

# Molecular Epidemiology of HIV in San Diego and Tijuana

Tracking HIV



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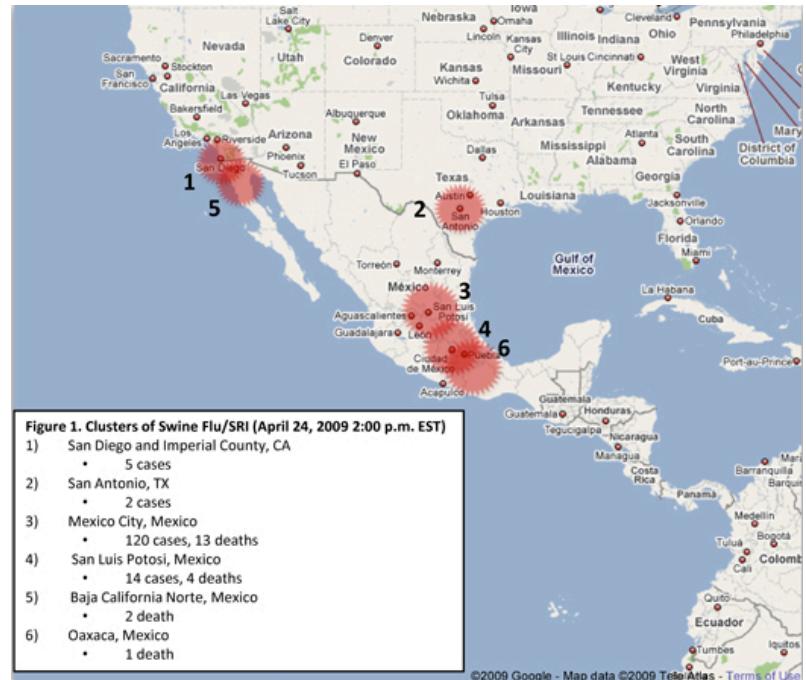
# San Diego-Tijuana Border

- Worlds busiest land border
- Over 50 million border crossings each year



# Does the border limit the spread of infectious diseases?

- From a small town in Veracruz, Mexico the 2009 H1N1 epidemic spread into Imperial and San Diego counties first in the US.



# HIV in Mexico

- In 1980s, most HIV cases in Mexico were in individuals who previously lived in the US.
- By 1991, 44.3% of cases were in previous US residents.
- In 2000 the rate dropped to ~12%, but was higher in rural areas, with over 20% of HIV cases in Michoacan and Zacatecas acquired in the US.



Magis-Rodriguez JAIDS 2004  
Strathdee et al JAMA 2008

# Questions

- 1) Are the San Diego and Tijuana epidemics connected?
- 2) What is the direction of viral migration across the border?
- 3) What risk factors driving the border HIV epidemic?

# Molecular Epidemiology

Using the relationships between viral sequence data sampled from infected individuals to characterize the spread of HIV

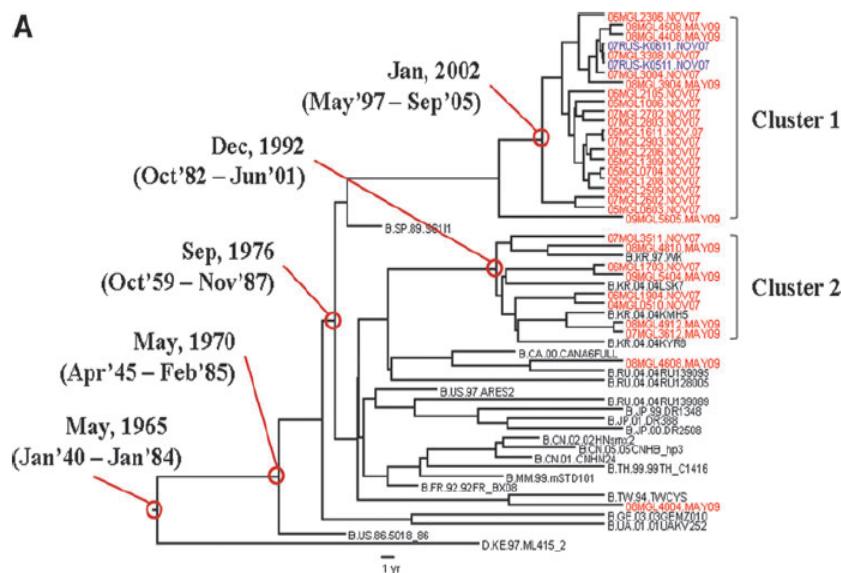


- 1) AACTGATCGC
- 2) AACAGATCGC

# Clustering

## Phylogenetic Trees

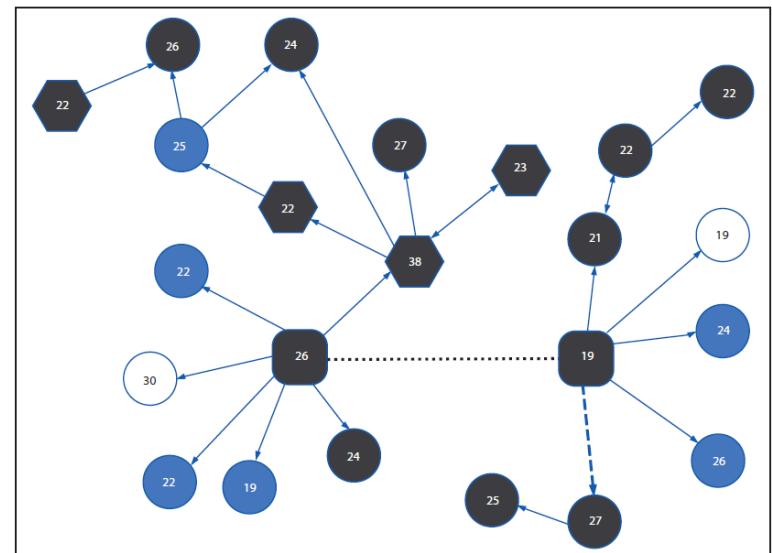
A



- 1) AACTGATCGC
- 2) AACAGATCGC

Evolutionary Difference at each site

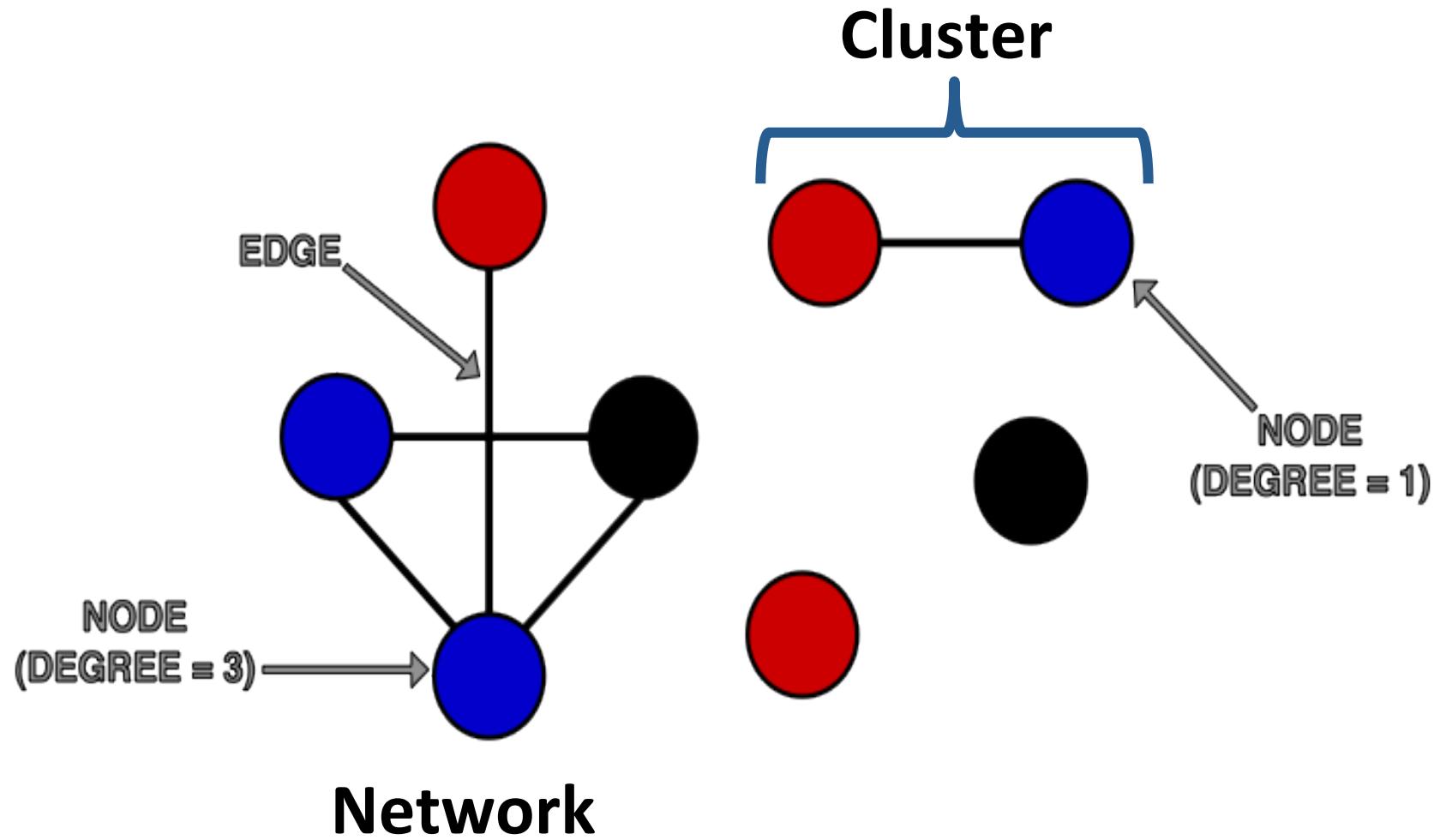
## Network Maps



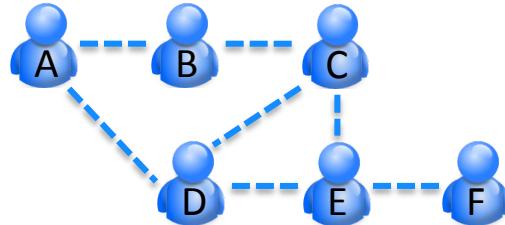
- 1) AACTGATCGC
- 2) AACAGATCGC

10% difference

# Terminology - Networks

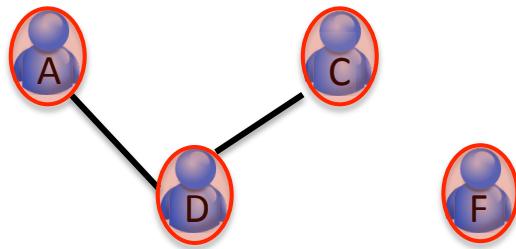


# Understanding HIV Transmission Networks



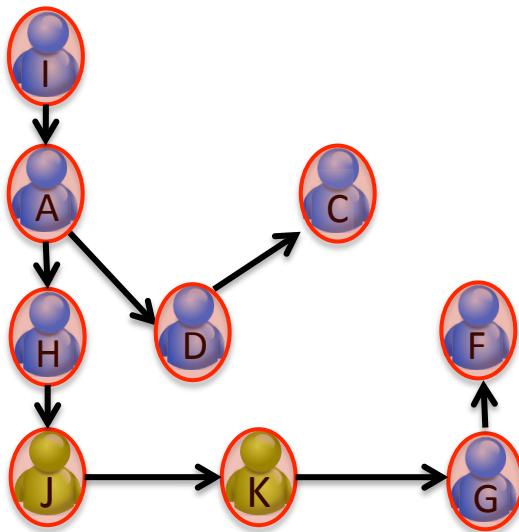
## A Sexual Network: Real World Network

- Dashed lines indicate sexual contact



## An HIV Transmission Network: What we see

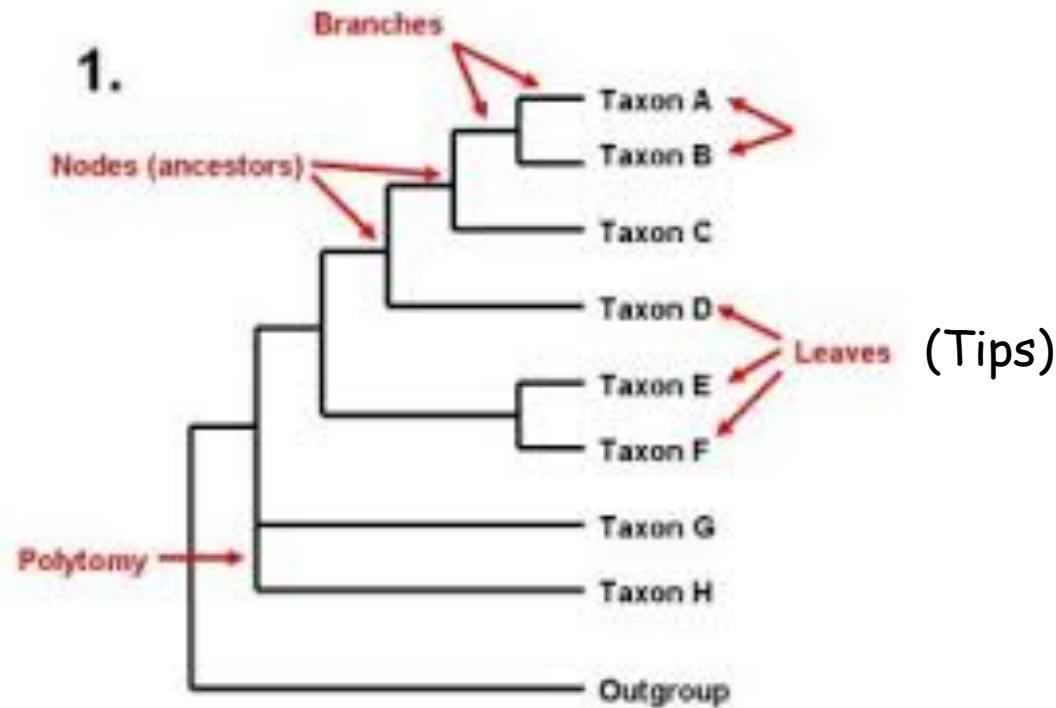
- Solid lines indicate very similar viruses
- Red circles indicate HIV infected persons
- Other individuals are HIV negative so don't appear



## An Transmission Network: Limitations of our knowledge

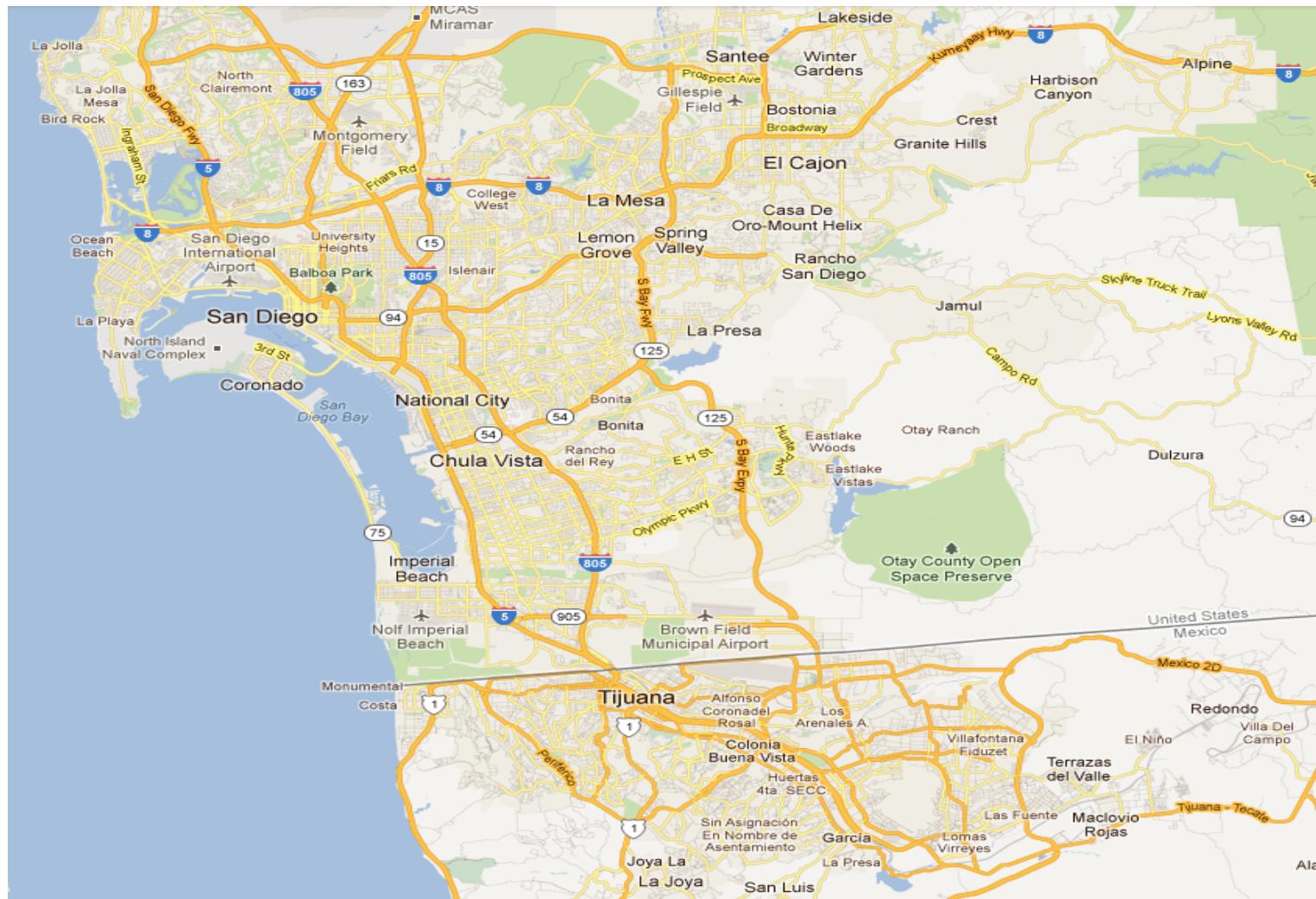
- Dates of infection are used to assign direction of transmission
- New HIV infected persons already in care appear
- Other potential “sources” of HIV transmission identified
- What we don't see remains missing

# Terminology – Phylogenetic Trees



Time or Genetic Difference →

# San Diego – Tijuana Molecular Epidemiology Project



# Collaborating Projects Across the Border Region

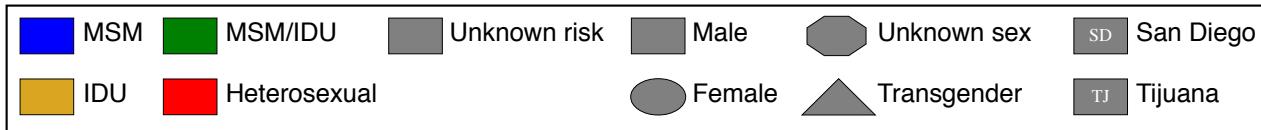
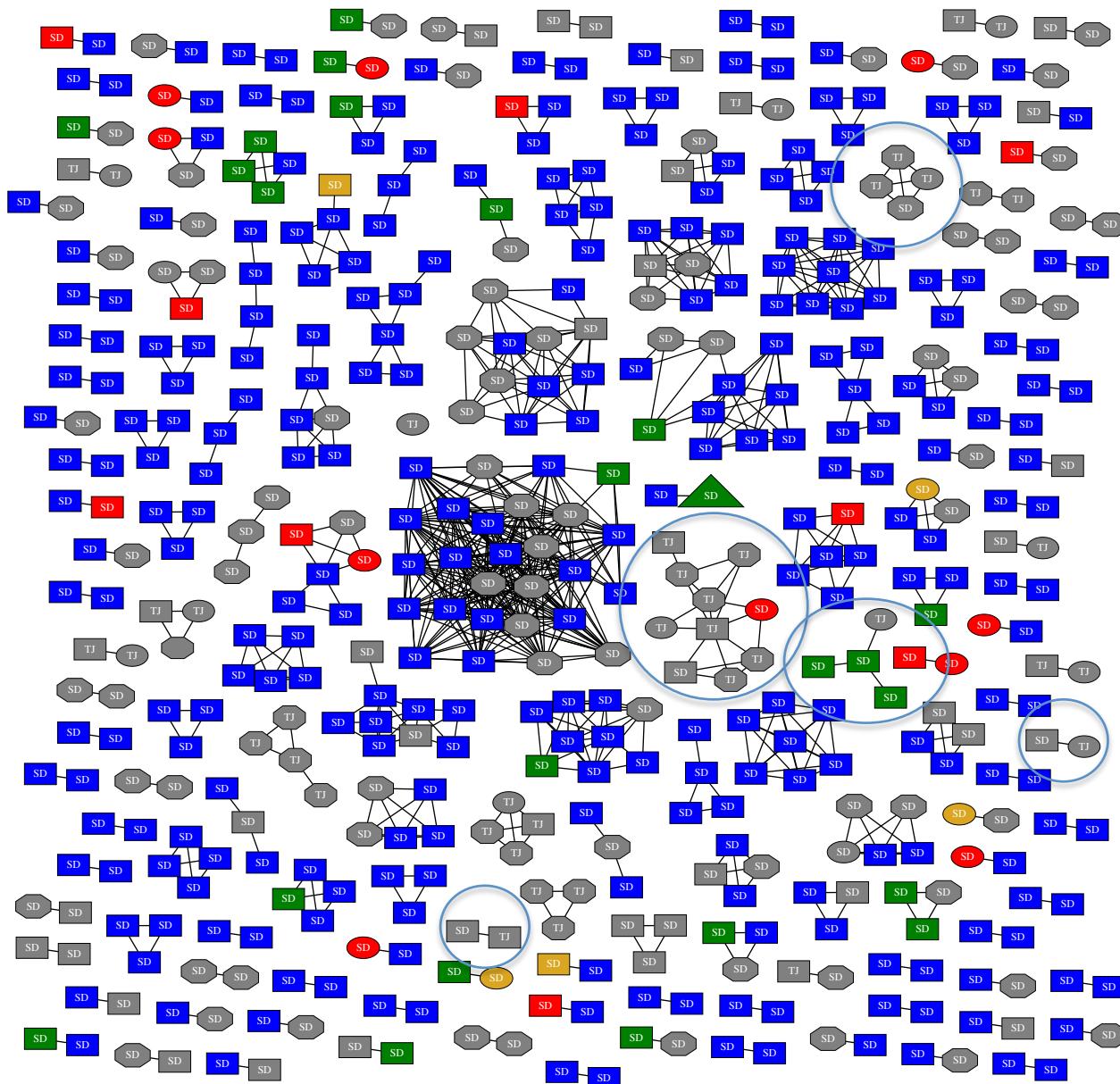
- Tijuana
  - Persons who inject drugs (PWID) - Proyecto El Cuete
  - Female sex workers (FSW) and Clients - Mujer Segura, Mujer Mas Segura, Proyecto Parejas, Hombre Seguro, Amigos
  - Truck Drivers - Crossing Borders - Proyecto Mapa
  - Community HIV clinic - CAPACITS clinic -future
  - Prenatal HIV clinic - IMPAACT - future
  - MSM in Tijuana -future
- San Diego
  - MSM - Primary Infection Cohort
  - PWID - STAHR study and STAHR II study
  - South Bay Primary Infection Surveillance
  - MSM & PWID - HNRC
  - CNICS Cohort - future

# Collaboration

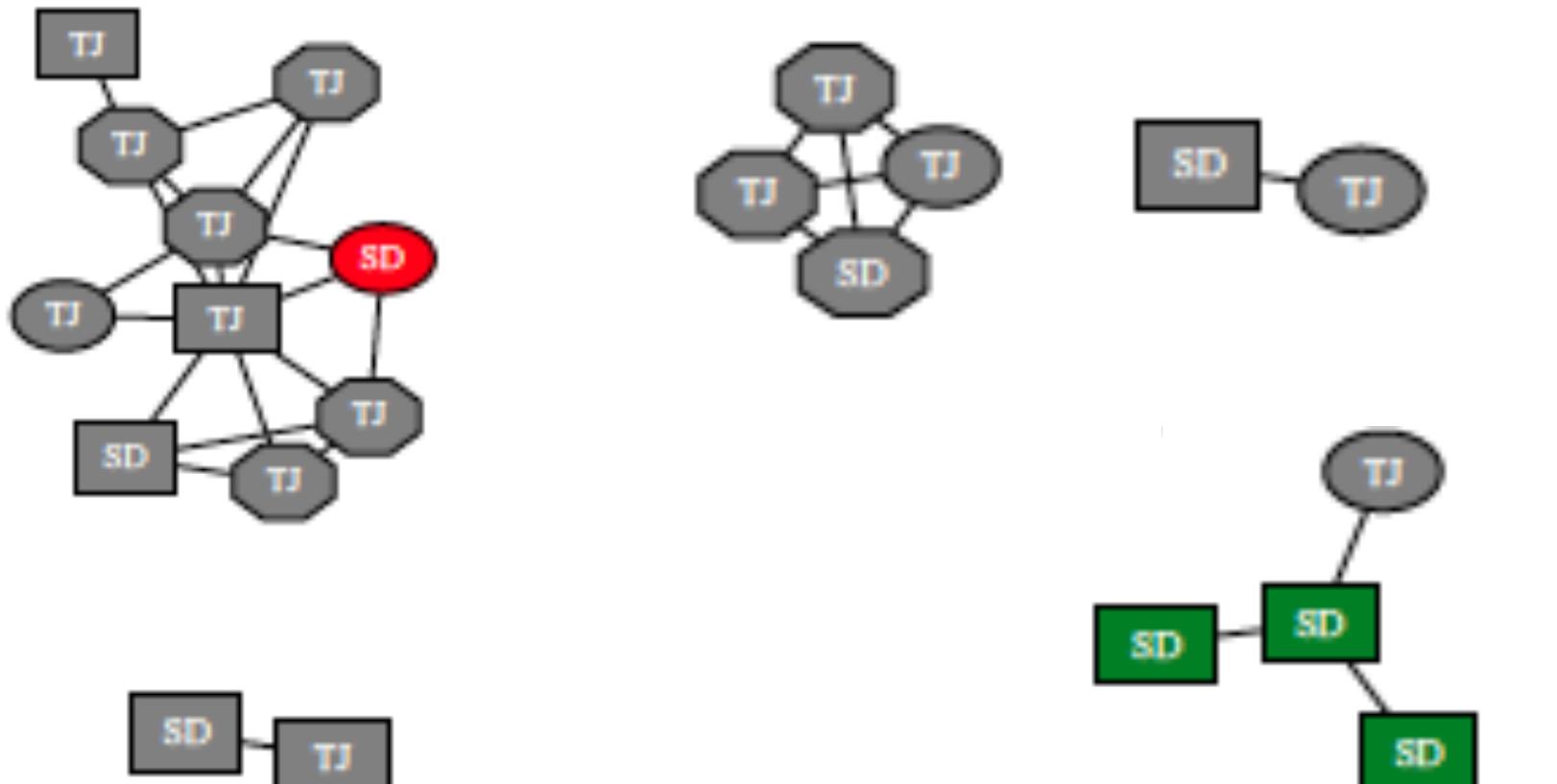
- Projects used various sampling methods
  - Respondent Driven Sampling
  - Convenience Sampling
  - Venue-based Sampling
  - Targeted Sampling

# Study

- 1111 HIV sequences were collected from the collaborating studies (including 263 background sequences)
- 4 sequences were removed due to lab contamination or duplication
- The remaining 1107 sequences included
  - 76 from subjects residing in Tijuana
  - 768 from subjects residing in San Diego
  - 263 background sequences from San Diego



# San Diego-Tijuana Cross-Border Clusters



	MSM		MSM/IDU		Unknown risk		Male		Unknown sex		SD		Tijuana
	IDU		Heterosexual				Female		Transgender		TJ		

# Clustering

- Clusters represent groups of inferred transmission events
- 164 transmission clusters (2-33 individuals)
- 17 included sequences from Tijuana, and 5 included sequences from both Tijuana and San Diego

# Clustering

- 8 Clusters made up of predominantly PWID
  - Interestingly, bisexual individuals were significantly more common in these clusters than others
- 16 Clusters were made up predominantly of heterosexuals
  - All of these that had 3 or more individuals were predominantly made up of females
- 89 clusters were made up predominantly of MSM

# Tijuana Clusters

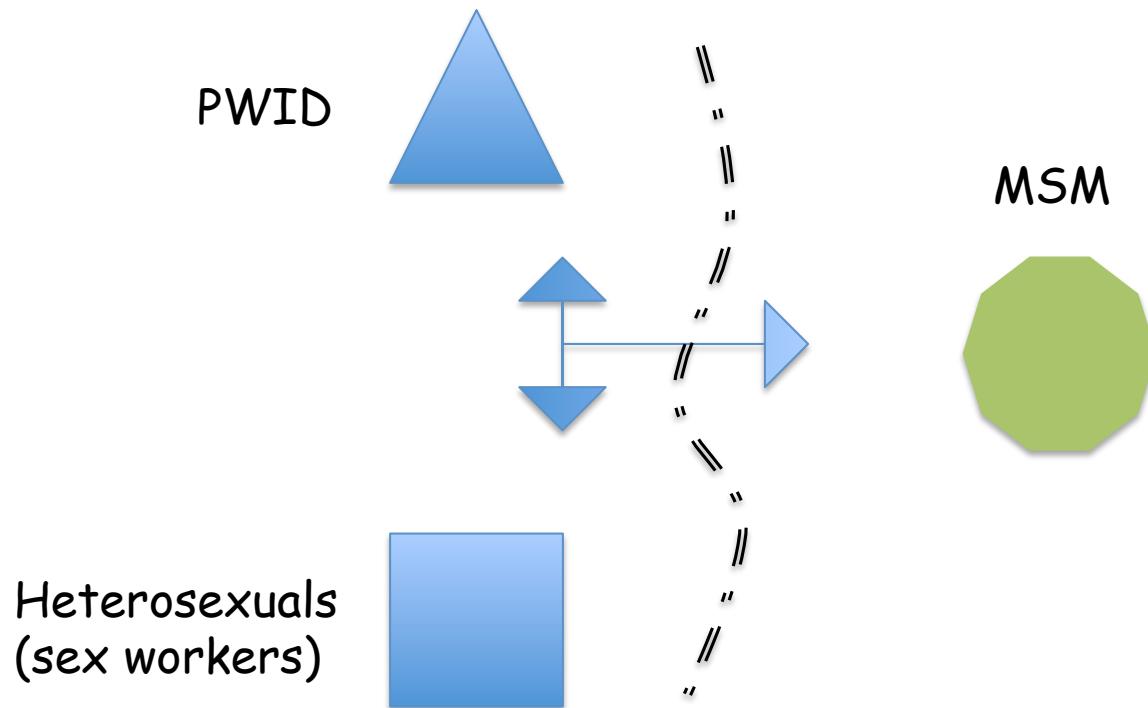
- 17 clusters identified in subjects residing in Tijuana
  - Predominantly involved sex workers and injection drug users
  - In 6 individuals who seroconverted over the course of the study, 4 were linked to another individual
  - In two identified epidemiologically linked pairs who seroconverted over the course of the study, only one was genetically linked

# Are the San Diego and Tijuana Epidemics Connected?

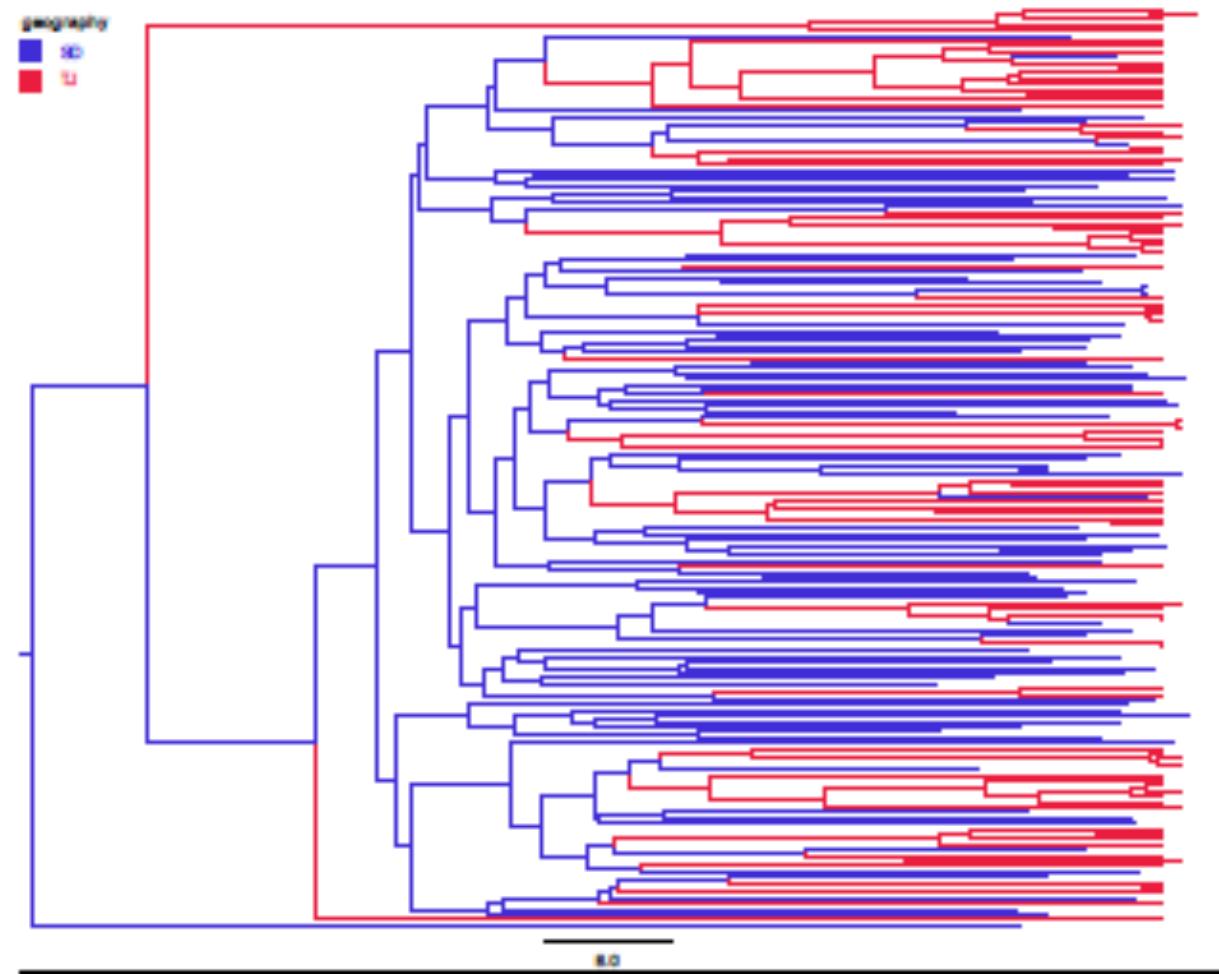
- 5 identified clusters including sequences from San Diego and Tijuana
  - Significantly higher proportion of
    - Females ( $p=0.02$ )
    - Heterosexuals ( $p=0.0003$ )

# Cross-border Clusters

- 3/5 clusters included PWID and heterosexuals in Tijuana, and MSM in US (ie bridging of risk groups across the border)

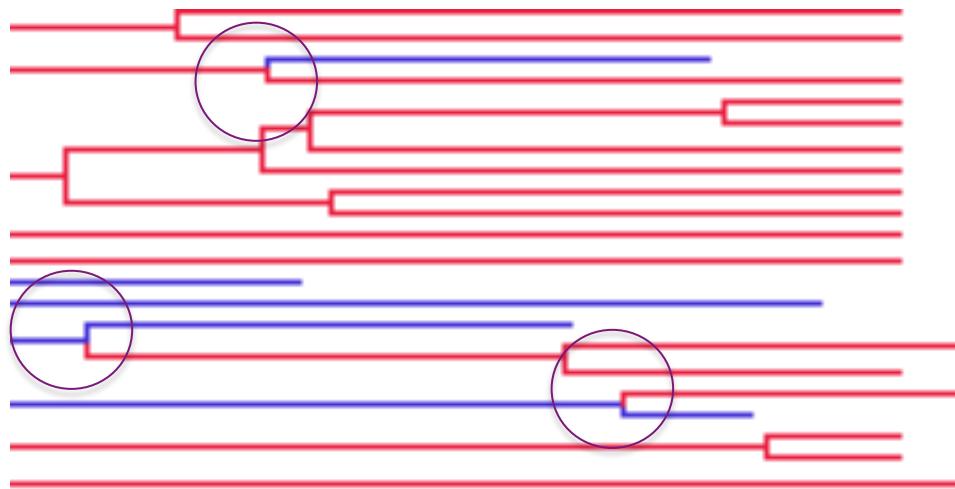


# What is the direction of viral migration across the border?



Time scaled phylogenetic tree

# Viral Migration

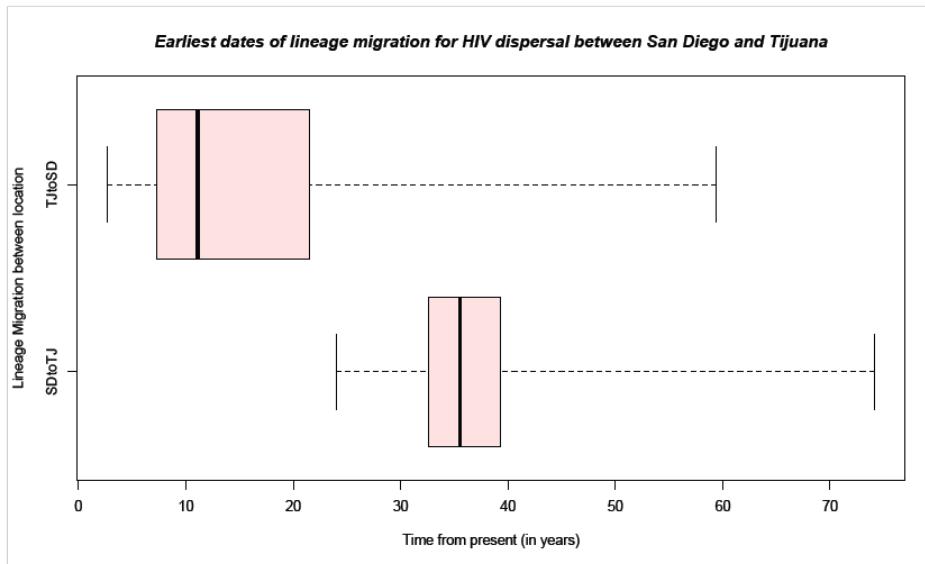


Transition from

- 1) San Diego to Tijuana (Blue to Red)
- 2) Tijuana to San Diego (Red to Blue)

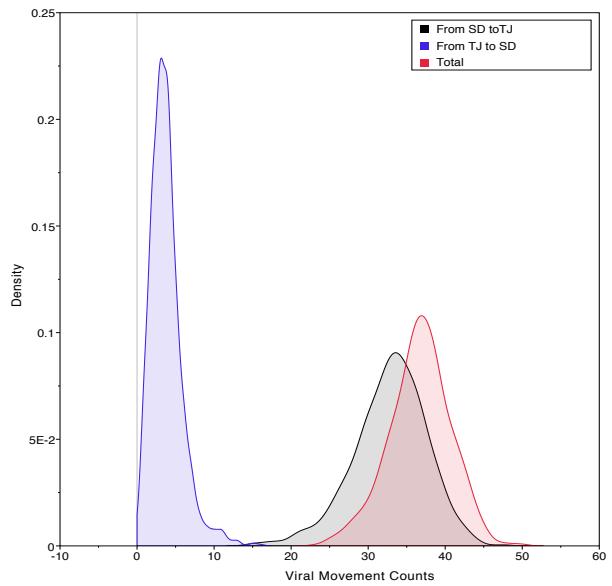
# Viral Migration

When?



Timing of Viral Migration between  
San Diego and Tijuana

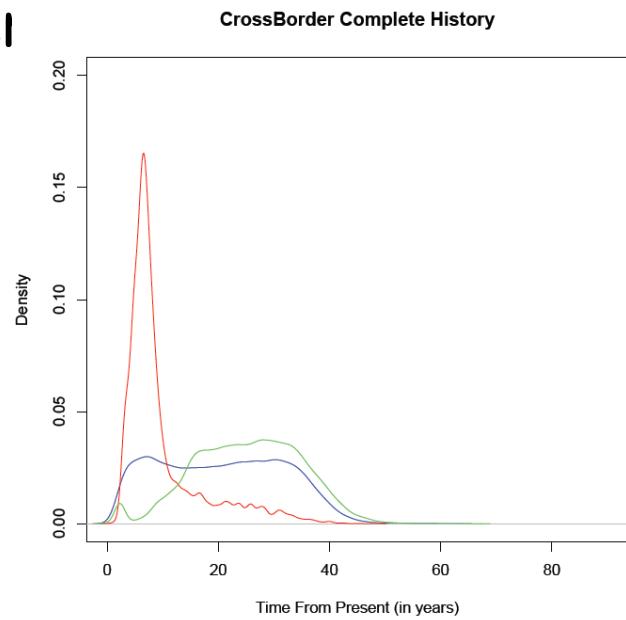
How Much?



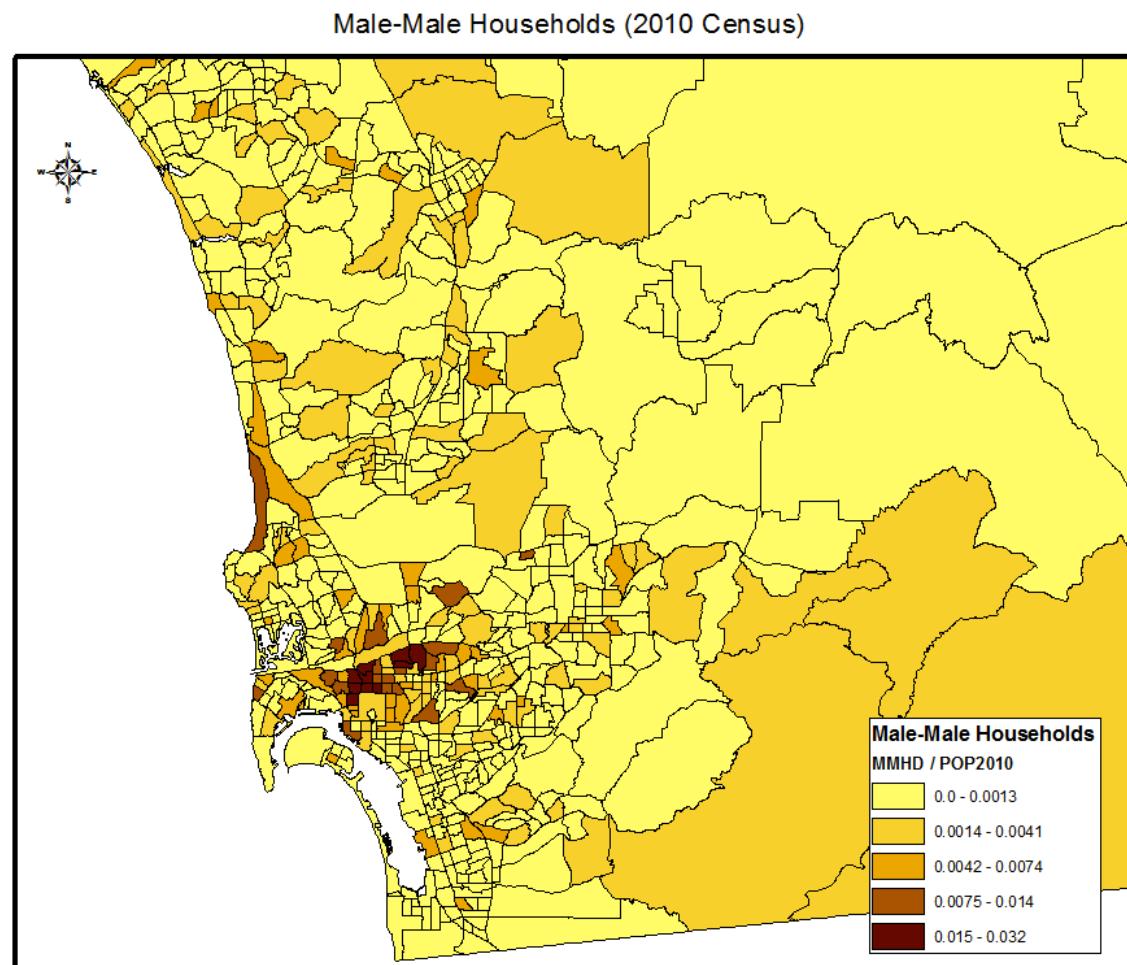
Amount of Viral Migration

# Is the US still exporting HIV to Mexico?

- The answer appears to be yes
  - Based on this sample, at a lesser rate than in past
  - 8 deportees involved in transmission clusters
    - 4 likely acquired infection in TJ
    - Other 4 deported with HIV?

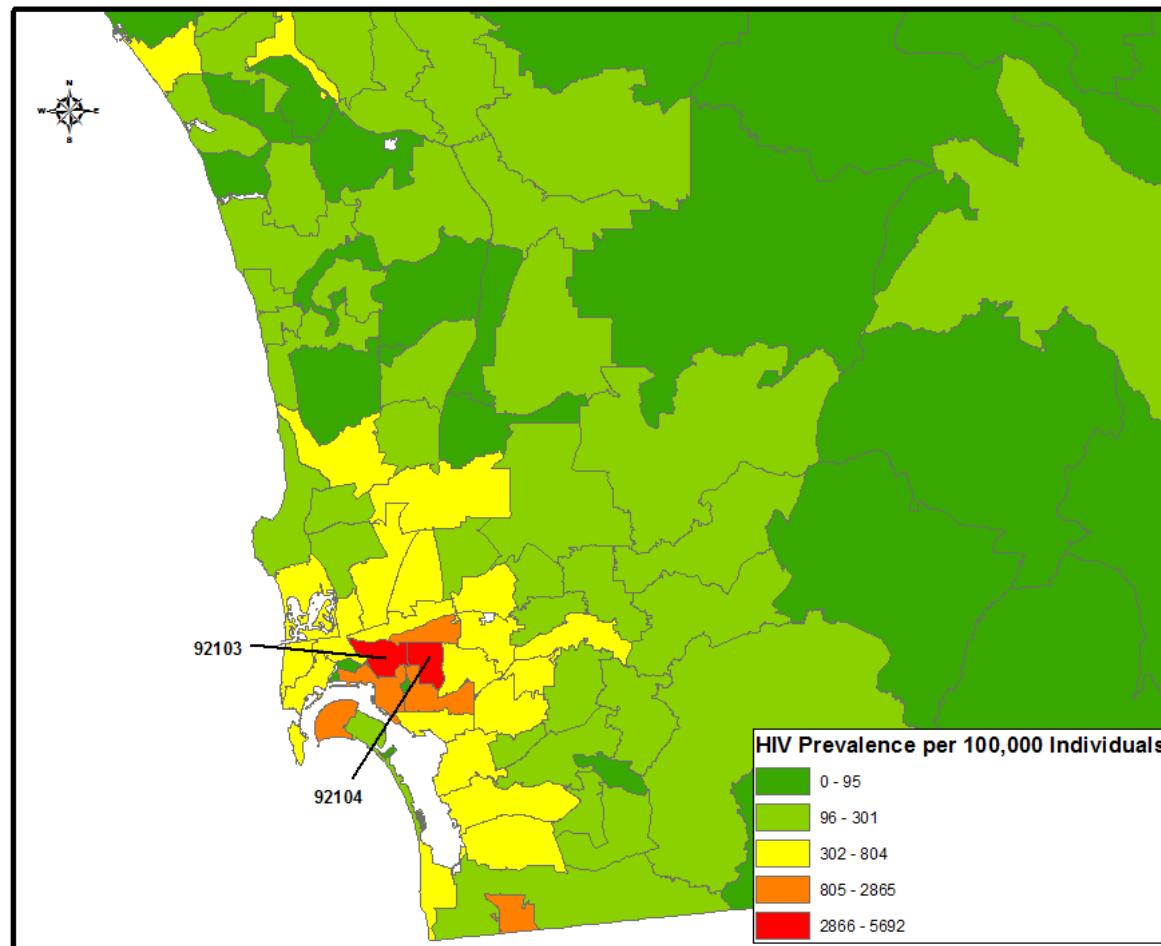


# What risk factors are driving the border HIV epidemic?



# A Focus of the non-MSM Epidemic in San Diego lies just across the Border

Rates of Adults/Adolescents living with Diagnosed HIV per 100,00 Population



# Conclusions based on our Sample

- The San Diego and Tijuana epidemics are connected bridging risk groups across the border
- There is evidence of bi-directional viral migration across the border
  - 1990s - More migration from SD to TJ
  - 2000s - More migration from TJ to SD
- The demographics of the border epidemic likely differs from that of the overall San Diego epidemic

# Question

Does the disparity in resources in Mexico  
affect HIV prevention in the US?

# Acknowledgements

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## Bioinformatics Team

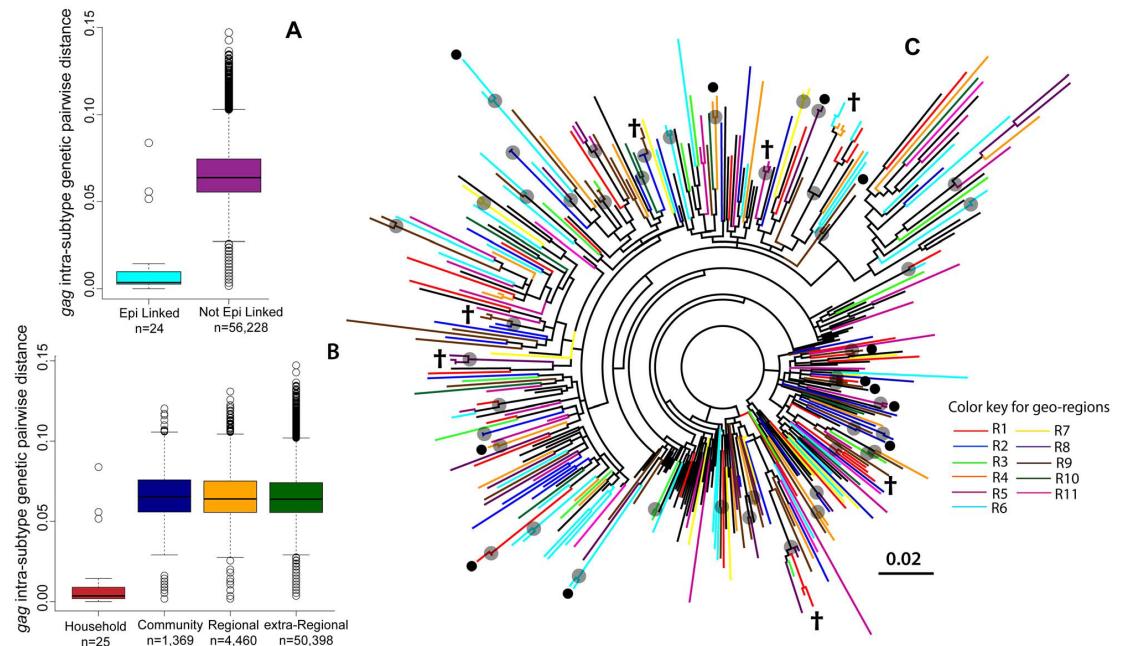
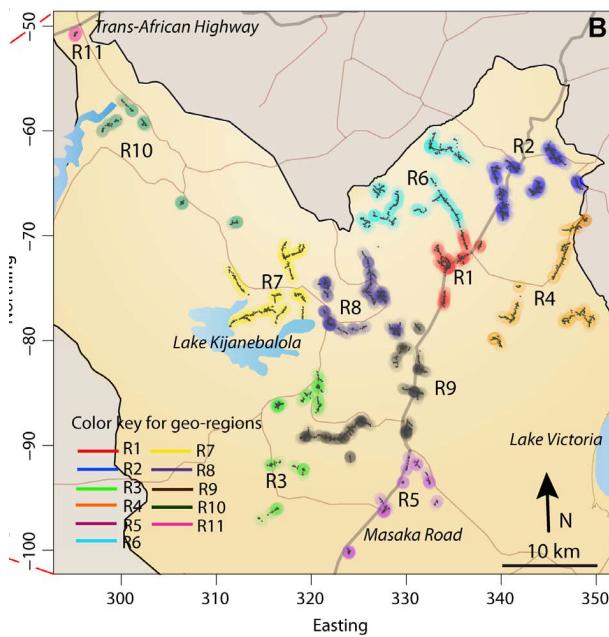


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Konrad Scheffler  
Joel Wertheim  
Jason Young



# Does the Disparity in Resources in Mexico Affect HIV Prevention in the US?

## Rakai Cohort, Uganda



69% of non-household transmissions were from outside the community

# Does the Disparity in Resources in Mexico Affect HIV Prevention in the US?

- Treatment as Prevention
  - Theoretically works best in a closed population
  - Efficacy limited by viral introductions