Geocoding and selection bias in epidemiologic research using GIS

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Place matters

- Family medicine, public health, and epidemiological researchers using GIS to assess association between population health and area characteristics
  -- surveillance, cluster analysis, exposure, measured & unmeasured factors affecting disease.

Locating the place

- Initial task: assign geographic location to study subjects – geocoding
- Completeness varies
  -- positional accuracy
  -- differential match rates by region
- Incomplete geocoding can lead to biased results

Selection bias

- Differential match rates by geographic region can lead to biased results owing to unrepresentative data and a consequent selection bias
- Non-random missingness: social, economic, political, other reasons
- Place matters, and social determinants may be confounded with place

Prostate cancer in Virginia, 1990-99

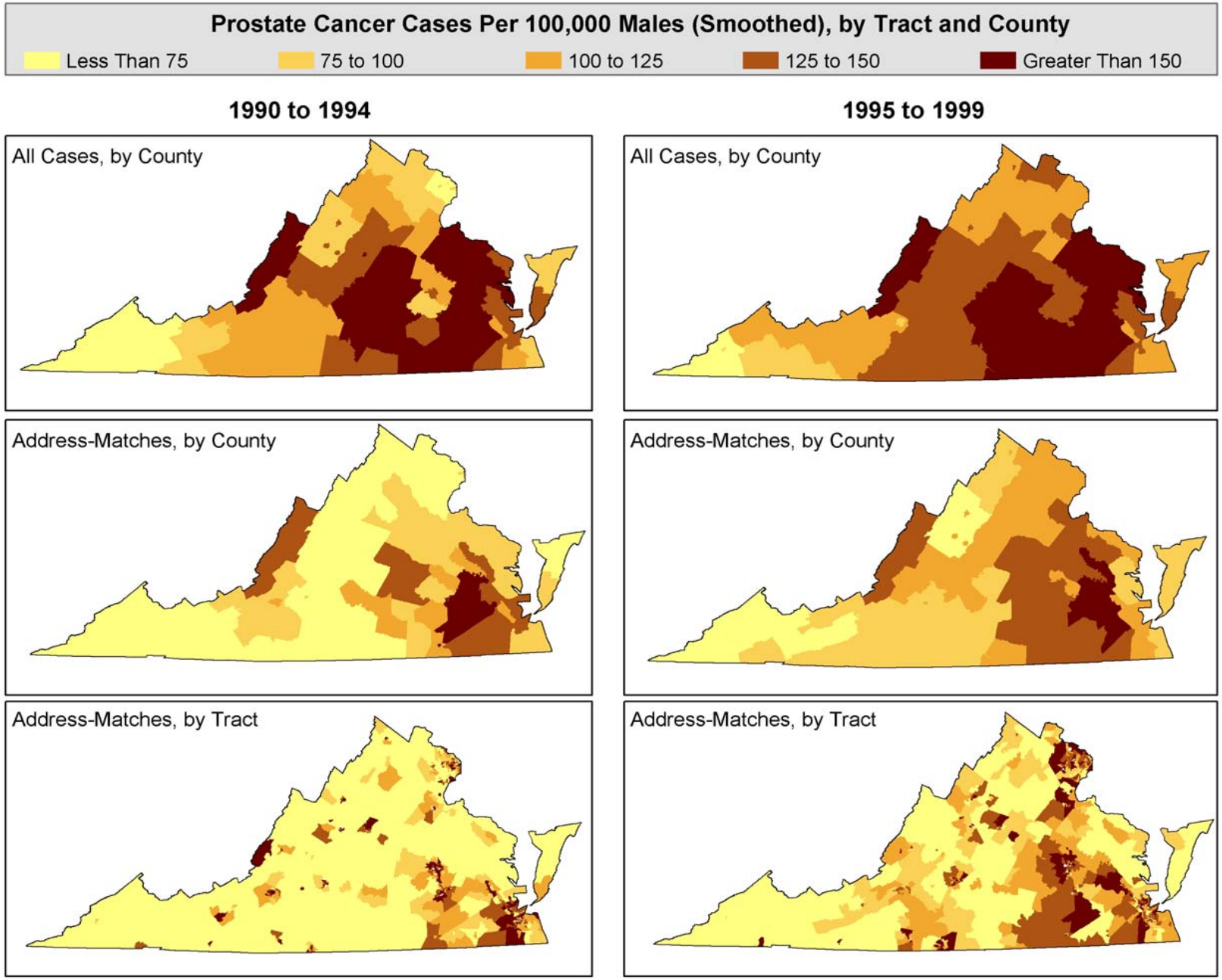
- Study of CaP incidence, assessing association of age, racial category, and area-level measures of SES with this outcome
- Positive assoc btw CaP incidence and income, urban status (all)
- Negative assoc btw CaP incidence and poverty, low educ (whites only)
- These effects seen only at the census-tract level
- MAUP?

Table 1. Census Tract geocoding results broken down by address type.

			% Of address types			
	No.	**%**	**Street Addresses**	**Rural Routes[a]**	**P.O. Boxes[a]**	**Other[a,b]**
Matched[c]						
African American	6,060	74.0	92.7	0.0	0.0	0.0
White	20,278	73.4	92.6	0.0	0.0	0.0
Unmatched[c]						
African American	2,192	26.0	7.3	100.0	100.0	100.0
White	7,136	26.6	7.4	100.0	100.0	100.0

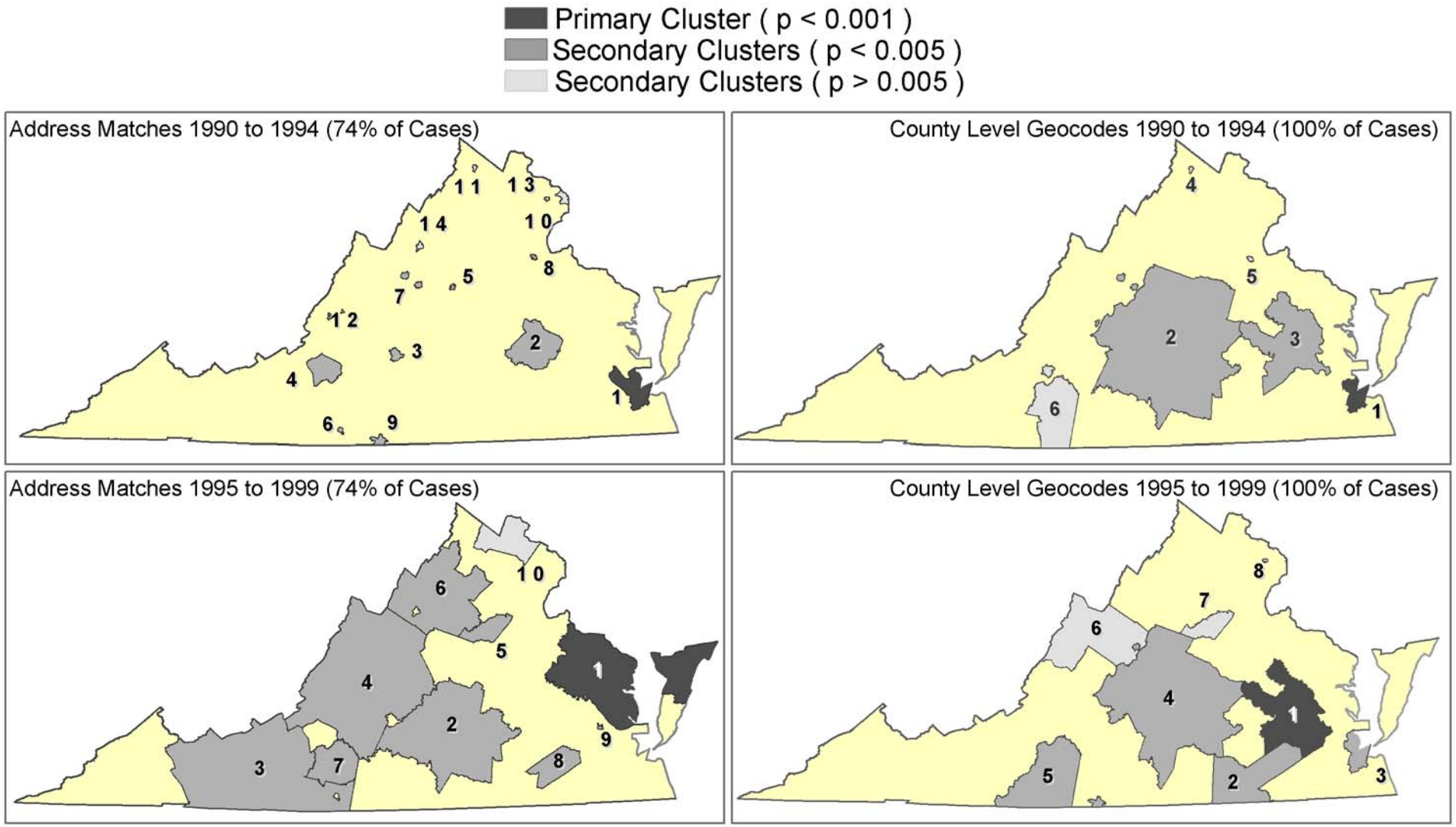
[a]Accurate geocoding to the Census tract cannot be performed on this address type.
[b]Includes garbled and incomplete addresses.
[c]To the Census Tract.

Figure 1. Annualized age-adjusted prostate cancer incidence, Virginia 1990 - 99



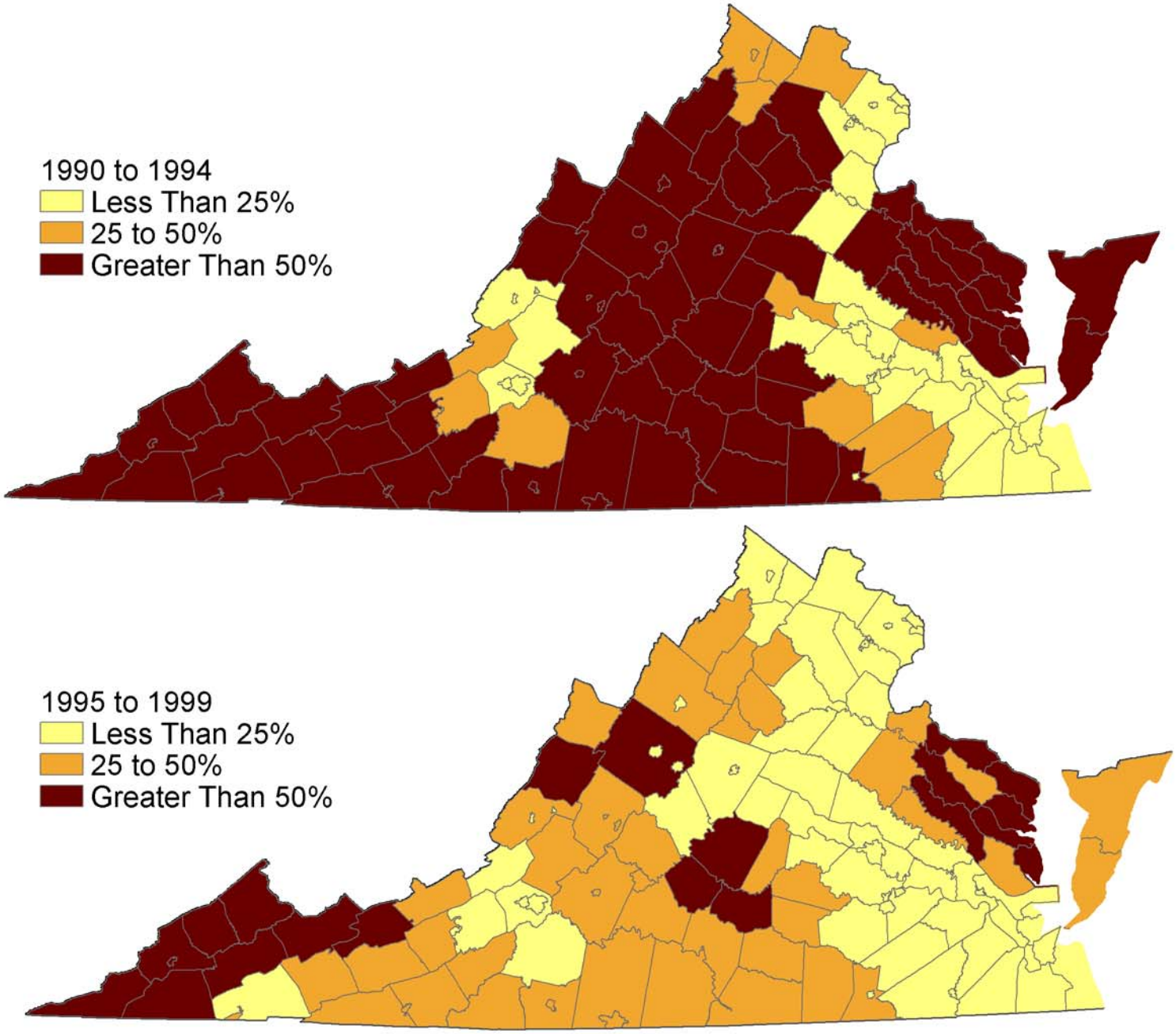
Source: 1990 to 1999 Virginia Cancer Registry and 1990 Population Census

Figure 2. Prostate cancer incidence clusters, Virginia 1990 - 99



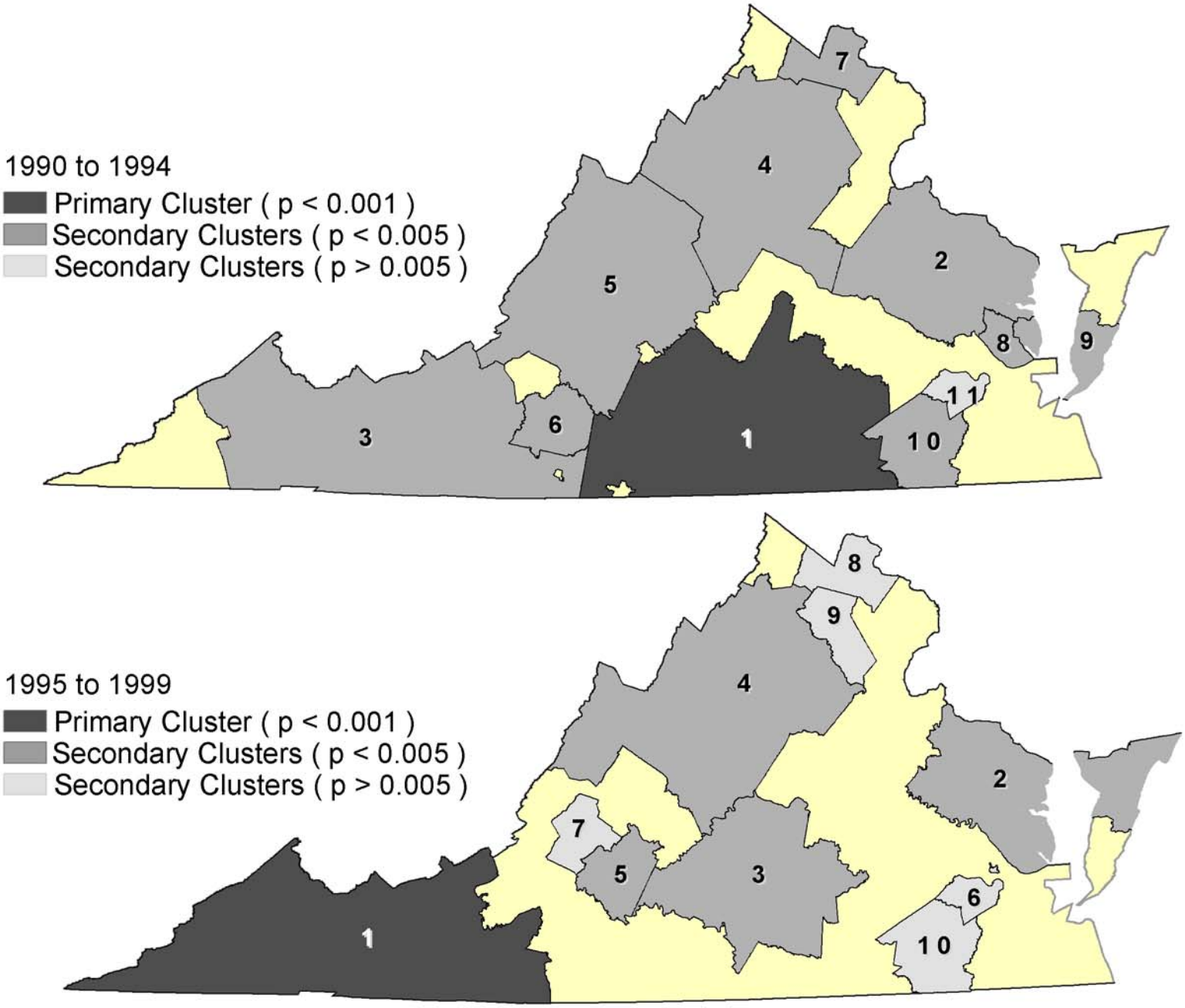
Source: 1990 to 1999 Virginia Cancer Registry and 1990 Population Census

Figure 3. Proportion of unmatched prostate cancer cases



Source: 1990 to 1999 Virginia Cancer Registry and 1990 Population Census

Figure 4. Clusters by proportion of unmatched prostate cancer cases



Source: 1990 to 1999 Virginia Cancer Registry and 1990 Population Census

Geographic patterns: Are they real?

- GIS used to identify geographic patterning
- In our VCR study, spatial patterns may be reflection of data distribution rather than underlying disease patterns
- Cluster analysis of proportion of missing cases shows significantly different patterns resulting from non-random differences in geocoding completeness

Cartographic confounding

- Classic epi: measure of the effect of one factor on disease risk biased because of its assoc with another factor (confounder) *and* the disease
- *Similarly, when the factor of interest is* ***geographic,*** *a factor related to the disease that is not distributed randomly across the study area can confound the appearance of maps of that disease.*

Location, location, location

- Systematically missing data resulting from location
- However, location's sociodemographic characteristics associated with likelihood of missing data from that location
- As well as location being associated with likelihood of disease in that area.
- Spatial disease patterns – the look of the map – may confound location with social determinants of disease
- Standard methods of dealing with this challenge are not enough – ignore geography.
  -- case ascertainment (90%), multivariate analysis.
- Must assess geographically – e.g., cluster analysis
- Iterative process of statistical and spatial analyses

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