There and Back Again: Demographic Survey Sampling in the 21st century

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NORC

Overview

- History of Demographic Survey Sampling
- 20th Century Sample Design
- New Directions
- Evaluation of Lists, GIS, and Maps
- Implications
- New National Sample Designs
- Swiss Cheese
- Tailored Samples vs Master Samples
- Conclusion

History 1

- **A N Kiaer (1895)**
  - **ISI Berne *Representative Enumerations***
  - **Miniature of the population**
  - **Multi-stage design – *places, towns, streets, HUs***
  - **Stratified**
- **US implementation**
  - **Cressy L Wilbur (1896-7) – [vital statistics]**
    - ***small representative areas***
  - **Carroll D Wright (1875 et seq) – [labor statistics]**
    - ***representative statistics***
  - **Non-probability samples**

History 2 – Development

- **Bowley (1906)**
  - **Theory for simple random sampling**
- **Neyman (1934)**
  - **Superiority of probability sampling**
  - **Theory for unequal cluster sampling**
- **Hansen Hurwitz Madow 1940s**
  - **PPS at higher stages**
    - **Adequate "representation" of important units**
    - **Leads to identification of *certainty PSUs***
  - **Equal workloads at final stage (HUs)**
    - **Efficiency of field allocation and estimators**
- **1950s: national master samples ISR, NORC, et al.**

The Basic National Demographic Design

- **Multi-stage**
  - **Costs**
  - **Feasibility**
- **Some self-representing PSUs**
- **Stratified**
  - **Incorporating knowledge of population and structure**

20th Century Demographic Survey Sample Design Elsewhere

- **Scandinavia**
  - **Register-based**
- **China**
  - **Register-based**
  - **Late 1980s, registers deteriorated**
- **UK**
  - **Electoral registers, updated annually**
  - **1980s, registers deteriorated**
  - **Postcode address file (PAF), centrally available**
  - **Periodic redesign**

20th Century Demographic Survey
Sample Design in USA

- **Decennial update of frame, and**
- **Absence of a current list of population elements**
  - **Selection of a Master Sample of PSUs and SSUs**
  - **Listing of the frame for the master sample**
  - **Use as reservoir for the decade**
  - **Updating in the field for the sample only**

New Directions in the USA

- **Availability of current administrative lists**
- **Matching and pre-classification of geographies**
- **GIS and GPS**

- **Tailored samples vs master samples**

Why Lists Would Make a Difference

- **Cost parameters would change**
- **Nature of PSU might change**
- **Subsampling fraction might change**
- **Timing of revisions could change**

The (Non-Census) Administrative Alternative

- **USPS delivery sequence file**
  - **Ordered within ZIP by carrier route**
  - **Within carrier route by walk sequence**
- **Available through licensees**
  - **Primarily purchased by direct-mail organizations**
- **Usability**
  - **Basis for MAF in urban areas**
  - **Addresses in standard format**
  - **Operational incentives for updating**
  - **Can be geocoded and mapped**
  - **Contains PO boxes and rural route boxes (not mappable)**

USING/EVALUATING THE LIST

- 1 Direct/non-evaluative use, single city survey, 2001 RTI
- 2 Evaluation against traditional listing, 2001-2 NORC
- 3 Inner-city evaluation and use, 2002-3 NORC
- 4 Direct/non-evaluative use as national frame, 2003 RTI
- 5 "Rural" evaluation, 2003 NORC
- 6 Basis for national design template, 2003-4 NORC
- 7 National comparison with traditional listing, 2004 NORC/ISR

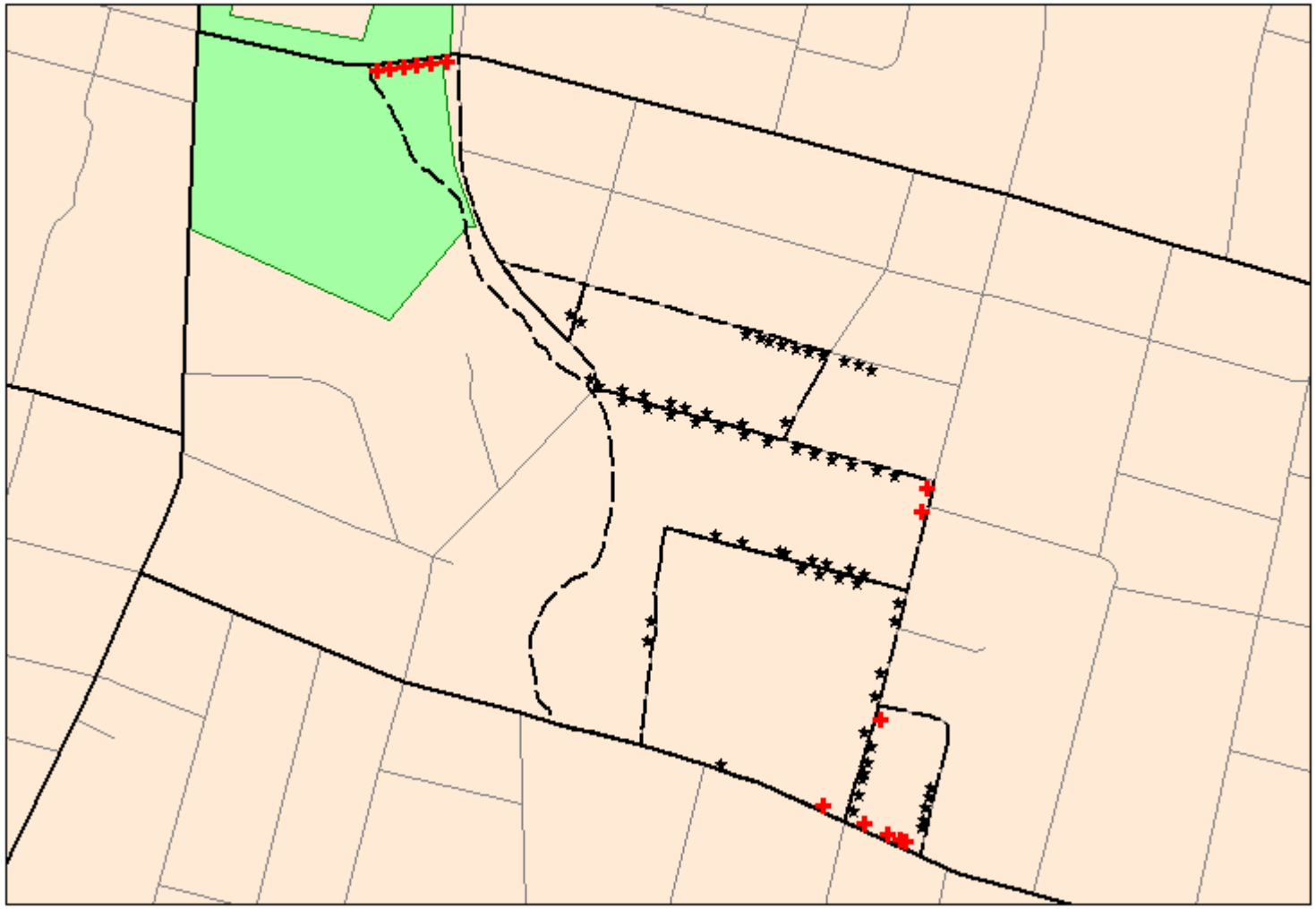
Direct Use (RTI-2001)

- **Iannachione, Staab, Redden**
  - **Houston, TX**
  - **Geocoded > 99% of addresses**
  - **Selected sample from list**
  - **97% of selected addresses yielded HUs**
  - **Order of magnitude of list and census count same**
  - **No direct coverage check**

VALIDATING THE LIST (NORC 2001-2)

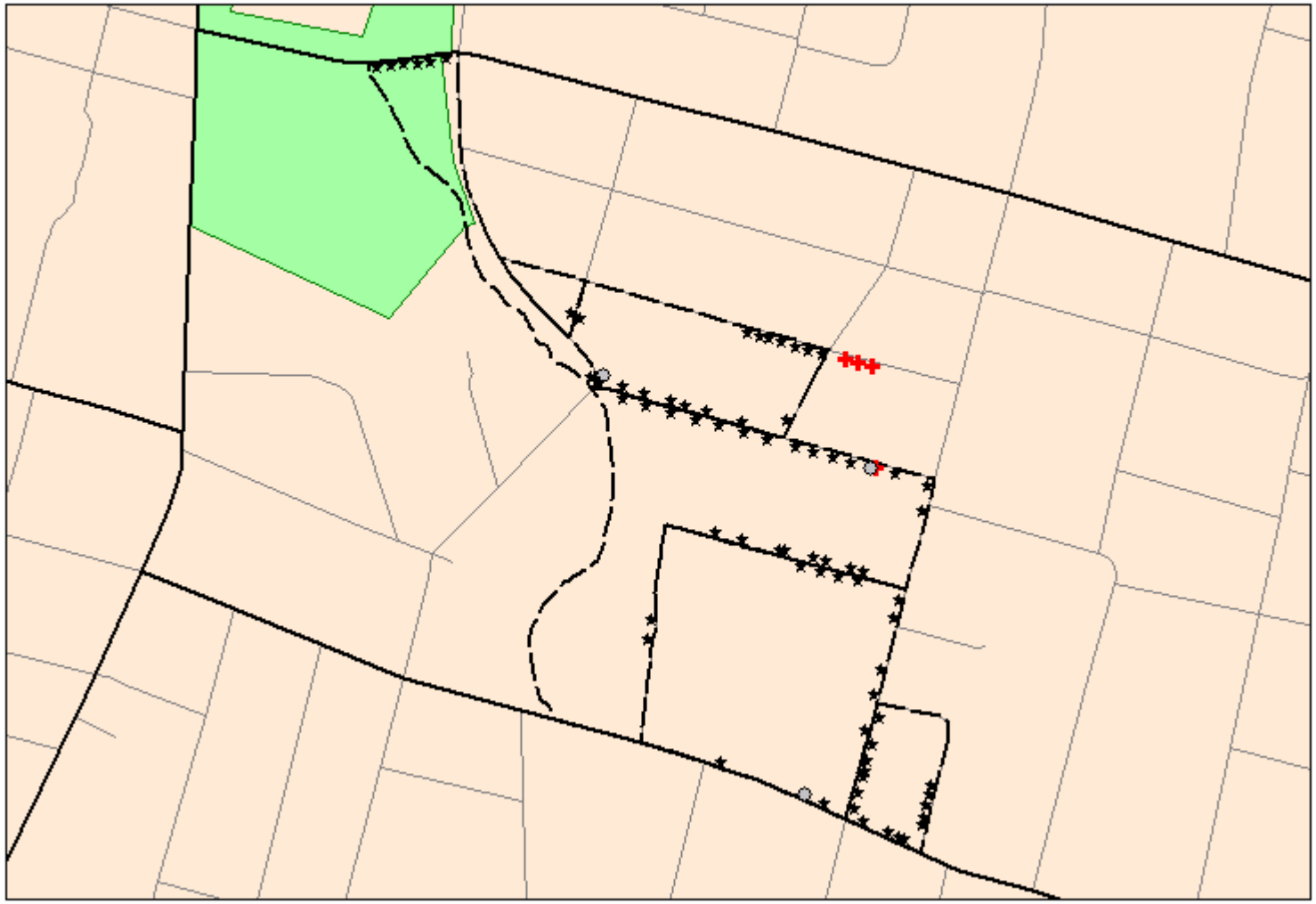
- O'Muircheartaigh, Eckman, and Weiss
- NORC GSS Field Test 2001: 14 segments
  - First, traditional listing (T)
  - Then, geocoded USPS list for the areas (U)
  - Finally, independent enhanced list (E) built from U
- Comparison of coverage
  - T – Traditional
  - U – USPS addresses geocoded inside segment
  - E – U enhanced in the field
  - USPS – full USPS list whether geocoded inside or not

Segment 100008-1000107
E,T HUs



NORC

Segment 100008-1000107
E,U HUs



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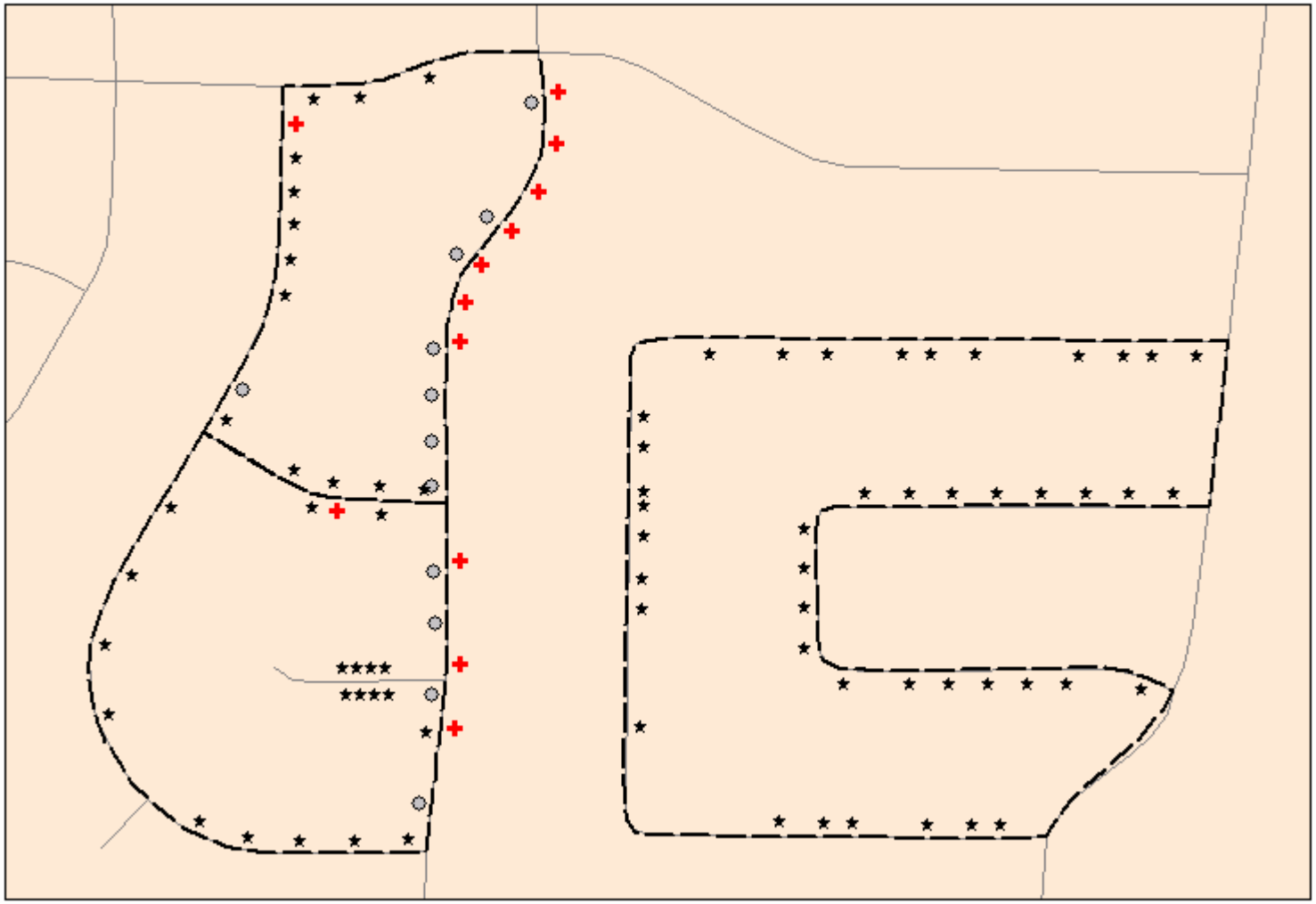
Issues Encountered in Enhanced Listing

- **Issues with USPS list**
  - **missing apartment numbers**
  - **addresses removed at request of resident**
  - **PO boxes, rural route boxes unusable**
  - **includes hard to find HUs missed by field listers**
- **Geocoding issues**
  - **block boundaries**
  - **side-of-street errors**
- **Matching geographies**
  - **ZIPs vs blocks, block groups, tracts**

Segment 100279-1000017
E,U HUs



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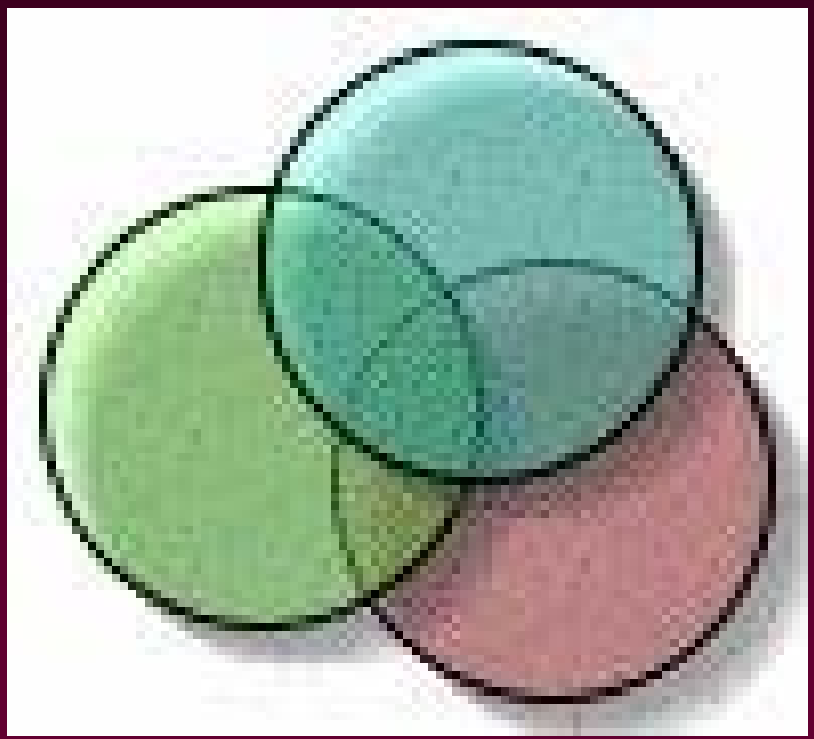
Cost Comparison T vs E

- **Travel costs, etc.**
  - **Equal**
- **Listing costs**
  - **T approximately twice as expensive as E**

COMPARISON OF T, U, AND E



- U in E 95%
- E in U 93%
- T in U 87%
- E in T 81%

- E in USPS 96%

Inner City Evaluations (NORC 2002-3)

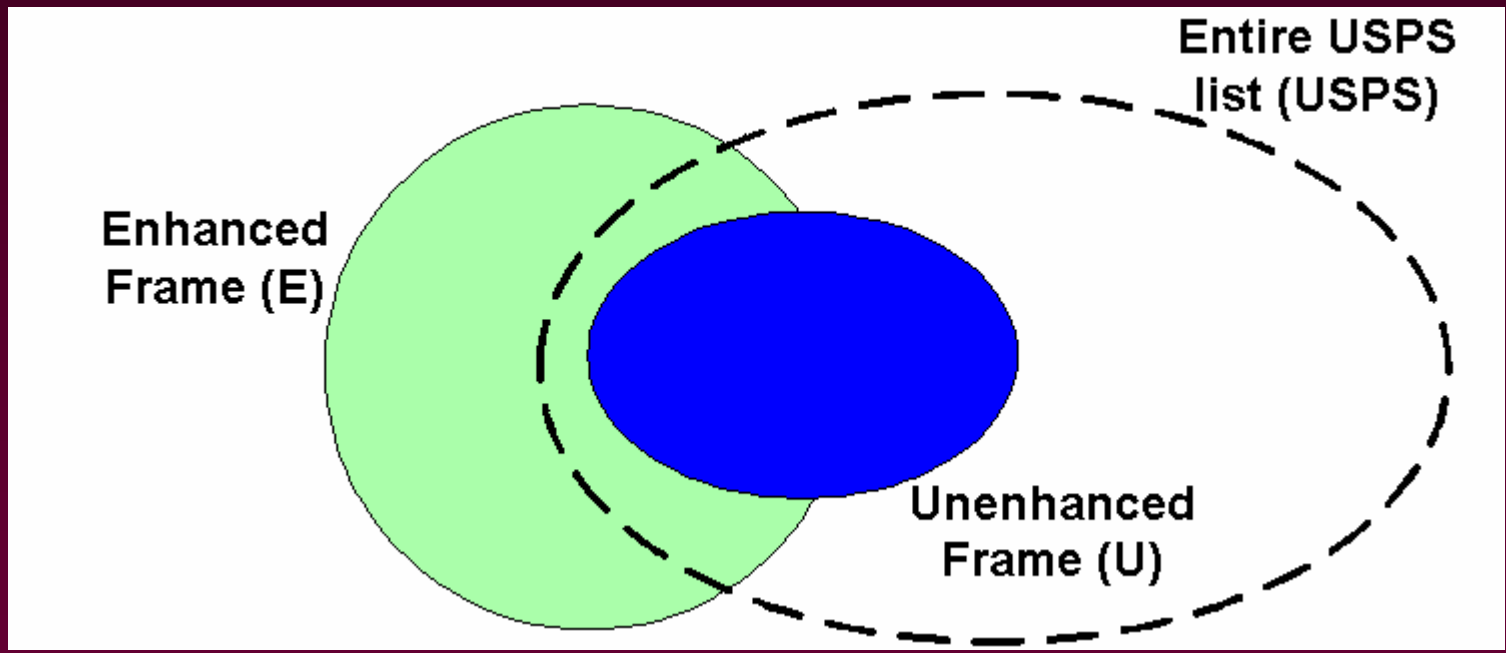
- O'Muircheartaigh, Eckman, English, and Haggerty
- The *Making Connections* Project
  - Funded by Annie E. Casey Foundation
- 10 Deprived Inner-City Communities
  - Denver, Des Moines, Indianapolis, San Antonio, Seattle
  - Milwaukee, Hartford, Providence, Oakland, Louisville

Inner City Evaluations

- **Purchased USPS lists for ZIPs surrounding whole community**
  - **Geocoded all**
  - **With U as base:**
    - **Produced E with in-person listing**
    - **Compared U and E for coverage**
  - **Compared U and E coverage during fieldwork**

Inner City Evaluations

- **Two key measures:**
  - **How much of E is in U (the geocoded part of USPS)?**
  - **How much of E is in USPS as a whole**



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Inner City Evaluations

- **Overall results**
  - **90% of E in U**
  - **94% of E in USPS**
    - **Difference due to geocoding/map inaccuracies**
- **Range across cities:**
  - **82% - 95% of E in U**
  - **83% - 99% of E in USPS**
- **Characteristics of missed HUs**
  - **In most severe cases, many vacant HUs**
- **MHU**
  - **Only moderately successful**

Direct Use National Frame (RTI 2003)

- Staab, Iannachione
- Used postal frame exclusively for EuroQol study
- Used postal geographies
- Ignored ZIPs with no residential addresses
- Ignored residents without street addresses

National List Evaluation (NORC/ISR 2004)

- **O'Muircheartaigh, Lepkowski, Heeringa**
  - **HRS and NSHAP**
  - **National listing of 549 segments by ISR**
  - **Purchase of USPS lists for 100 segments**
  - **Comparison of T and U**
  - **Nationally representative**

Use for NORC National Sample Design 2003

- **Geographic units**
- **Preclassification of list quality**
- **Stratification**
- **Optimal design**

The Population

- 8.2 million census blocks
- 66,275 tracts
- 3219 counties
- 281 (C)MSAs in Census 2000
  - Now 362 MSAs and 565 Micropolitan SAs
- Variable population density
- Variable list quality

Preclassification of Geographies

- Census classification of blocks [TEA – type of enumeration area]
  - Available for all blocks
  - Indicator of feasibility of using USPS list as frame
    - Whether suitable for mail-out
    - Address type
- Type A tracts
  - 95% of HUs in tract are in blocks classified as TEA=1
- Type B tracts
  - All other tracts

THE DESIGN – 1

Categorize MSAs/counties according to population density and list quality

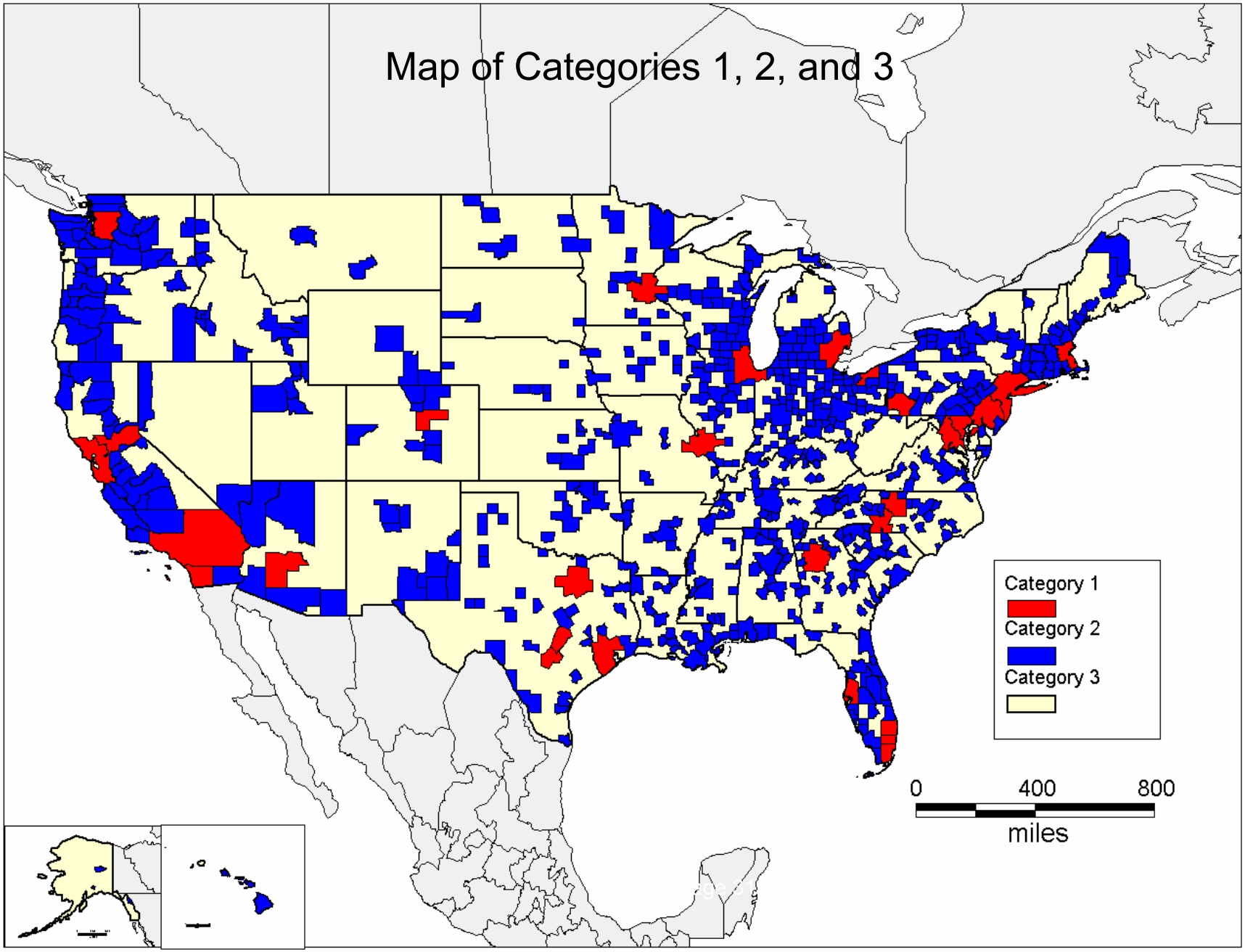
Large MSAs (likely certainty areas) with high-density population dominated by Type A tracts [category 1]

Small counties with less than 30% of population in type A tracts or less than 15,000 population [category 3]

All other counties/MSAs [category 2]

The Design – 2

- **Category 1**
  - **45% of population in 4.5% of the area**
- **Category 2**
  - **40% of population in 25% of the area**
- **Category 3**
  - **15% of population in 70% of the area**

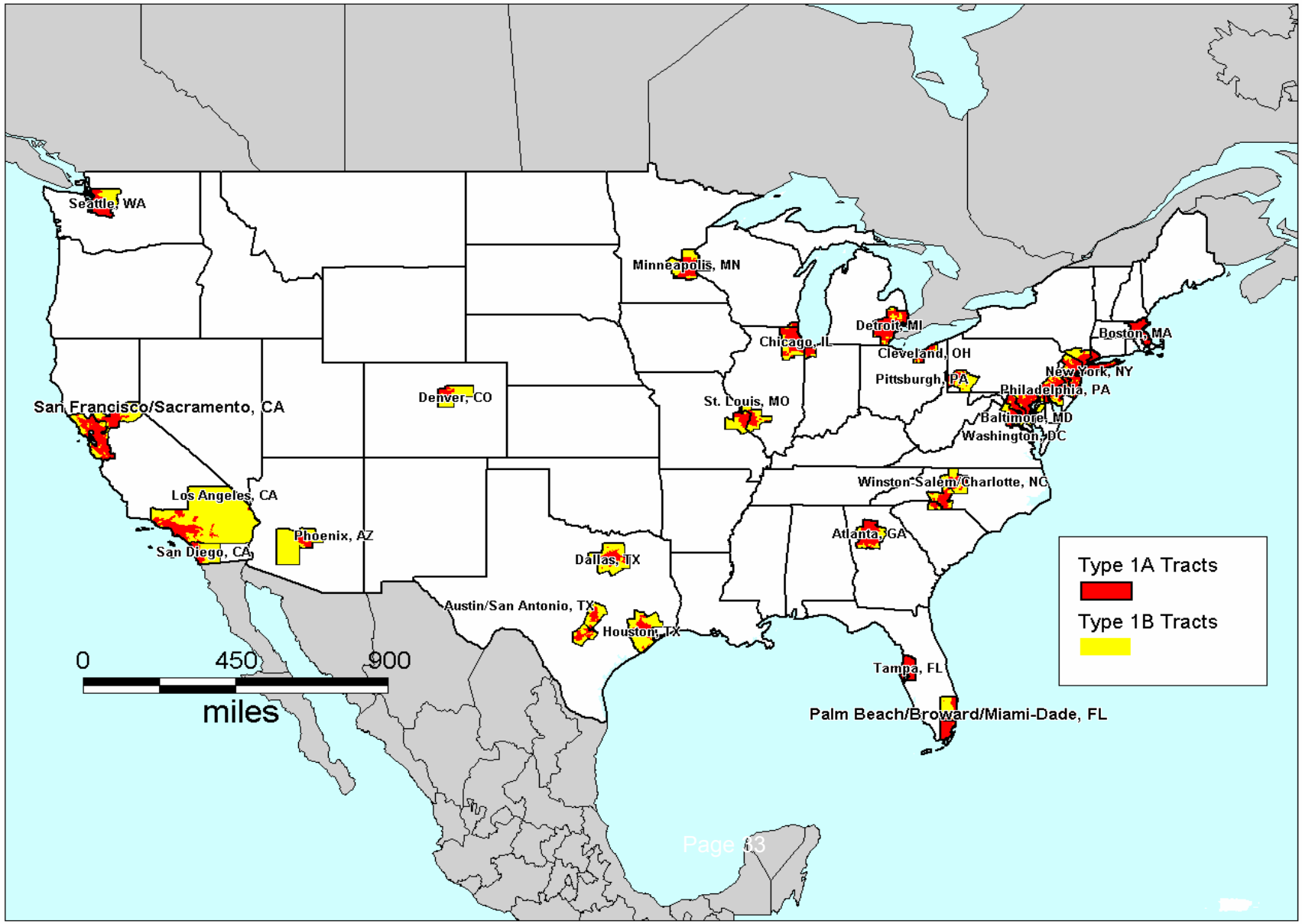

Map of Categories 1, 2, and 3
Category 1
Category 2
Category 3
0
400
800
miles

The Design – 3

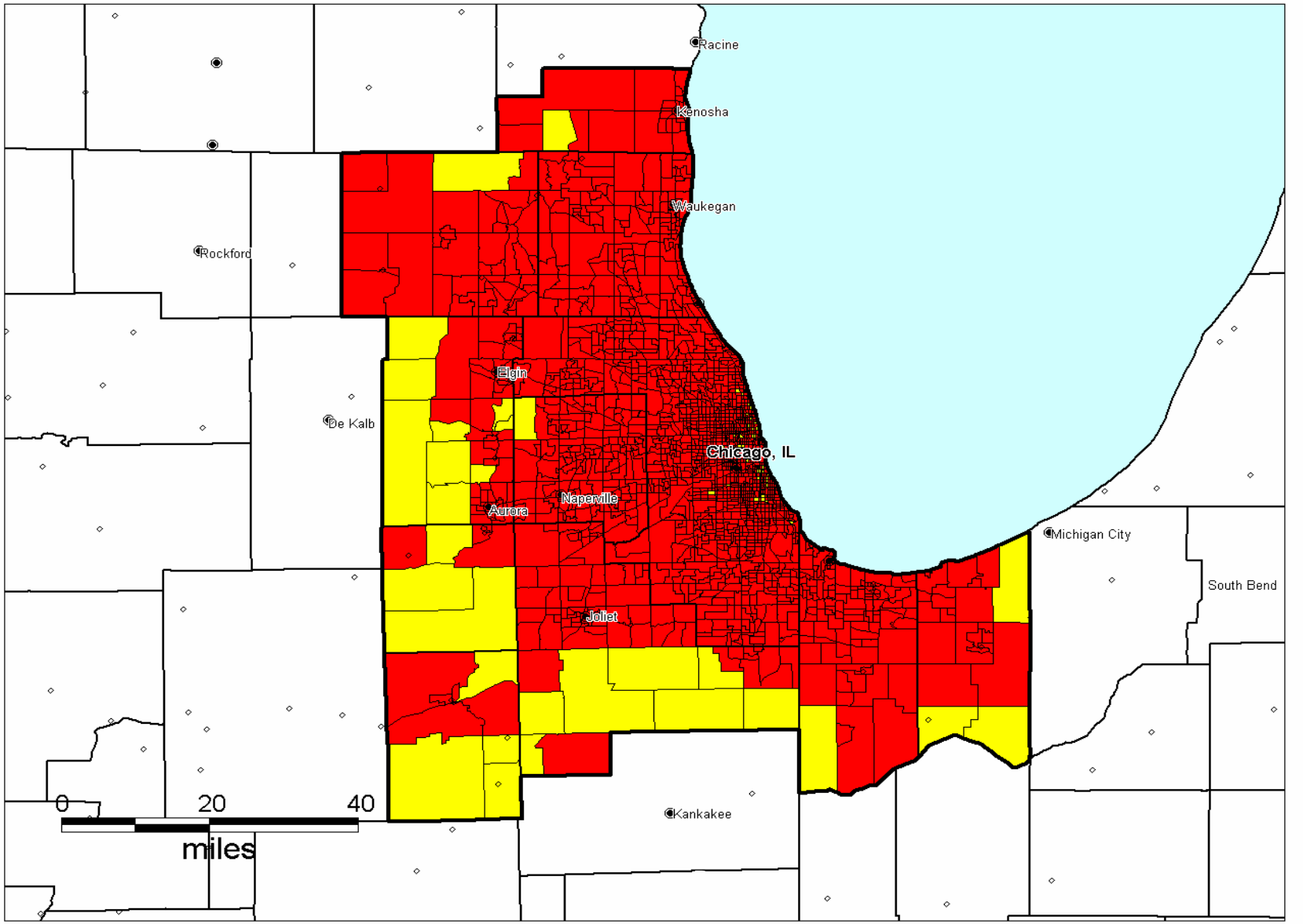
- **Different designs are appropriate for the different categories**

- **A major problem:**
  - **Even in the high density urban MSAs rural (non-street-style address) areas are interspersed with urban (street-style address) areas**

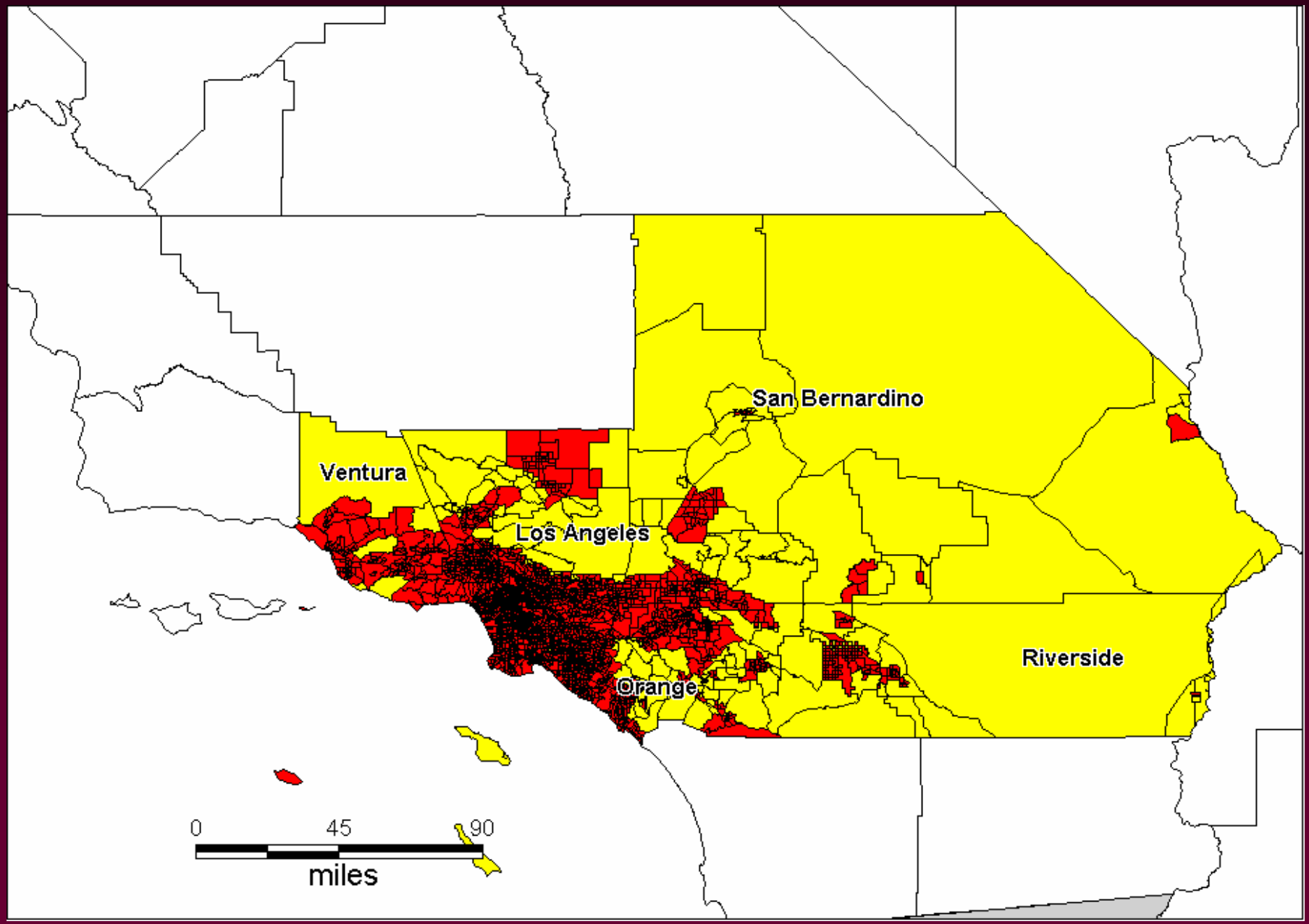
24 Category 1 Areas Showing Type A and Type B Tracts



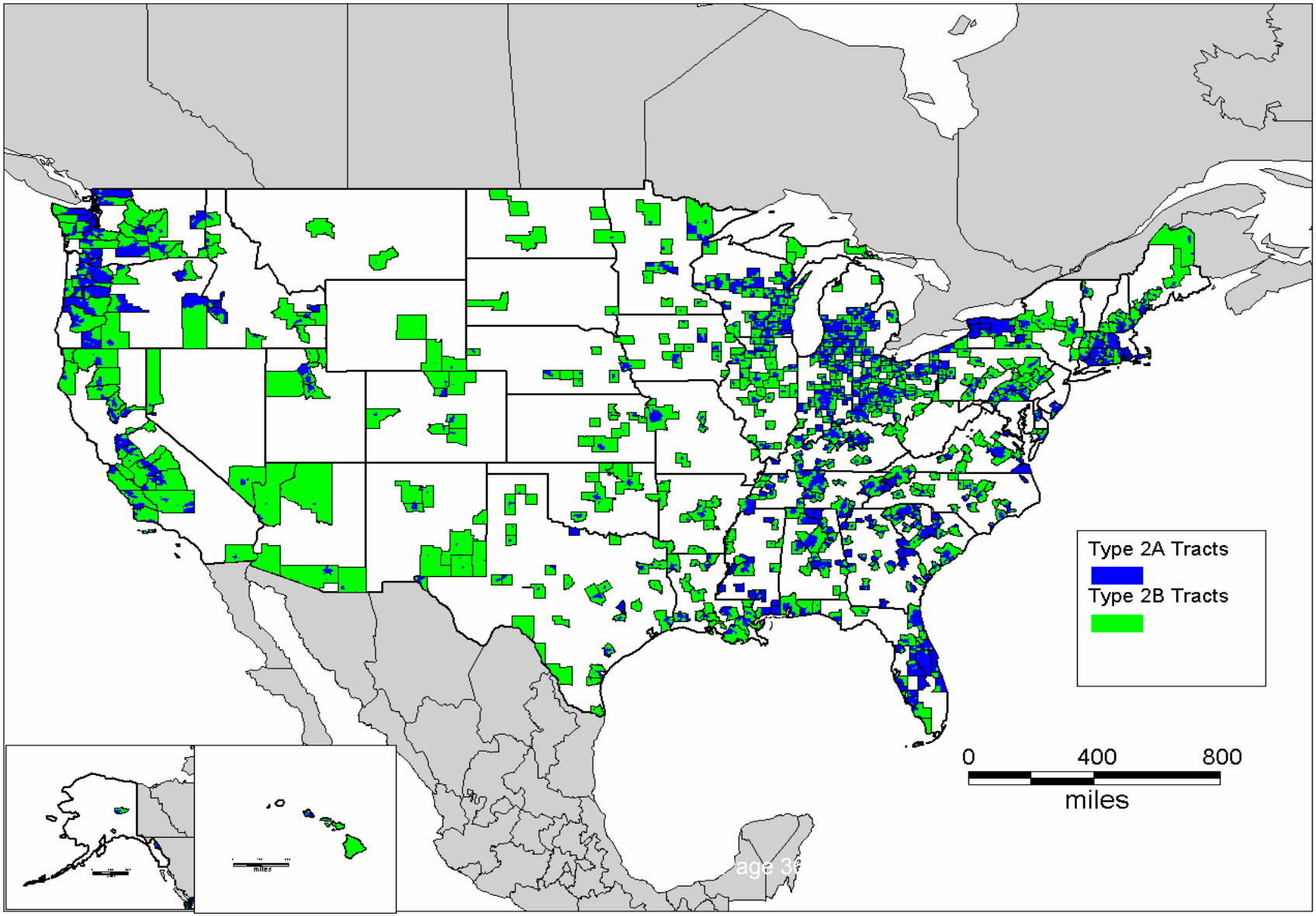
Chicago Category 1 MSA Showing Type A and B Tracts



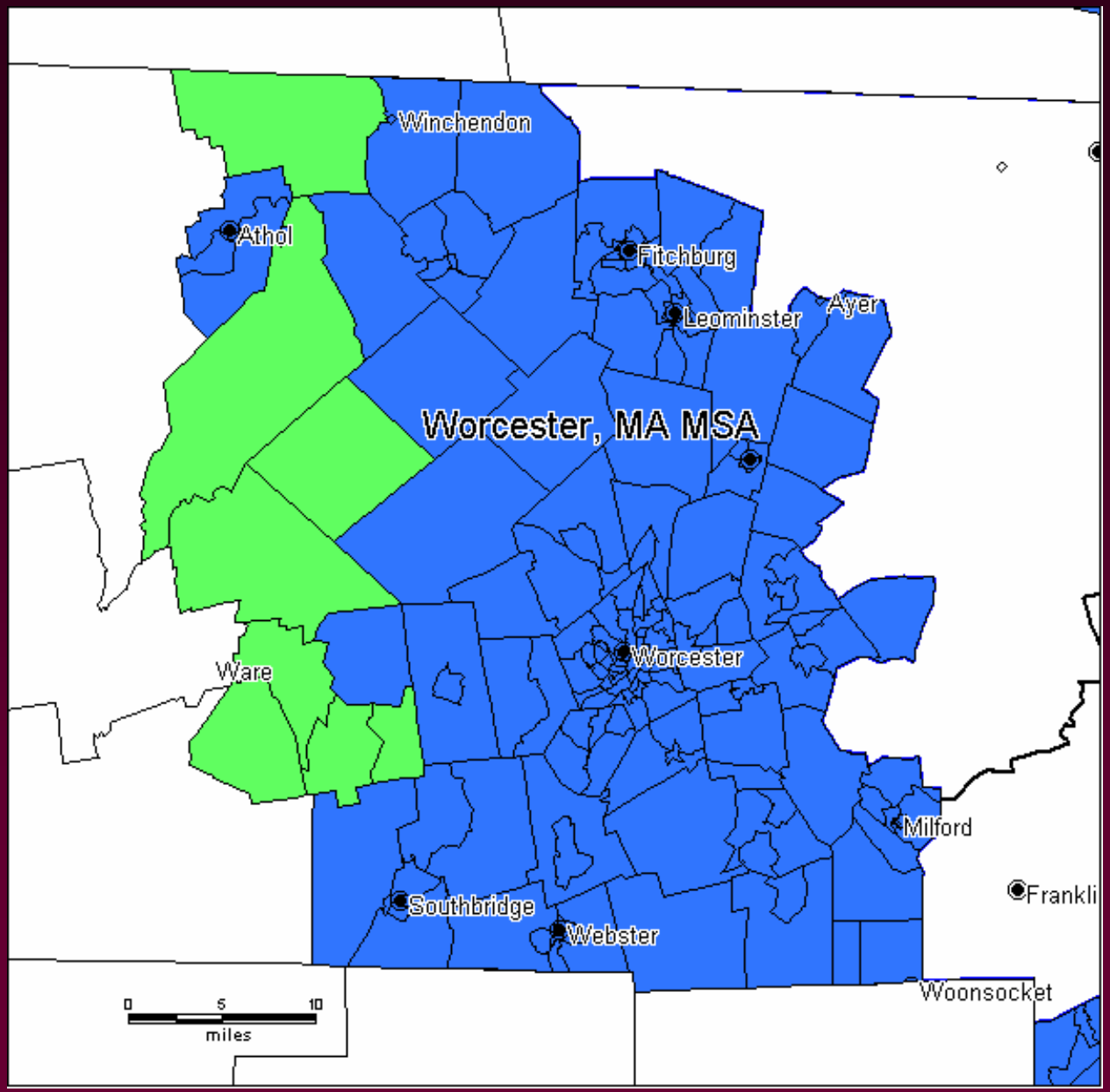
Los Angeles Category 1 MSA Showing Type A and B Tracts



Category 2 Areas Showing Type A and B Tracts



Type A and B Tracts In Worcester, MA [a category 2 MSA]



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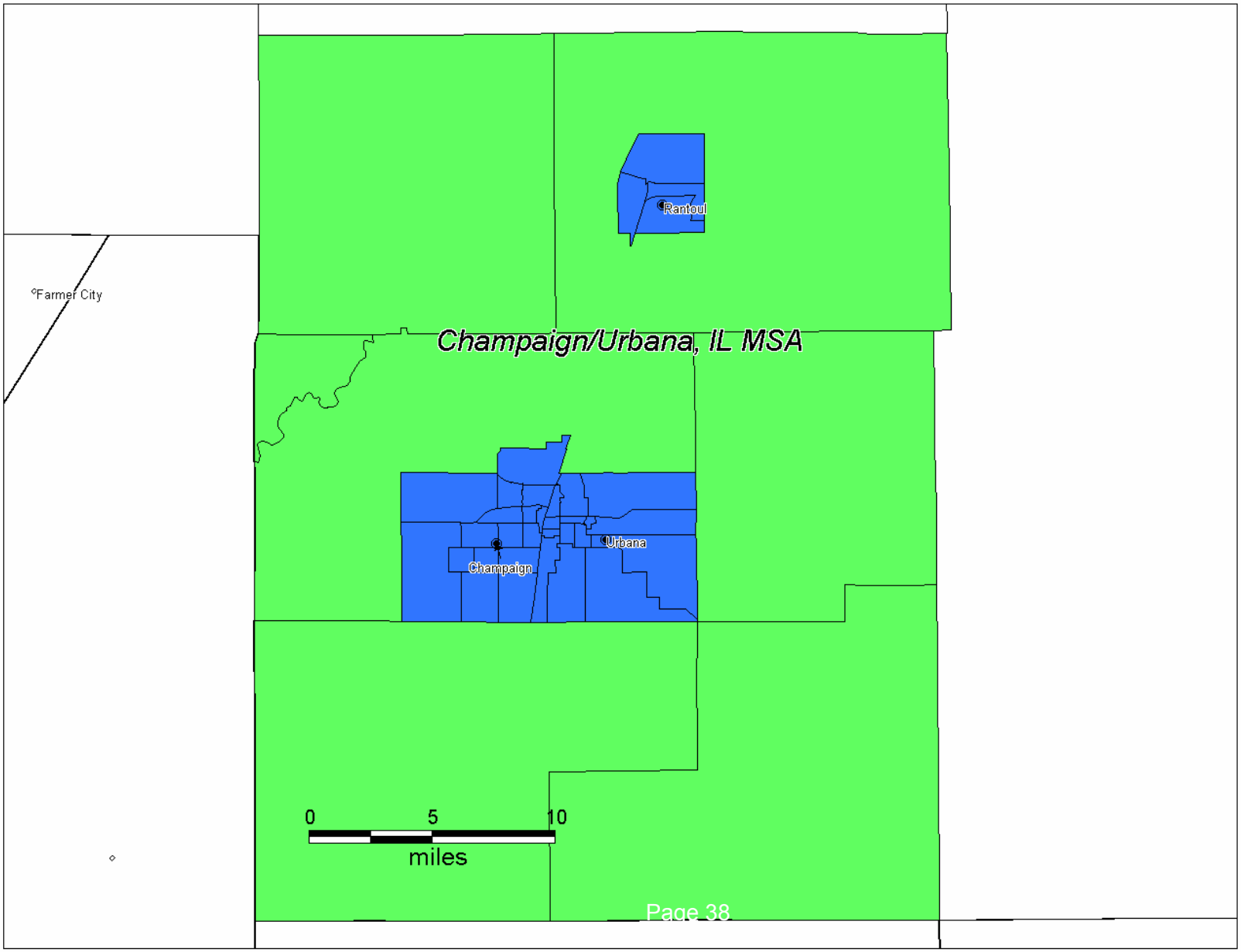
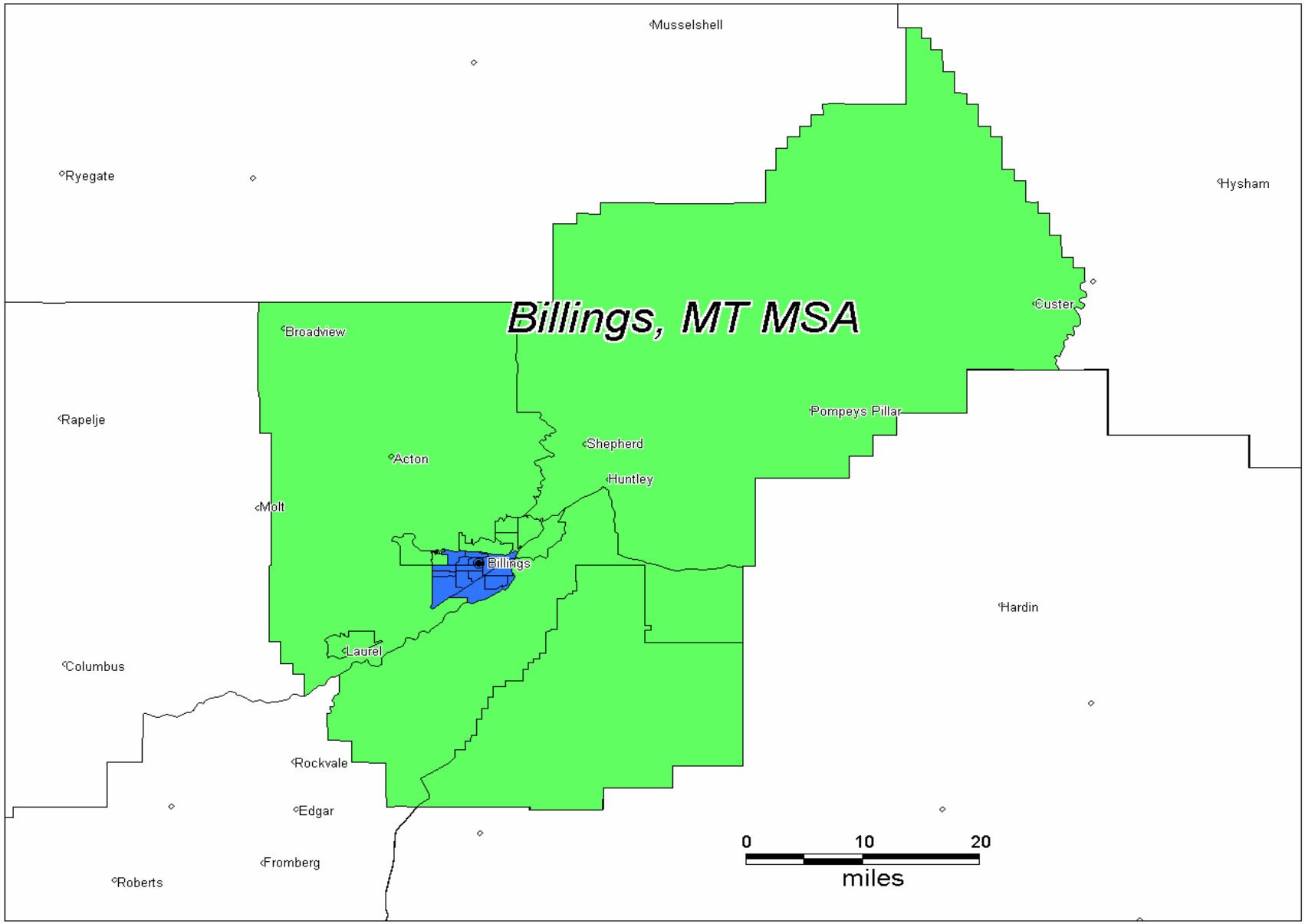
Type A and B Tracts In Champaign/Urbana, IL [a category 2 MSA]



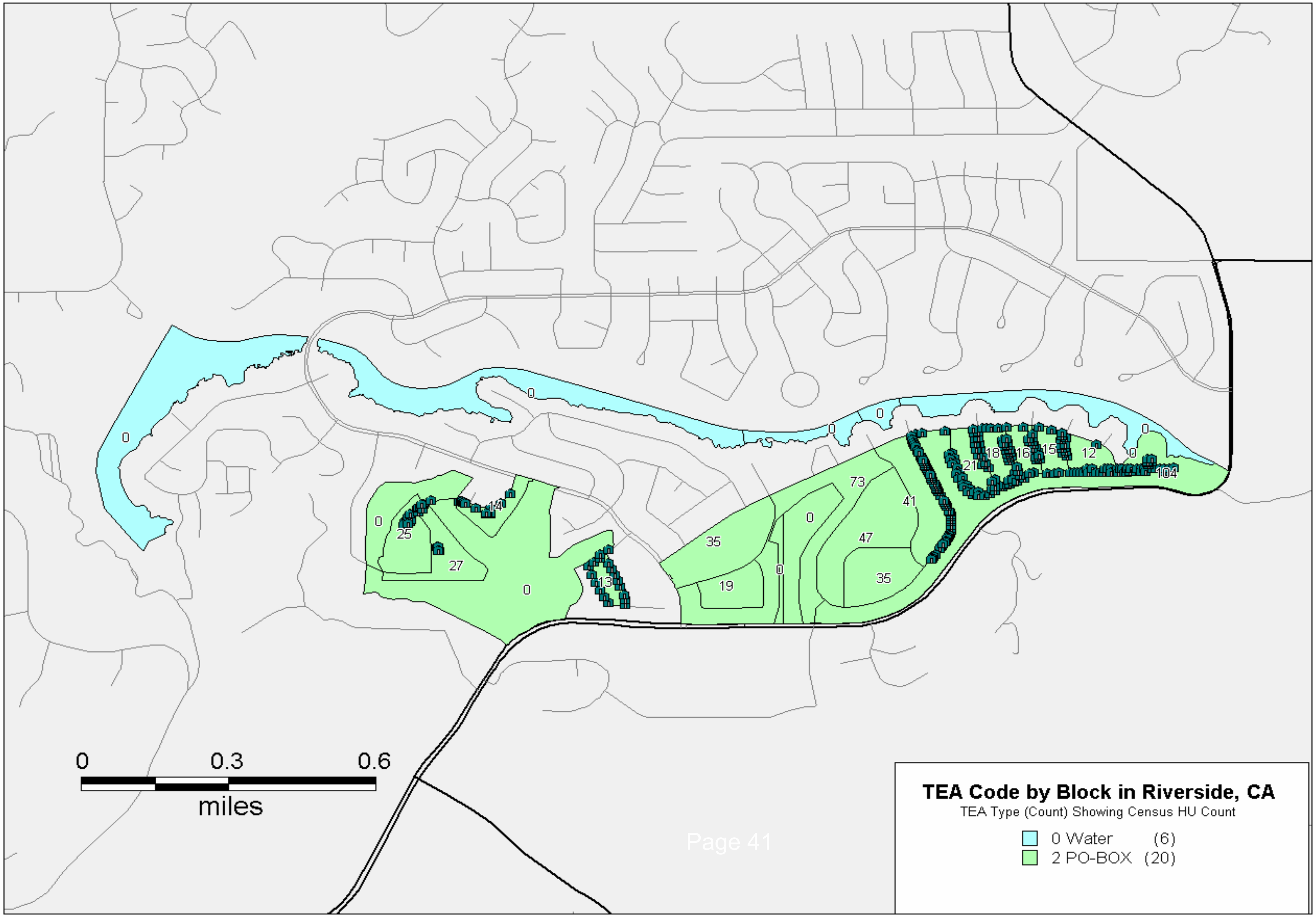
Type A and B Tracts In Billings, MT [a category 2 MSA]



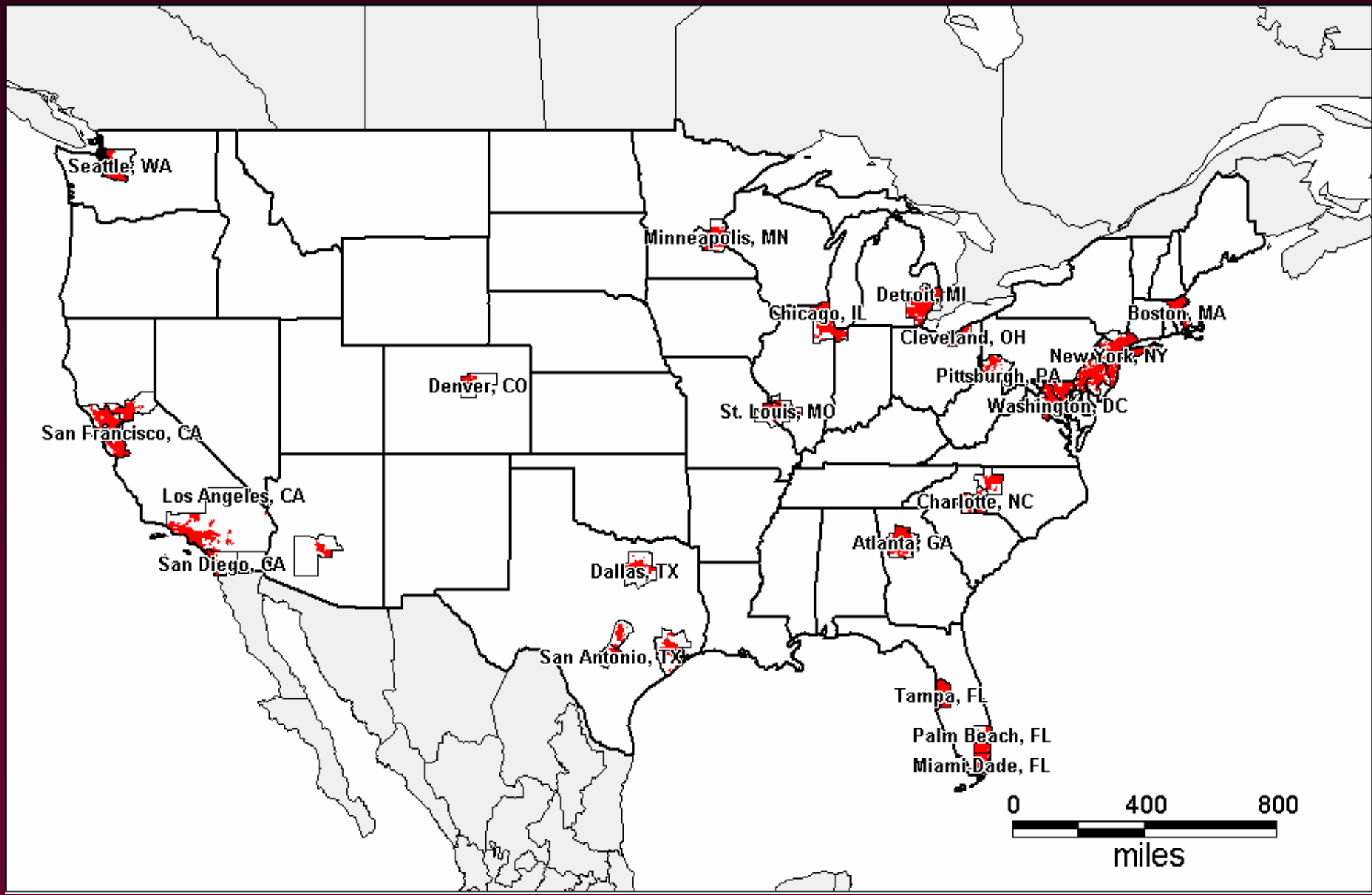
The Design Solution

- **The Swiss cheese frame**
  - **Stratum 1 contains all type A tracts in category 1**
    - **In this stratum, the tract is the PSU**
  - **Stratum 2 contains all type A tracts in category 2**
    - **In this stratum the MSA/county is the PSU**
  - **All remaining tracts (category 1B, category 2B, and category 3)**
    - **In this stratum, the MSA/county is the PSU**
    - **Supplementary tracts from category 1B**

Type 1B Segment in Riverside CA, showing TEA Type, Census Count, and USPS Address Locations



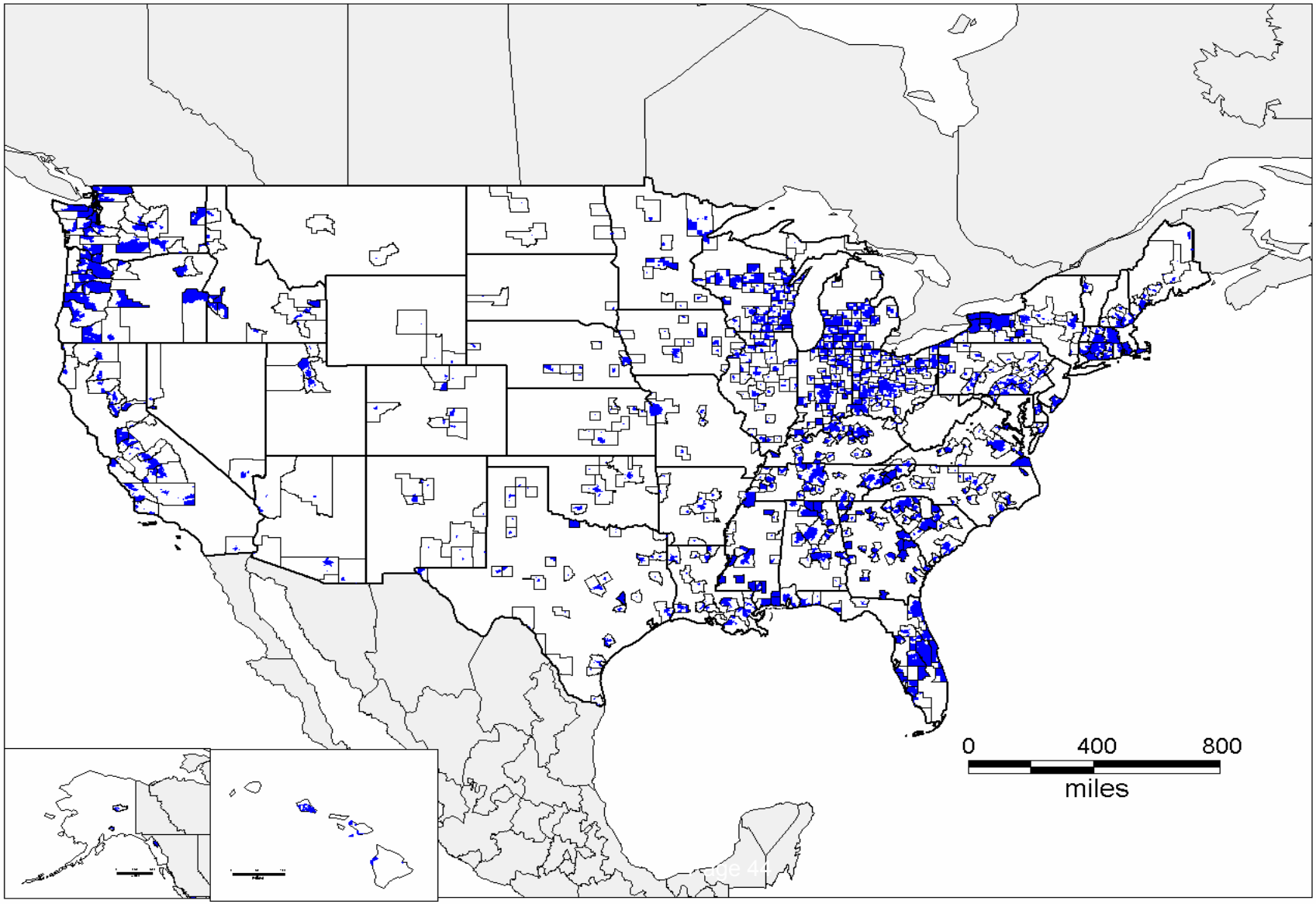
Stratum 1 – All Type A Tracts in Category 1 MSAs



STRATUM 1

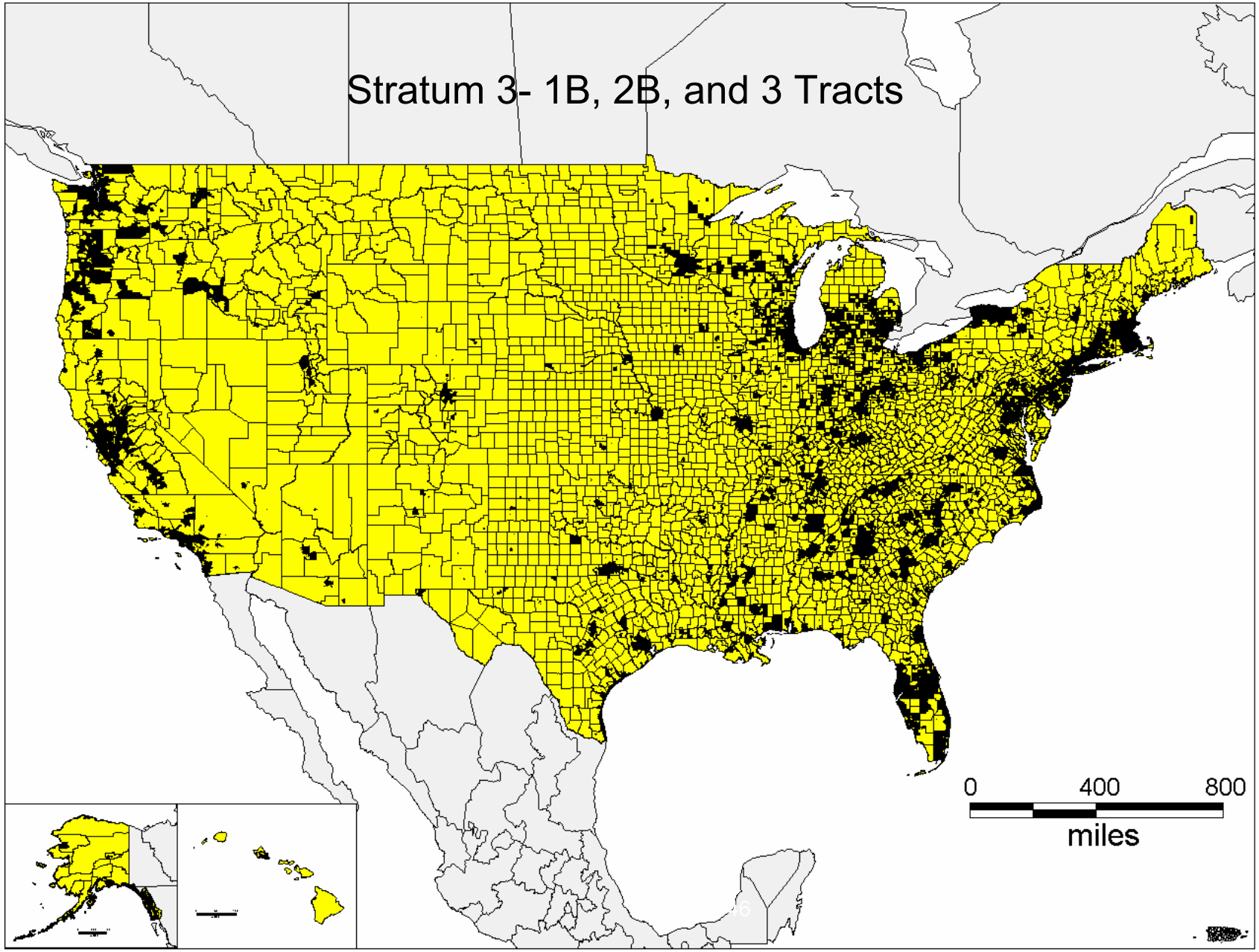
- **42% of population, 2% of area, 24 certainty areas**
- **Direct selection of tracts as PSUs**
- **Contemporaneous USPS list with MHU procedures for HU selection**

Stratum 2 – All Type A Tracts in Category 2 PSUs



STRATUM 2

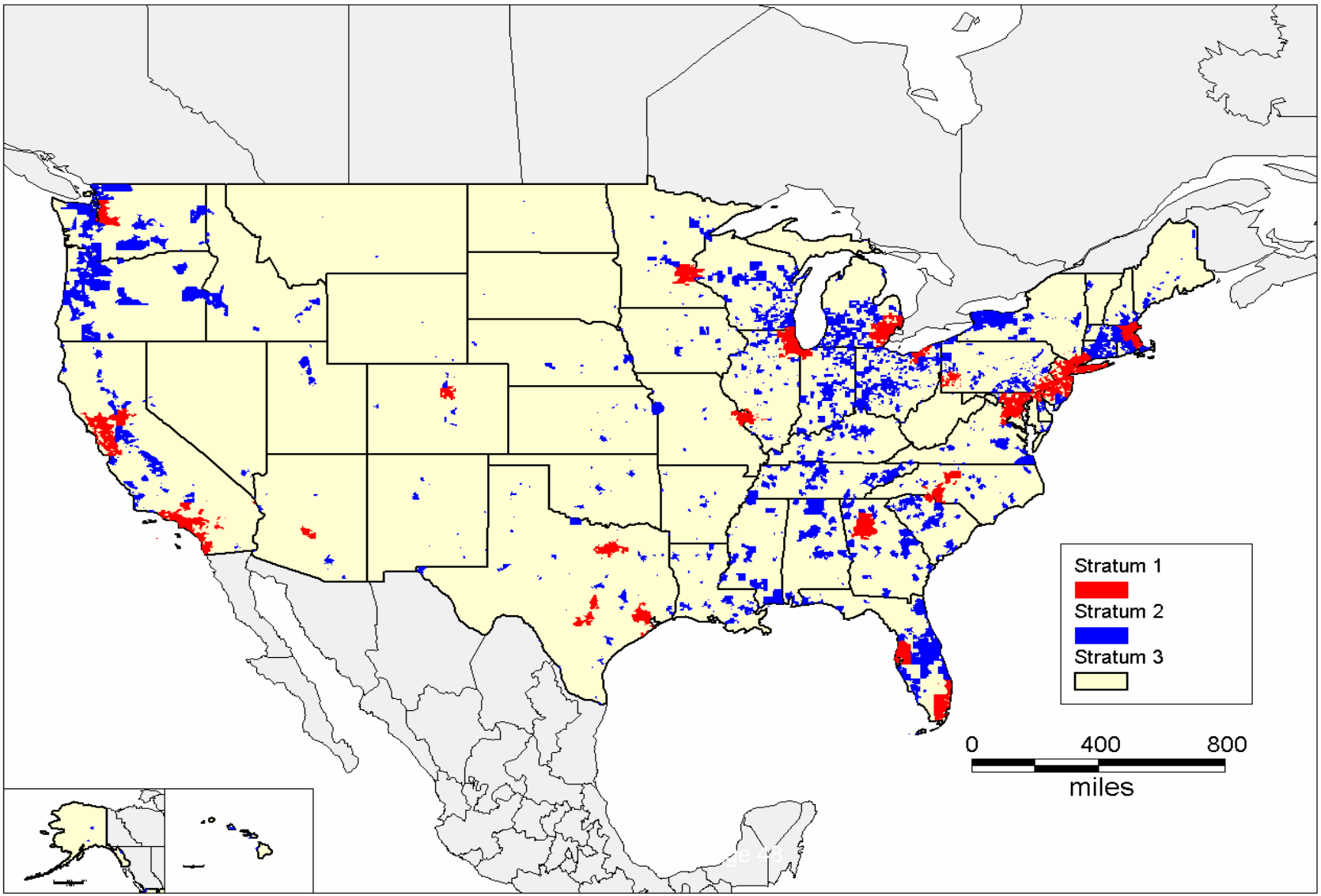
- 30% of population, 3% of area, 607 MSAs/counties (or parts thereof)
- 60 MSAs/counties (or parts thereof) as primary selections
- Selection of tracts as SSUs
- Contemporaneous USPS list with MHU procedures for HU selection


Stratum 3- 1B, 2B, and 3 Tracts
0
400
800
miles

STRATUM 3 [composite of categories 3, 2B, and 1B]

- 28% of population, 93% of area, 3074 MSAs/counties (or parts thereof)
- Selected of 28 MSAs/counties (or parts thereof) as PSUs
- Constructed segments (blocks or groups of blocks) as SSUs
- Listed master sample of HUs within segments
  - Collect geocode during listing (GPS devices)
  - Reservoir for decade

Map Showing Strata 1, 2, and 3



Implications of Lists for Sample Designs

- *Tailored* samples vs *Master* samples
- Rural – no change from previous designs
  - Definition of rural?
- Non-rural
  - For timeliness, coverage, and cost, E superior to T
  - Is U superior to T?
  - Not desirable to construct very much in advance
- Non-rural can be extended as quality permits

Features of New Designs

- **Flexibility for tailored designs**
  - **Accommodates modified stratification within strata 1 and 2 using ACS and/or other information during decade**
  - **Permits updates to HU frame using USPS lists**
  - **Allows different definition and number of PSUs per stratum depending on size of sample and precision requirements**
- **Timeliness**
  - **Can take advantage of any list upgrades or updates**

THERE …

- 19th Century
  - Multi-stage cluster sample of HUs
  - Stratified by urbanicity
  - Use of lists where possible
  - Selection from street addresses or registers
  - Designs tailored to specific projects

- Mid-20th Century
  - Area sampling as conceptual framework
  - Decennial listing/master samples
  - Re-design decennially

… and Back Again

- 21st Century
  - Lists as frames
  - GIS/location as unique identifier
  - Designs differentiated by cost/feasibility
- The Mechanisms
  - Available (high) quality lists
  - GIS – identification and tracking
  - Pre-classification of geographies
  - Computer power

- **The Result**
  - **Tailored samples**
  - **Cheaper, better samples**
  - **Unnecessary uniformity minimized**
  - **Subject matter can inform sample design**
  - **Database linkages for analysis**

CHALLENGES

- **For designers:**
  - **Matching list geographies and census geographies**
  - **Better map data bases**
  - **Unique identifiers for addresses**
  - **Confidentiality/anonymity concerns**
- **For users:**
  - **Taking advantage of the potential**
- **Overall, most exciting time for sampling since Neyman in 1934 and the subsequent CPS design**