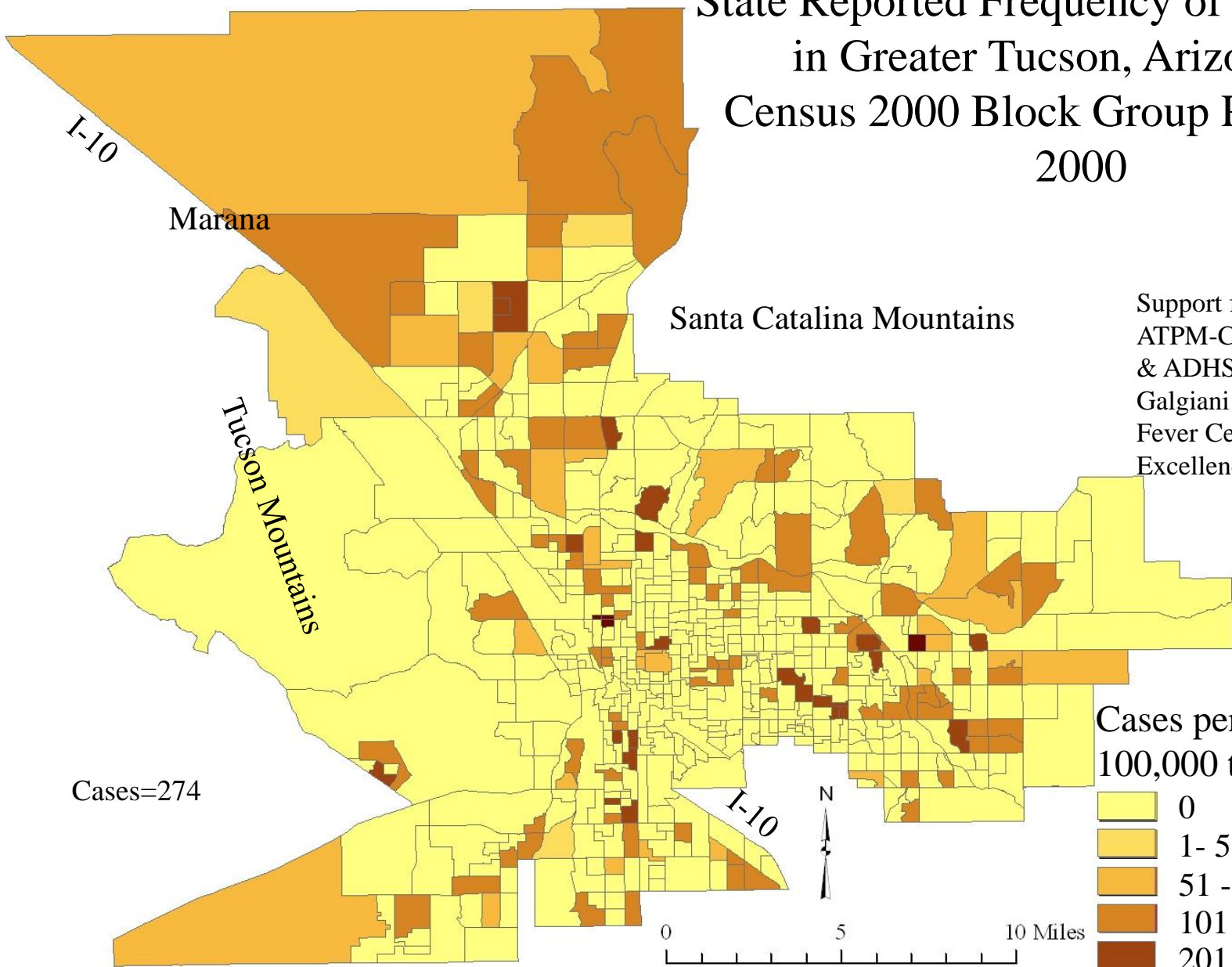
Support from ADCRC,
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Cases=284

Cases per
100,000 total population

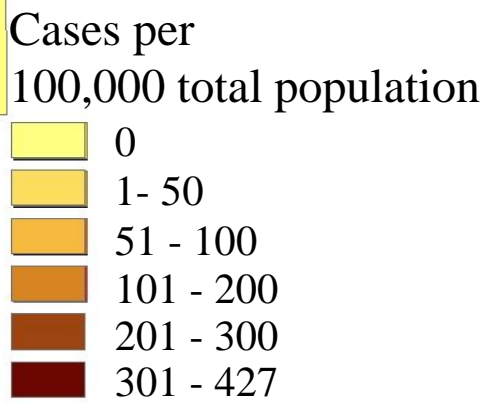
- 0
- 1 - 50
- 51 - 100
- 101 - 200
- 201 - 300
- 301 - 550

State Reported Frequency of Valley Fever in Greater Tucson, Arizona, by Census 2000 Block Group Populations 2000



Support from ADCRC,
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& ADHS, and Dr. John
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Cases=274



State Reported Frequency of Valley Fever in Greater Tucson, Arizona, by Census 2000 Block Group Populations 2001

I-10

Marana

Santa Catalina Mountains

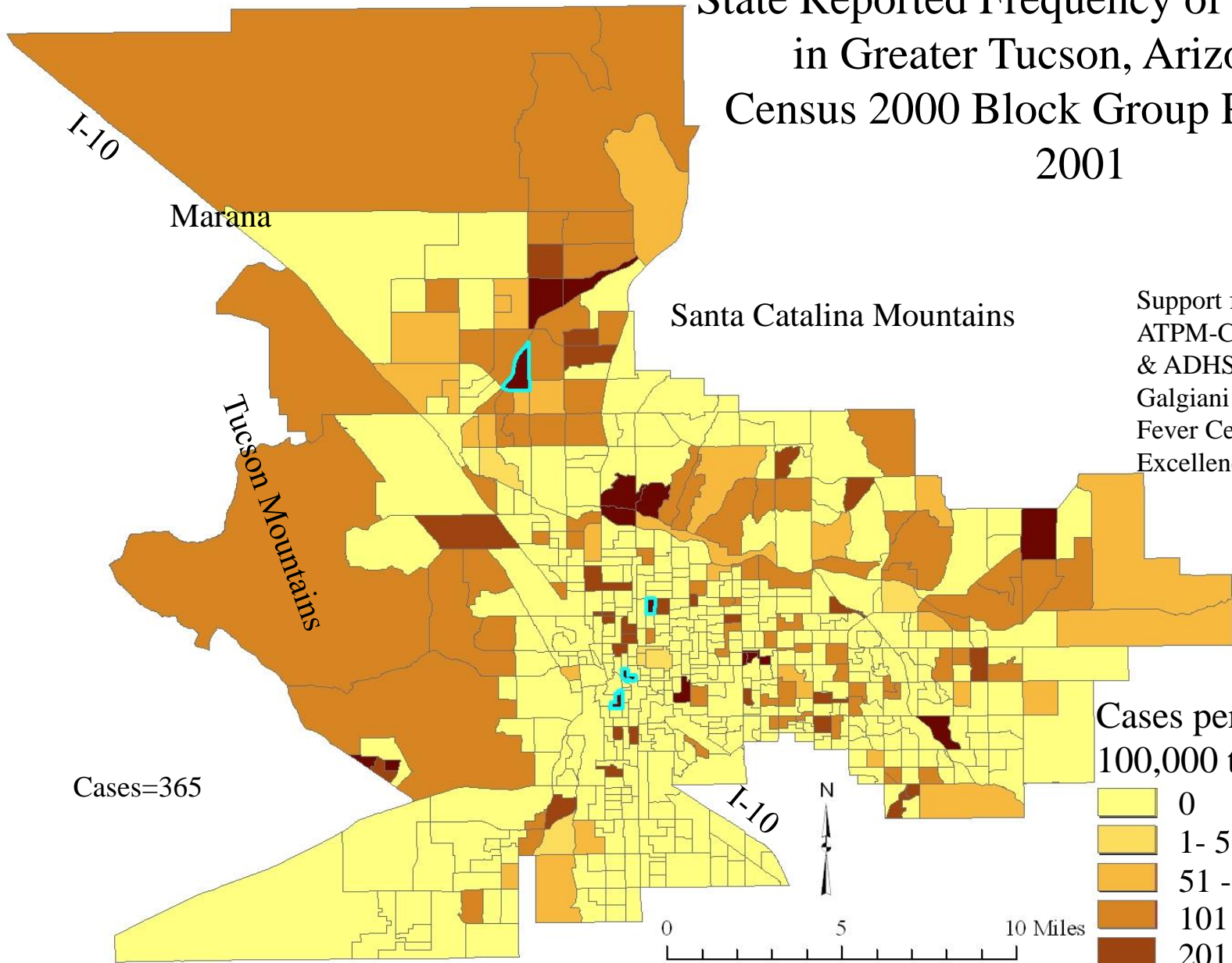
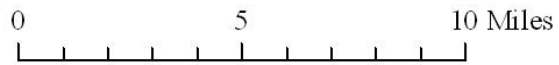
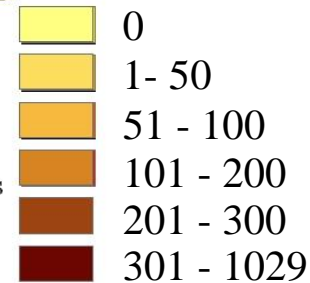
Tucson Mountains

Cases=365

I-10

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Cases per
100,000 total population



State Reported Frequency of Valley Fever in Greater Tucson, Arizona, by Census 2000 Block Group Populations 2002

I-10

Marana

Santa Catalina Mountains

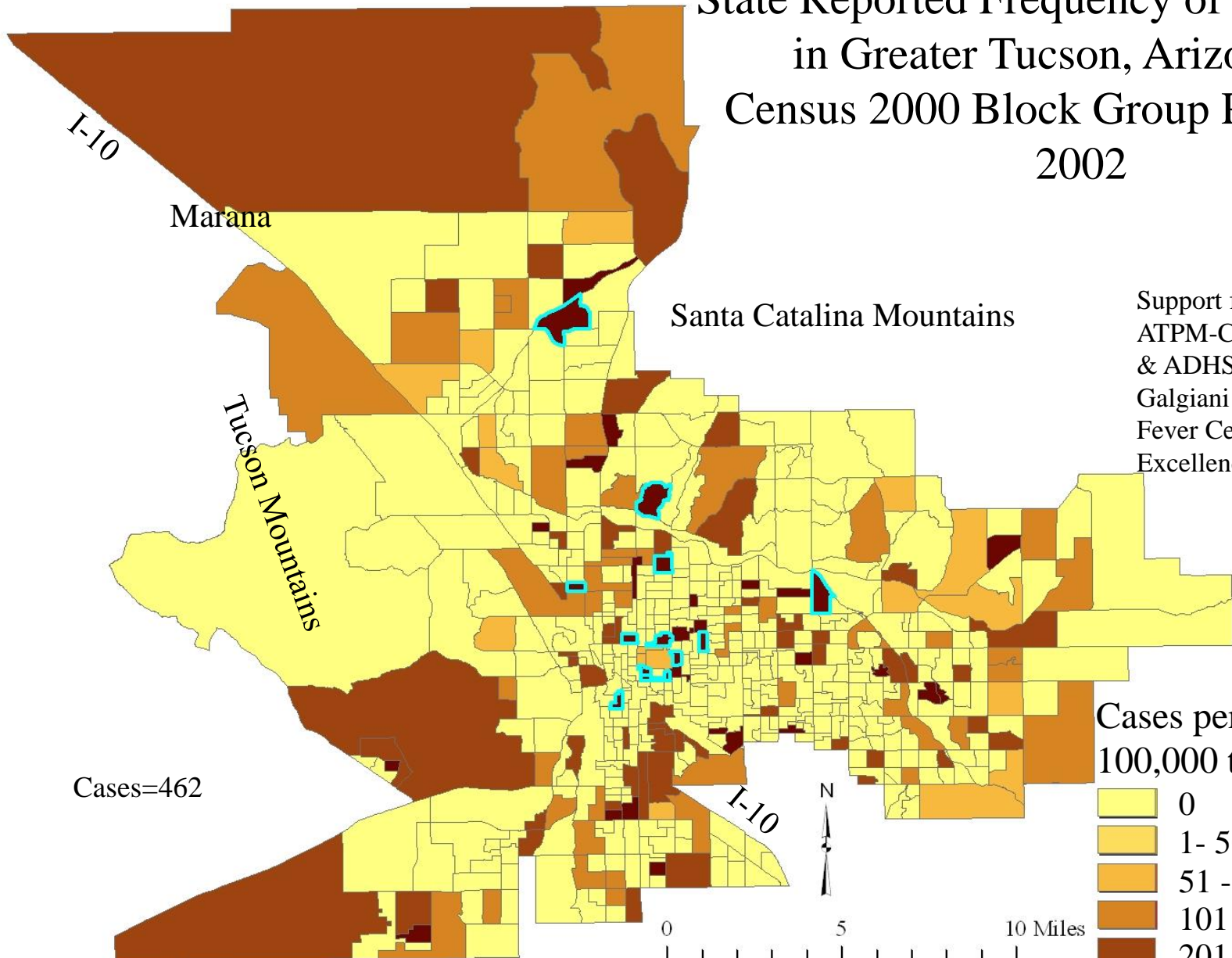
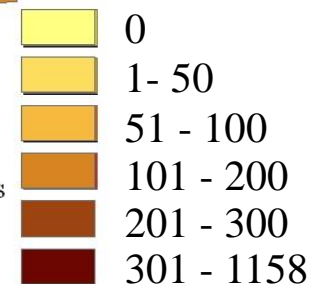
Tucson Mountains

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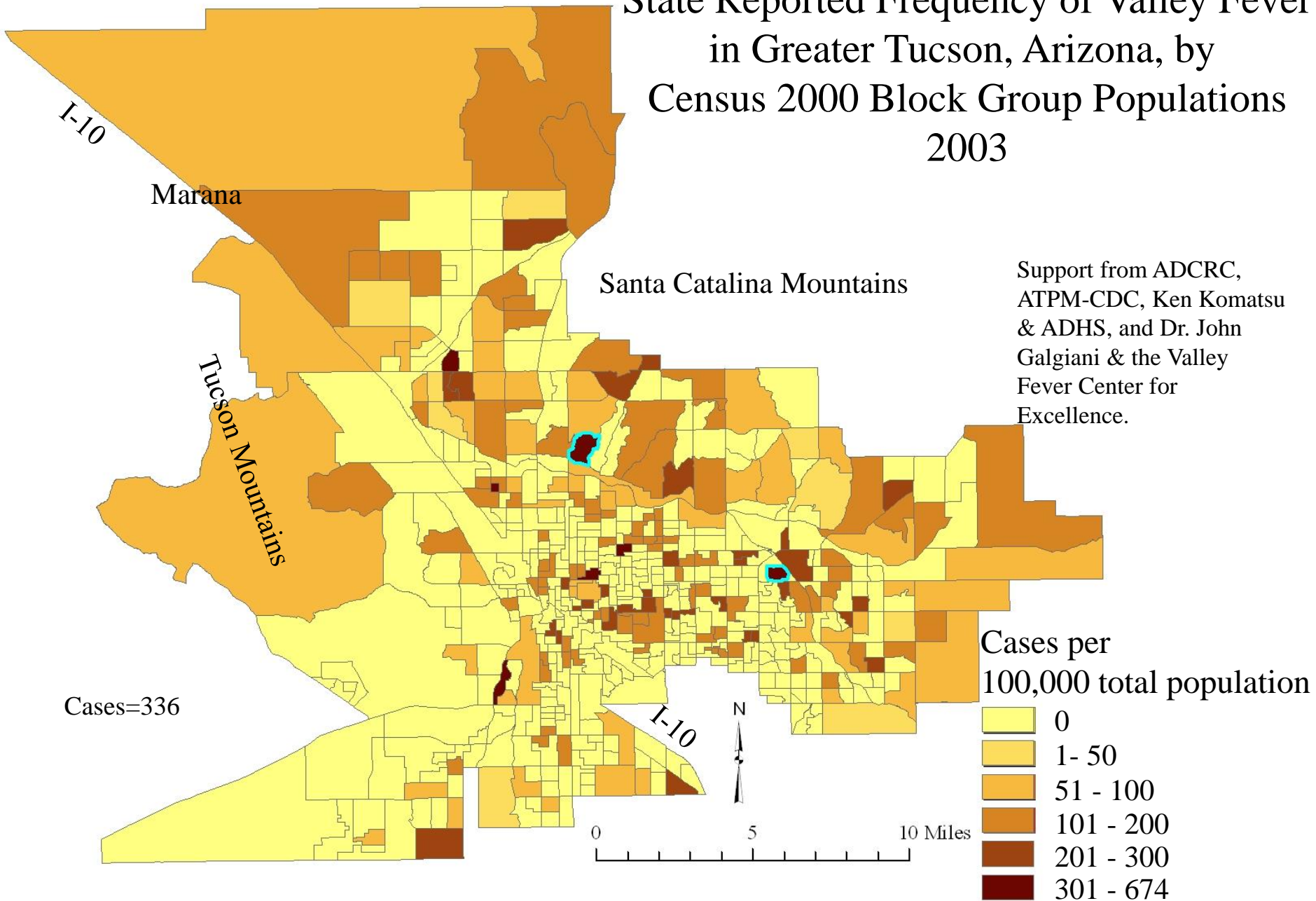
Cases=462

I-10

Cases per
100,000 total population



State Reported Frequency of Valley Fever in Greater Tucson, Arizona, by Census 2000 Block Group Populations 2003

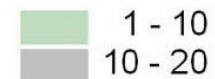



Odds ratios of canine valley fever for 1 km² areas. Values are based on a 2 month prevalence of the total study population. Tucson, Arizona

Odds ratios for 1 km² areas with dog populations greater than 20



Dog population density of areas with 20 dogs/km² or less.



 Major Streets

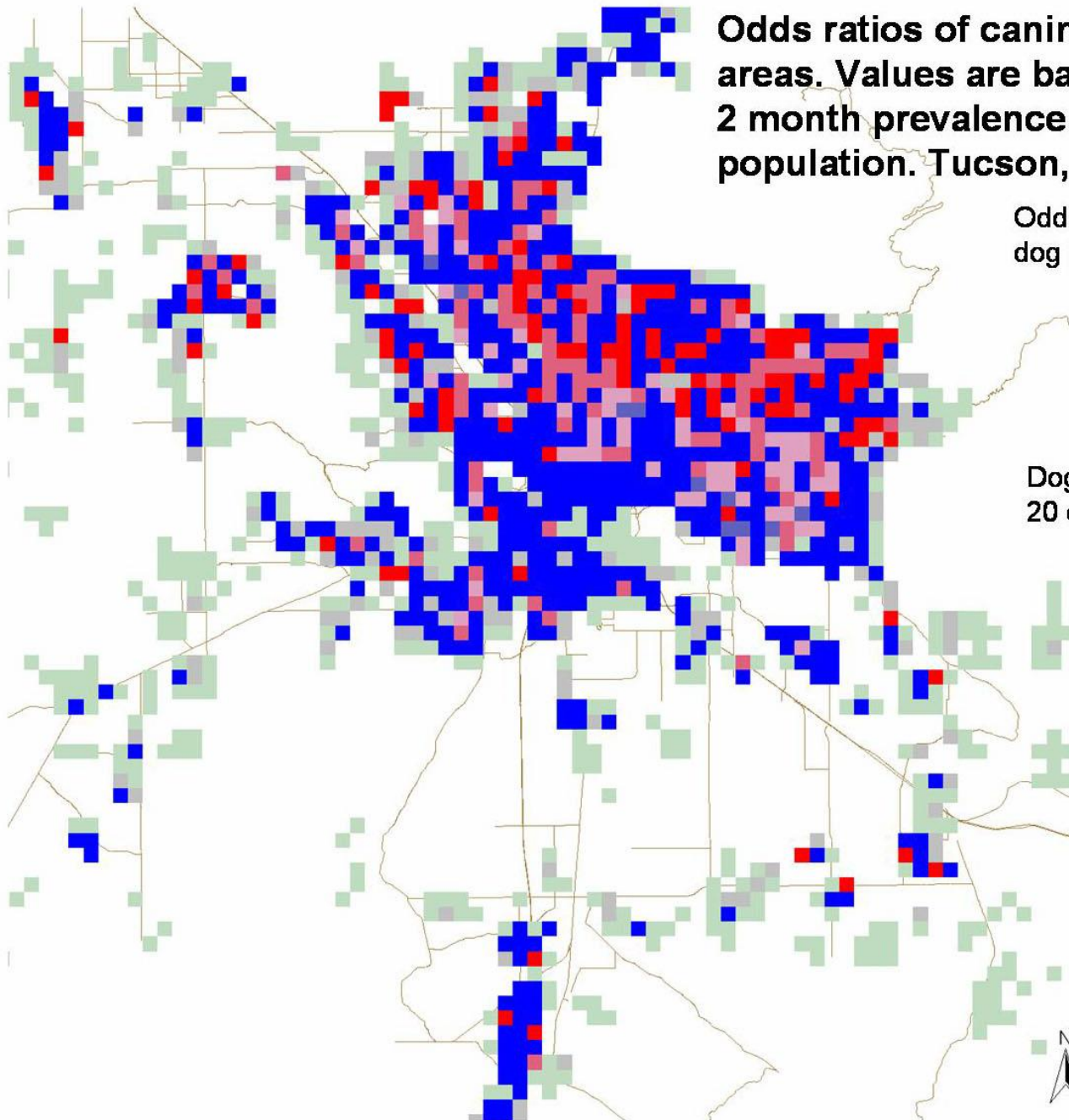
Cases reported (n = 473) over 53 days, from 11/16 to 23/99, 12/27/99 to 1/31/00, and 3/21 to 29/00. Dogs licensed by Pima County Animal Control in 2002 (n = 84,967) serve as the population denominator.

Funding provided by ATPM/CDC.

Arizona College of Public Health and College of Agriculture & Life Sciences, University of Arizona, July, 2002.

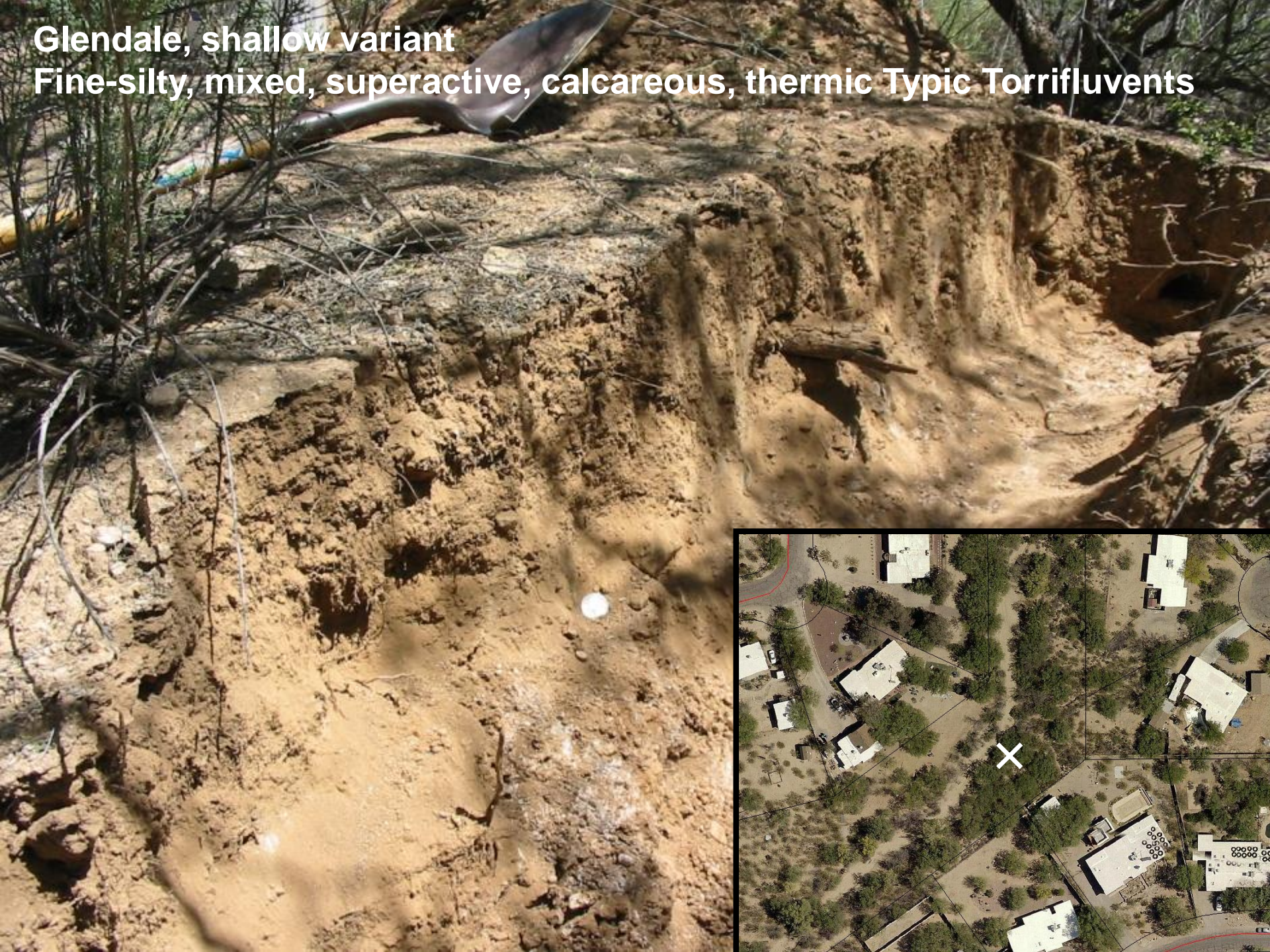


0 5 10 Miles



Glendale, shallow variant

Fine-silty, mixed, superactive, calcareous, thermic Typic Torrifuvents



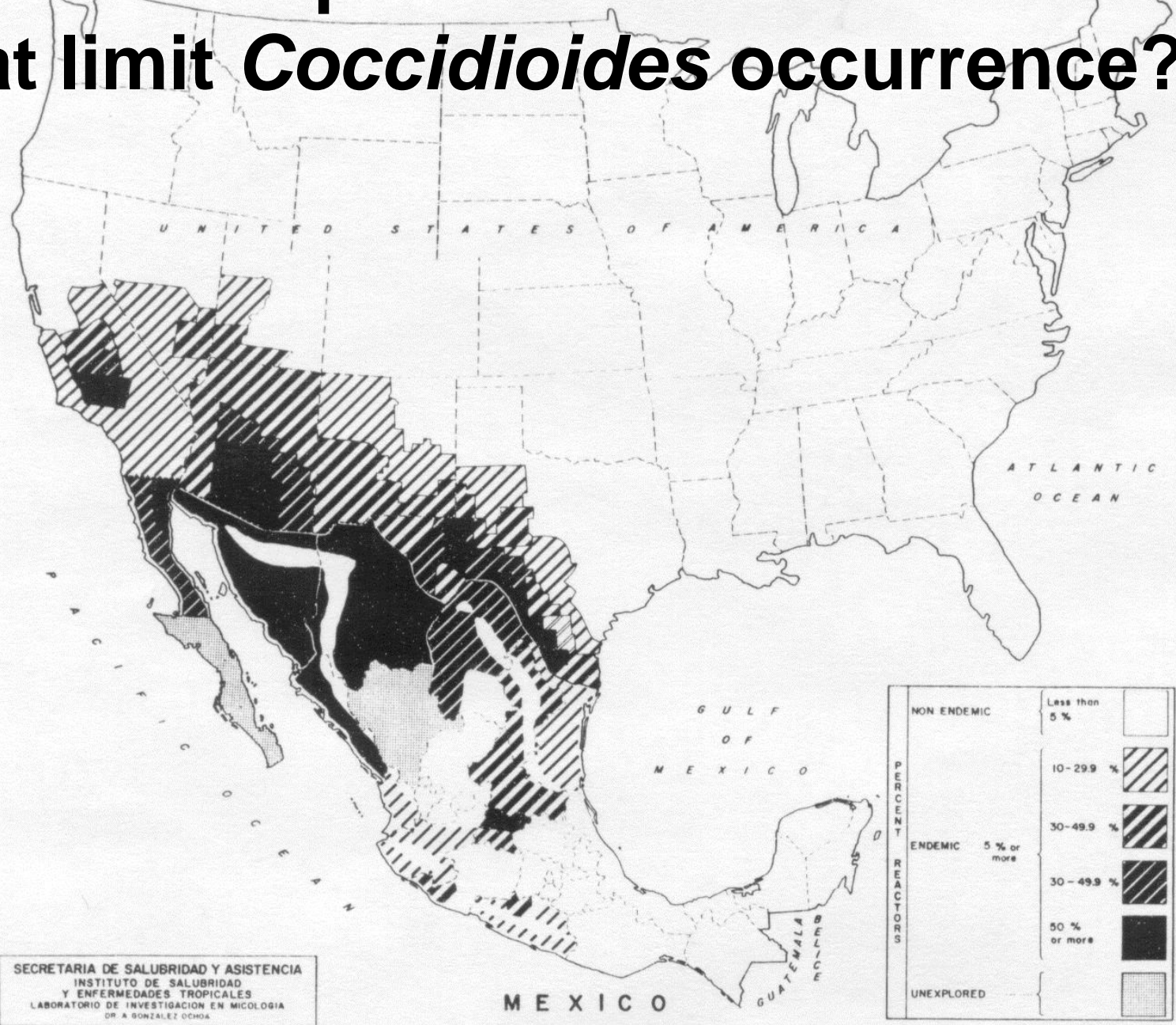
Current Facts

- Disease frequency is spatially and temporally variable at coarse and fine scales
- Group-level exposures are important at neighborhood-scale
- Disease frequency associated with weather and climate
- Limited to warm, dry areas of the Americas
- Soil surface temperatures $>50^{\circ}$ C kills spores
- UV light kills spores
- Mice are the detection standard, PCR & direct plating
- Hyphae 2 to 4 μm in diameter
- Maintains presence at site location for decades

Current Assumptions

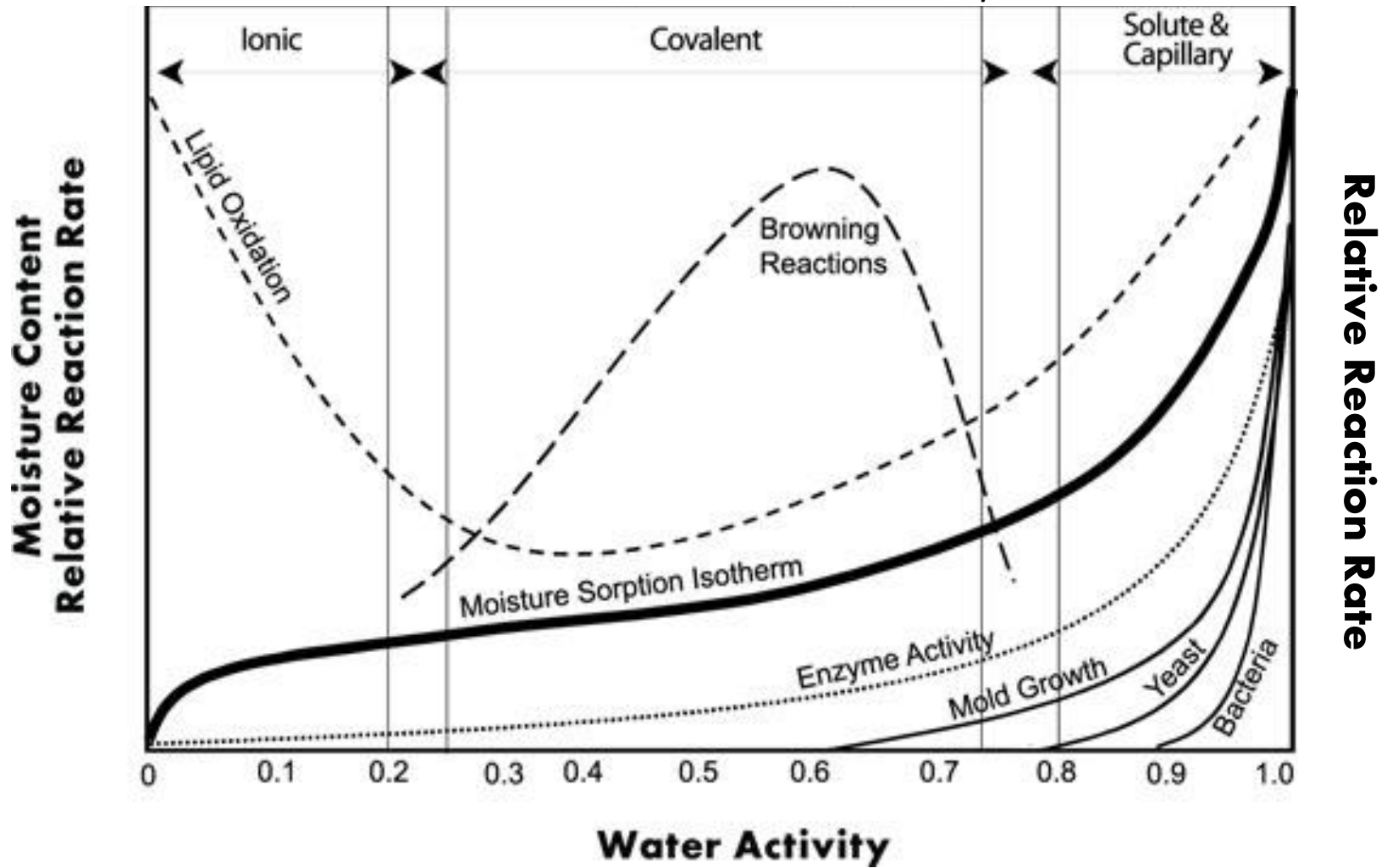
- More likely to occur in more alkaline soils, from the neutral to moderately alkaline range (pH 6.6 to 8.4)
- Less likely to occur in more clayey soils of the sand, loamy sand, and sandy loam soils
- More tolerant to salts than competing microorganisms
- Irrigation will kill-off *Coccidioides* spp.
- Spores remain viable up to 10 years (stored samples)
- Association with rodents
- Genetic variability of isolates suggest geographic dispersal is by mammals, not wind.

What are the processes/characteristics that limit *Coccidioides* occurrence?



Water activity (w_a) = soil water potential (Ψ)

$$(RT/V_w) \ln(w_a) = \Psi_T = \Psi_\pi + \Psi_\rho + \Psi_z$$



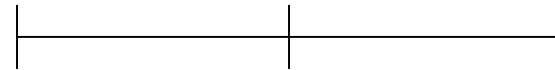
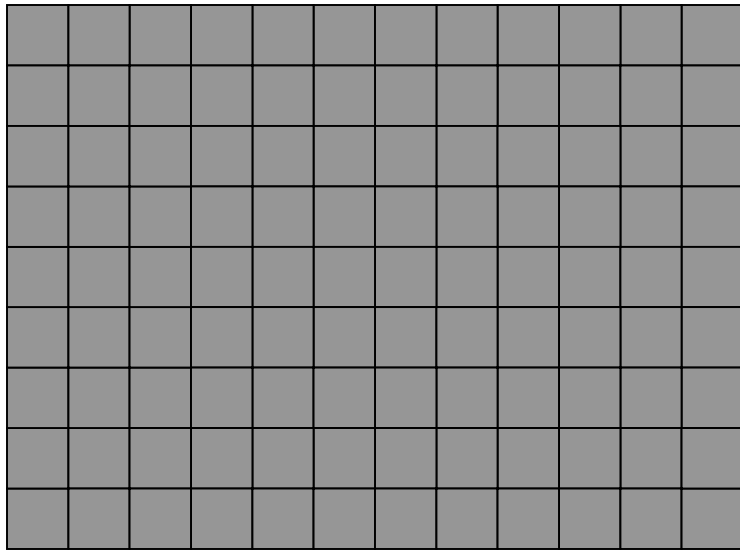
90% w_a or -13.4 MPa soil water potential

Grow and blow: patterns and scales using a landscape ecology approach

- Phenomenon scale
- Sampling scale
- Analytical scale

- Static and dynamic data
- Information rich and information poor areas

Scale and Spatial Relationships and Patterns



Kilometers?

Meters?

Centimeters?

