

# **Maryland's Forest Conservation Act and the Impact on Residential Development and Forest Cover Change**

**David Newburn**

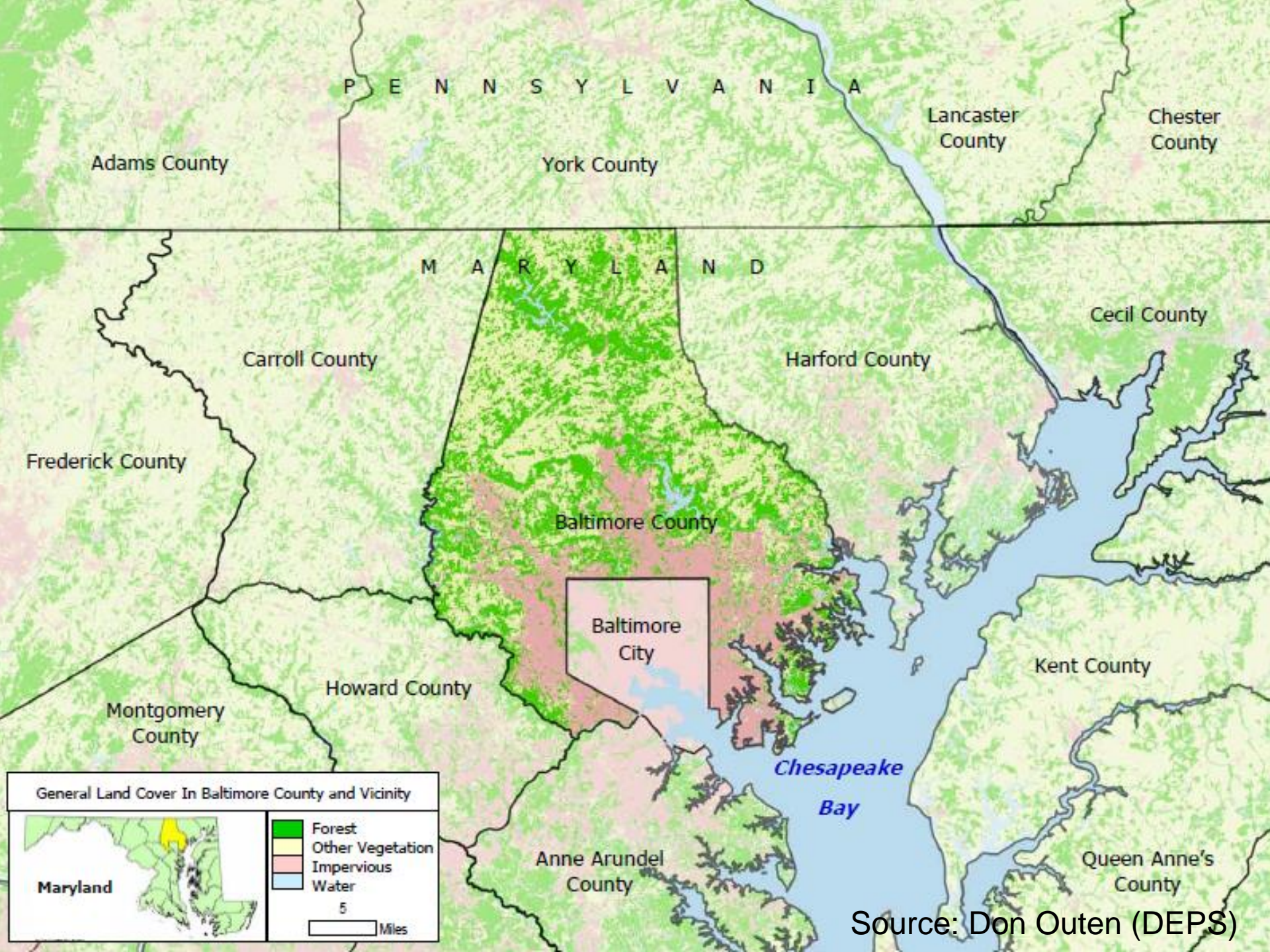
Department of Agricultural and Resource Economics  
University of Maryland

# Forest Conservation Act (FCA) and development

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- **Research question**
  - How did the 1993 Forest Conservation Act (FCA) in Maryland affect residential development and forest cover change decisions?
- **Study area and data**
  - Rural area in Baltimore County (Outside UGB)
  - Parcel-level residential development from tax assessment records
  - Forest cover data in 1984-2004 from North American Forest Dynamics Project
- **Panel Heckman selection model**
  - **First stage:** Panel probit model on residential development
    - Develop or remain developable in 1985-2000
    - Subdivisions before FCA (1985-1992) and after FCA (1993-2000)
  - **Second stage:** Forest cover change, conditional on development
  - **Explanatory variables**
    - Existing forest cover, zoning, accessibility, land quality, surrounding land uses





P E N N S Y L V A N I A

M A R Y L A N D

Adams County

York County

Lancaster County

Chester County

Carroll County

Harford County

Cecil County

Frederick County

Baltimore County

Baltimore City

Kent County

Montgomery County

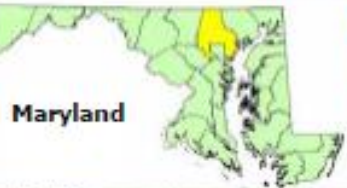
Howard County

Chesapeake Bay

Anne Arundel County

Queen Anne's County

General Land Cover In Baltimore County and Vicinity



- Forest
  - Other Vegetation
  - Impervious
  - Water
- 5 Miles

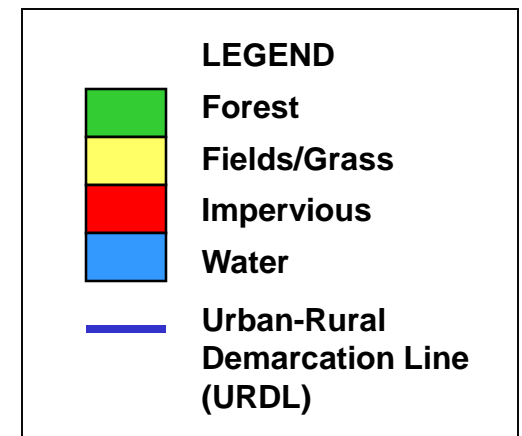
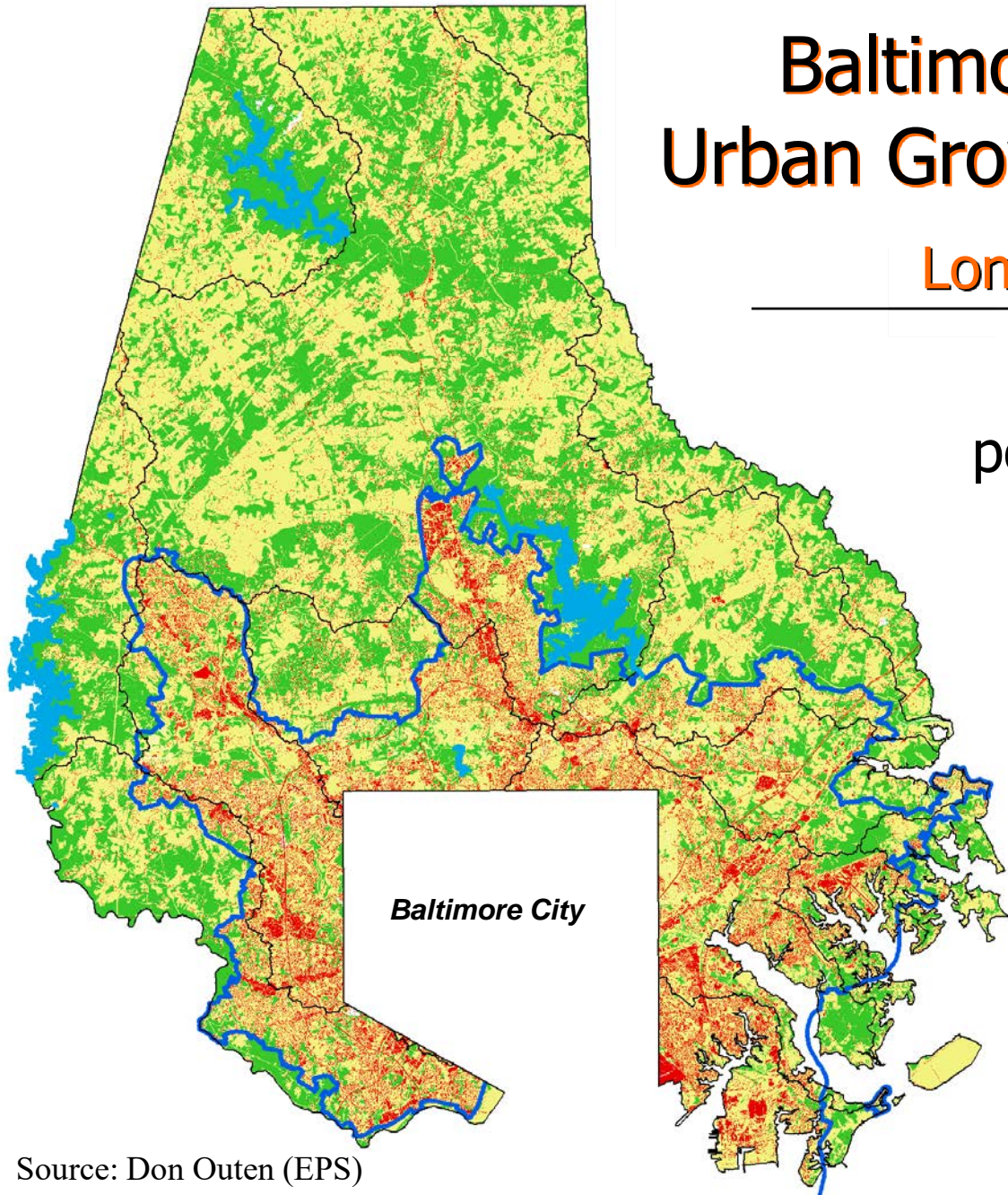
Source: Don Outen (DEPS)



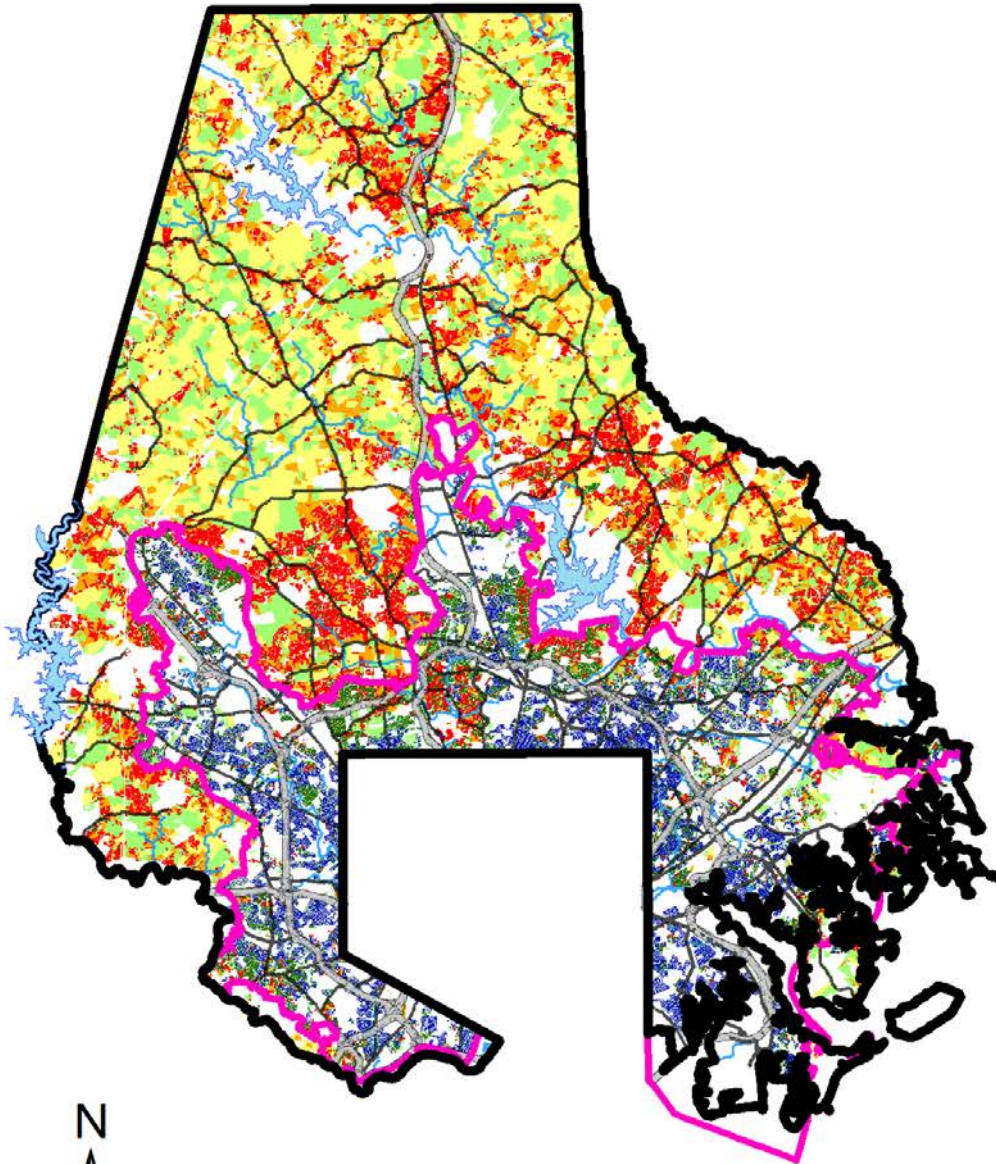
# Baltimore County Urban Growth Boundary

## Long-Term Results

90% of year 2000  
population lived inside  
the urban growth  
boundary (UGB) on  
1/3 of the land



# Residential density



▣ County Boundary

▣ Urban Rural Demarcation Line

▣ Reservoirs

— Major Rivers

— Interstate Highways

— Major Roads

## SINGLE-FAMILY RESIDENTIAL DENSITIES

▣ No development

▣ ≤0.05 units/acre (>20 acres/unit)

▣ >0.05 - 0.2 units/acre (>5 to 20 acres/unit)

▣ >0.2 - 1.0 units/acre (>1 to 5 acres/unit)

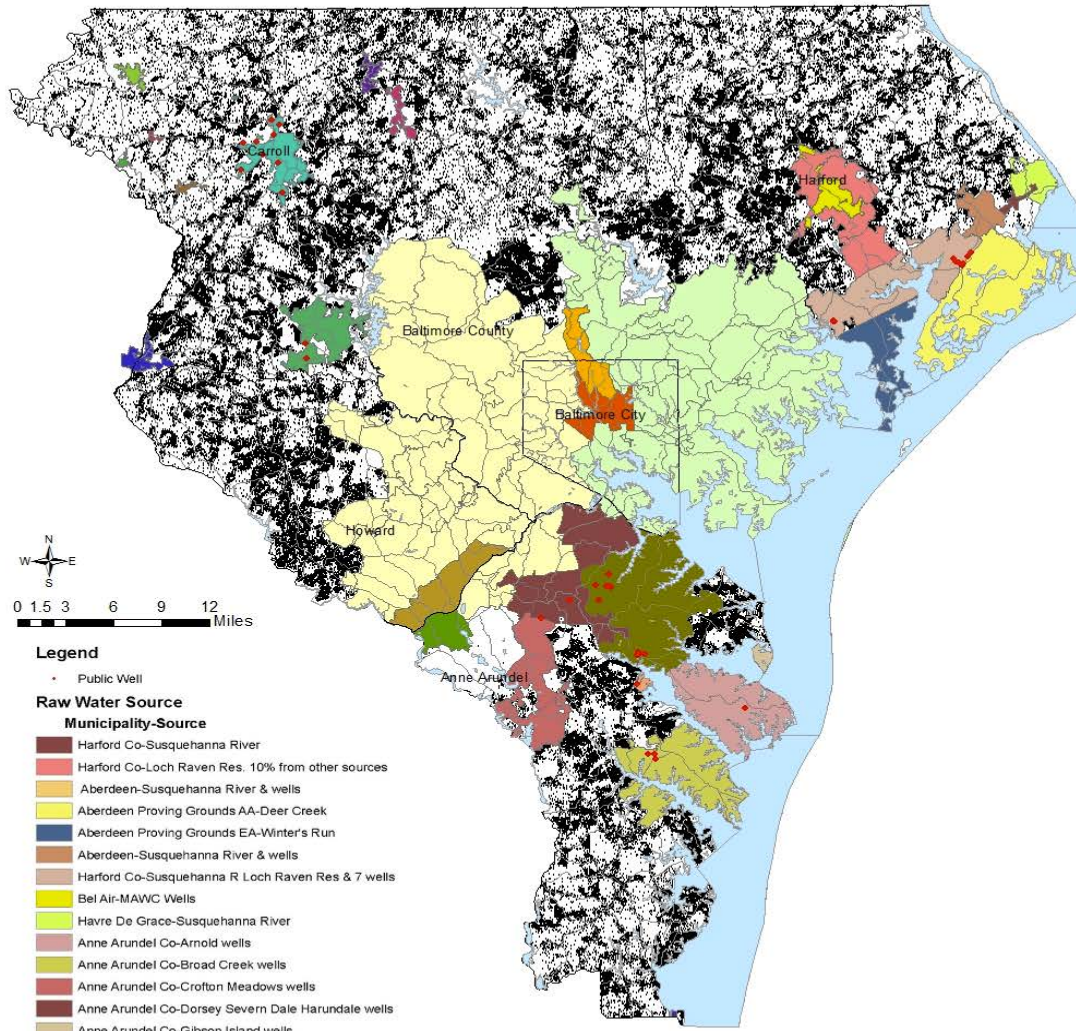
▣ >1.0 - 4.0 units/acre (>0.25 to 1 acres/unit)

▣ >4.0 units/acre (<0.25 acres/unit)



0 2.5 5 10 15 20 Miles





0 1.5 3 6 9 12 Miles

**Legend**

• Public Well

**Raw Water Source**

**Municipality-Source**

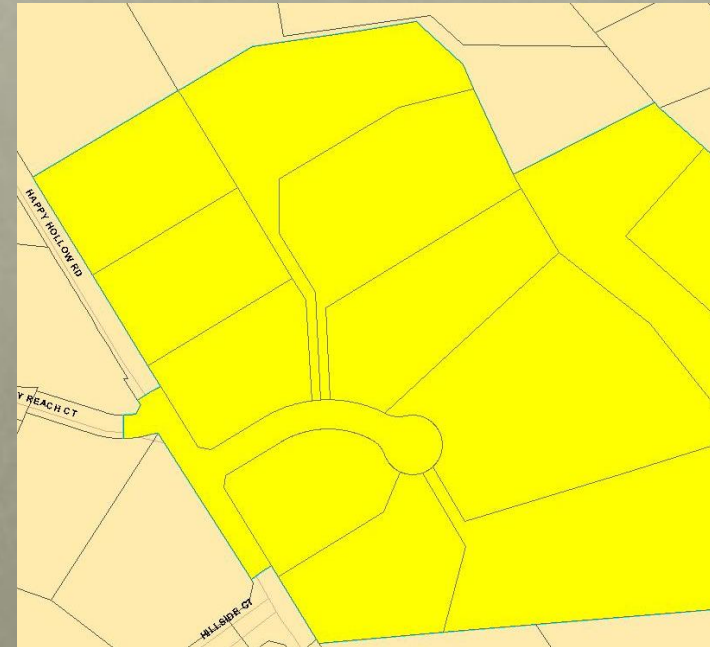
- Harford Co-Susquehanna River
- Harford Co-Loch Raven Res. 10% from other sources
- Aberdeen-Susquehanna River & wells
- Aberdeen Proving Grounds AA-Deer Creek
- Aberdeen Proving Grounds EA-Winter's Run
- Aberdeen-Susquehanna River & wells
- Harford Co-Susquehanna R Loch Raven Res & 7 wells
- Bel Air-MAWC Wells
- Havre De Grace-Susquehanna River
- Anne Arundel Co-Arnold wells
- Anne Arundel Co-Broad Creek wells
- Anne Arundel Co-Crofton Meadows wells
- Anne Arundel Co-Dorsey Severn Dale Harundale wells
- Anne Arundel Co-Gibson Island wells
- Anne Arundel Co-Herald Harbor wells
- Anne Arundel Co-Liberty Reservoir & Dorsey wells
- Anne Arundel Co-Rose Haven wells
- Anne Arundel Co-Severn Dale & Harundale wells
- Carrol County-Liberty Reservoir & 2 wells
- Bramble Hills-Cranberry Reservoir & 2 wells
- Hampstead-17 wells
- Manchester-14 wells
- Mt. Airy-10 wells
- New Windsor-2 wells
- Westminster-Cranberry Reservoir & 9 wells
- Pleasant Valley-wells
- Bark Hill-wells
- Towson-8 wells
- Howard Co-T. Howard Duckett Reservoir
- Baltimore City-50% Liberty Reservoir 50% Loch Raven Reservoir
- Baltimore City County Anne Arundell Co-Loch Raven Reservoir
- Baltimore City County-75% Loch Raven Reservoir 25% Liberty Reservoir
- Baltimore City County Howard Co Anne Arundel Co-Liberty Reservoir
- Maryland HUC 8 Watersheds
- Maryland Counties

Source: Josh Cole (UMBC)

# Subdivisions

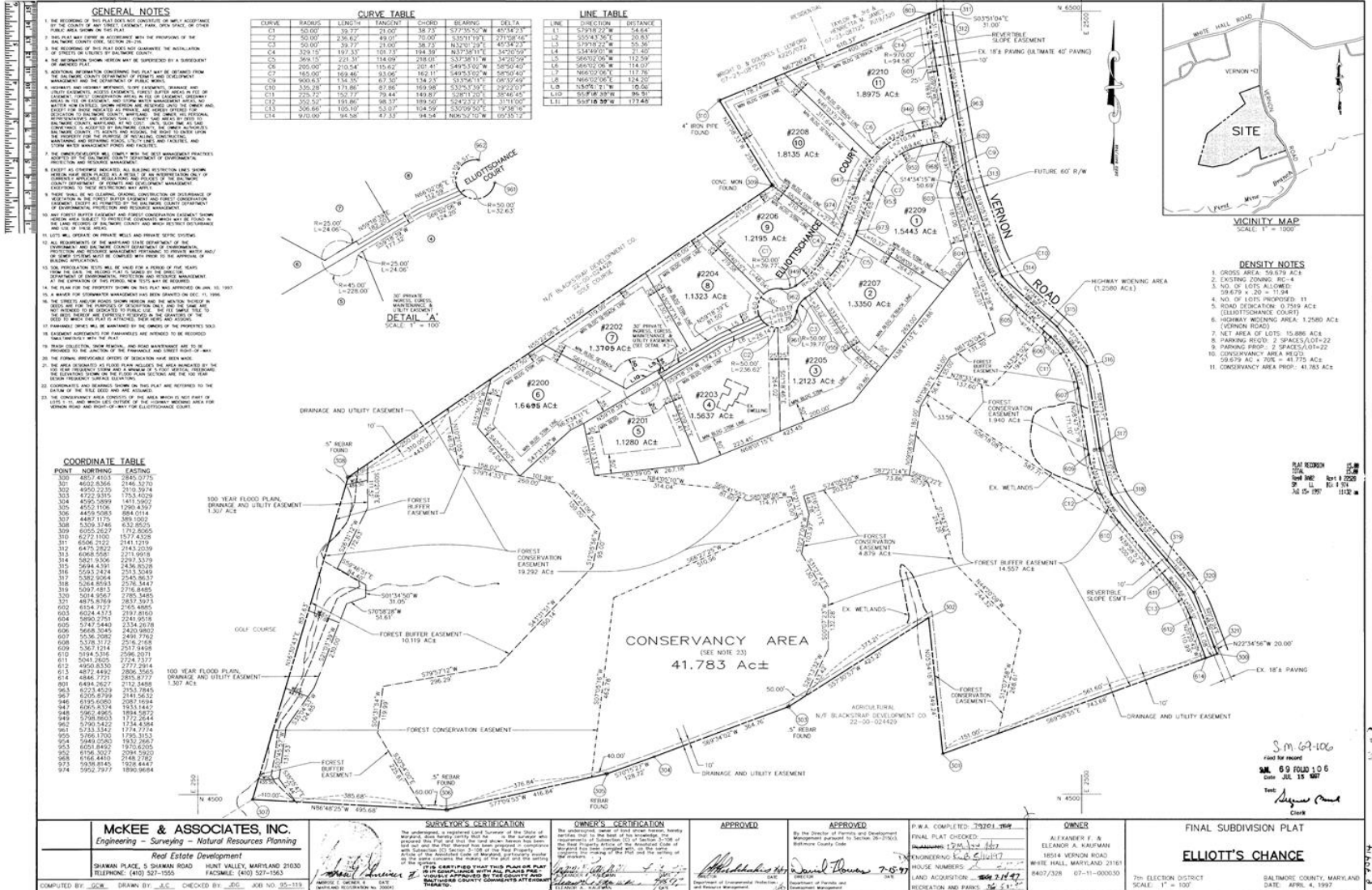
MD Property View parcel data to reconstruct historic subdivisions:

- Identify polygons in MDPV parcel layer within same subdivision
- Dissolve individual parcels into original parent parcel
- Record year start and number of lots in subdivision





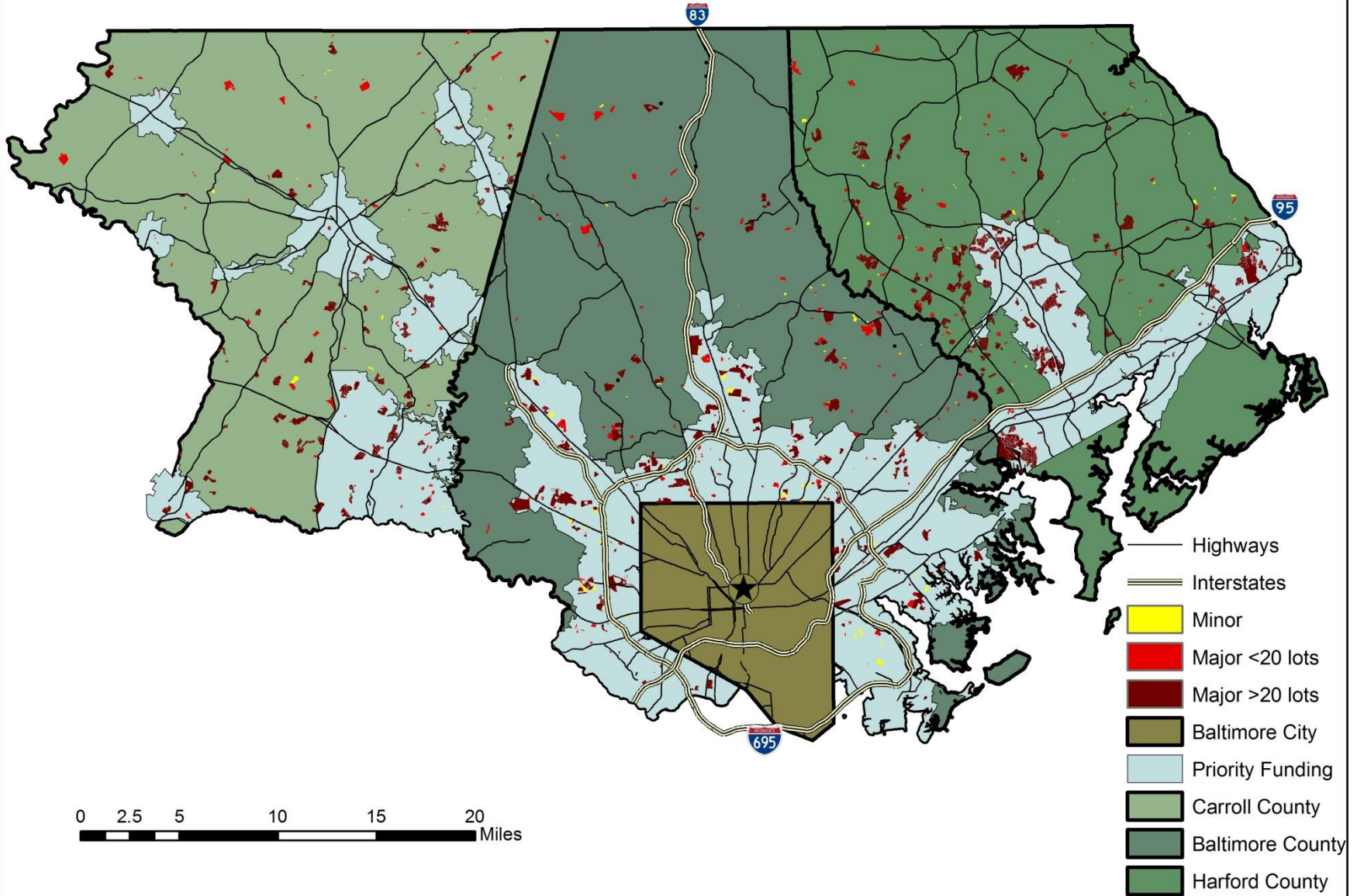
# Subdivision in RC4 zoning





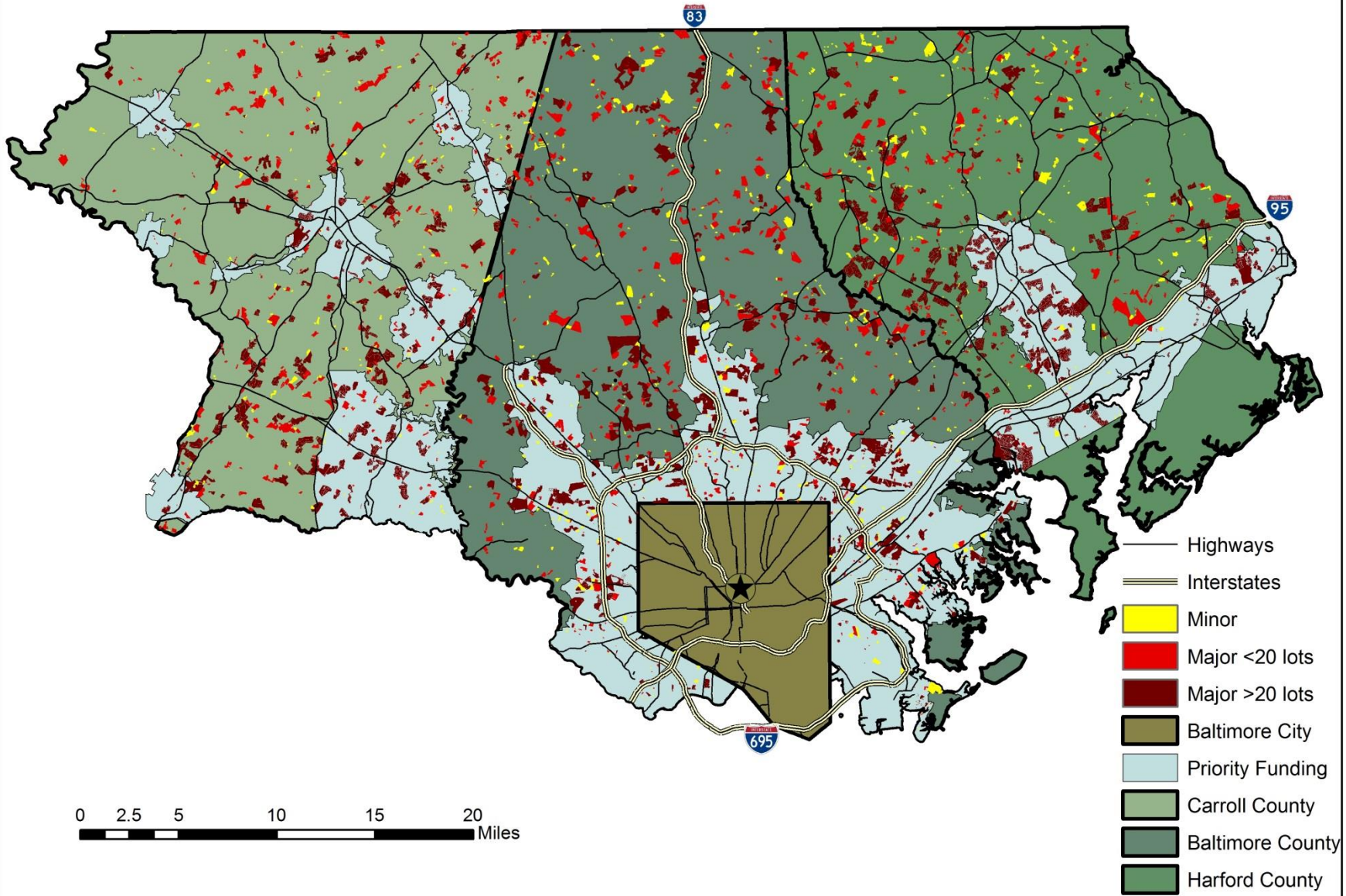


# Carroll, Baltimore, and Harford County Subdivisions 1960-1969





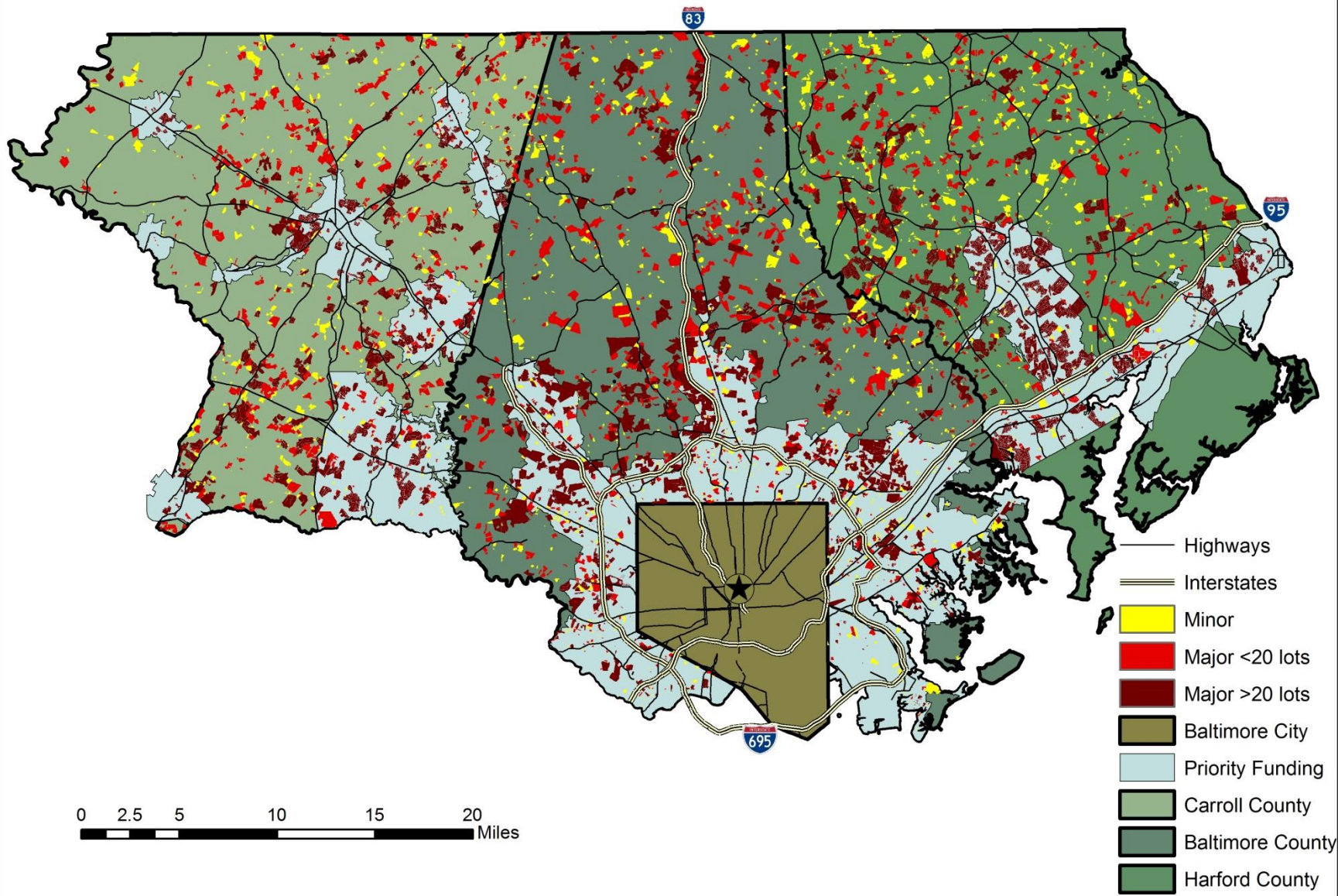
# Carroll, Baltimore, and Harford County Subdivisions 1960-1979







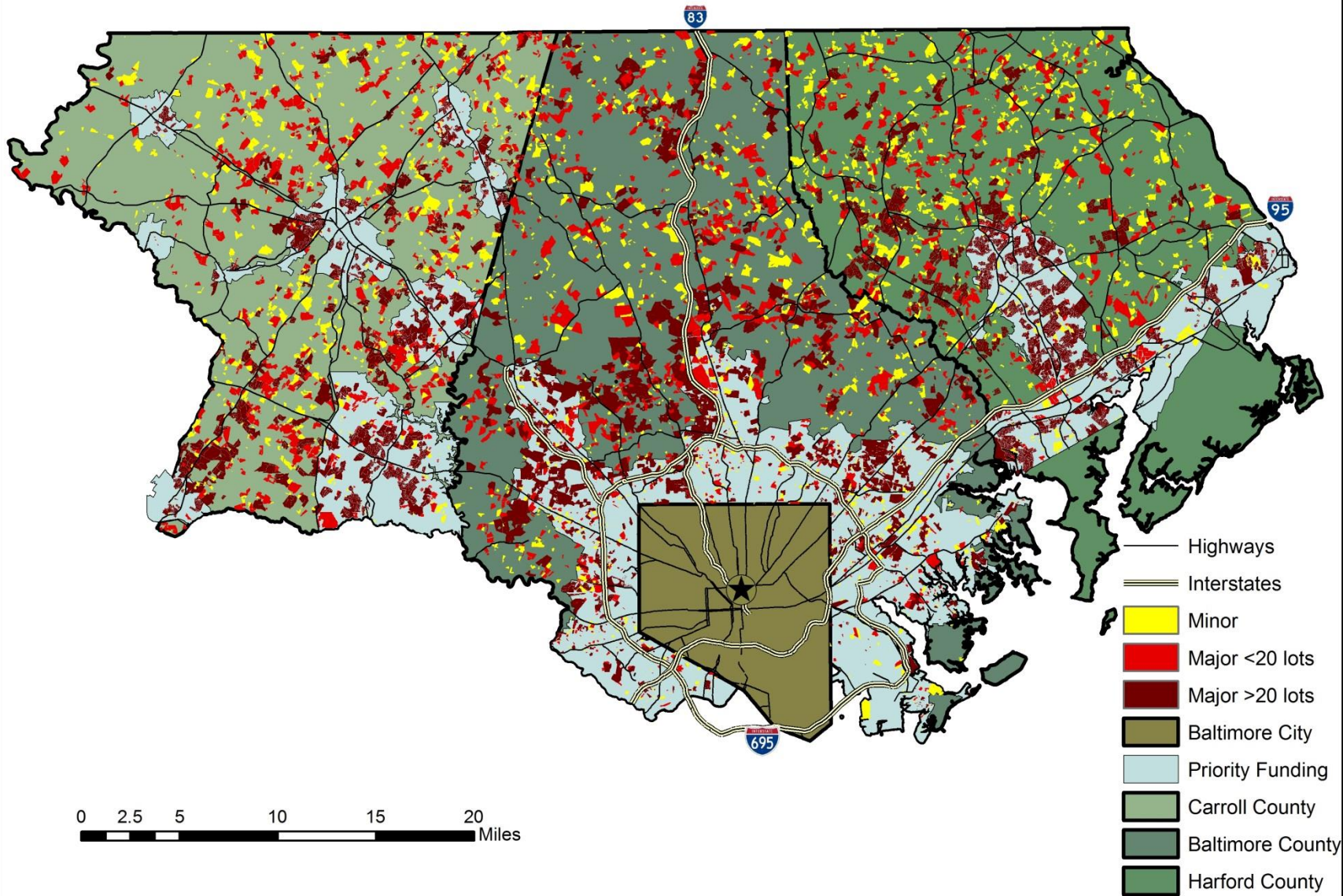
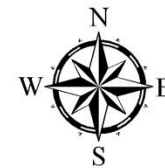
# Carroll, Baltimore, and Harford County Subdivisions 1960-1989







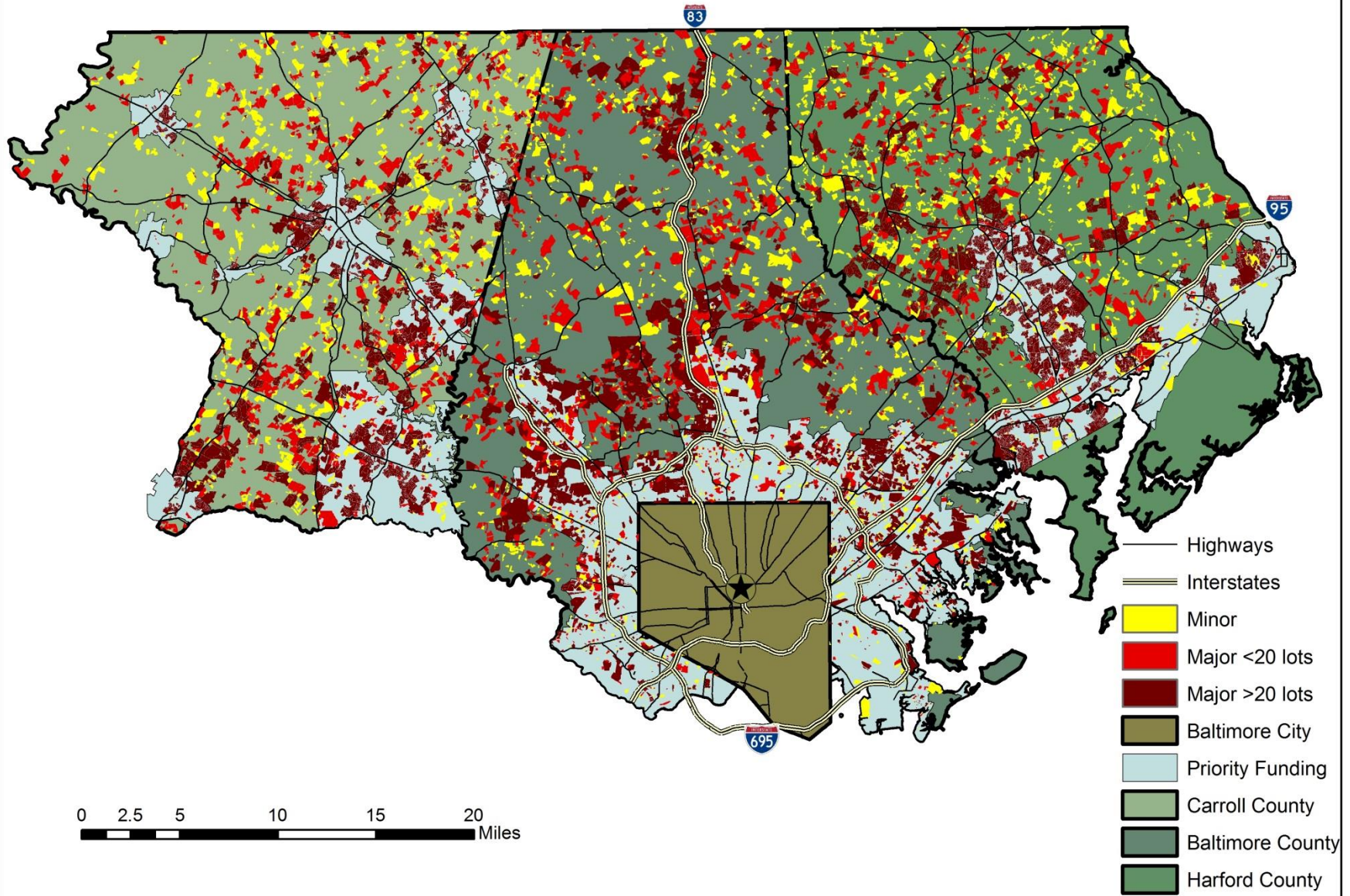
# Carroll, Baltimore, and Harford County Subdivisions 1960-1999



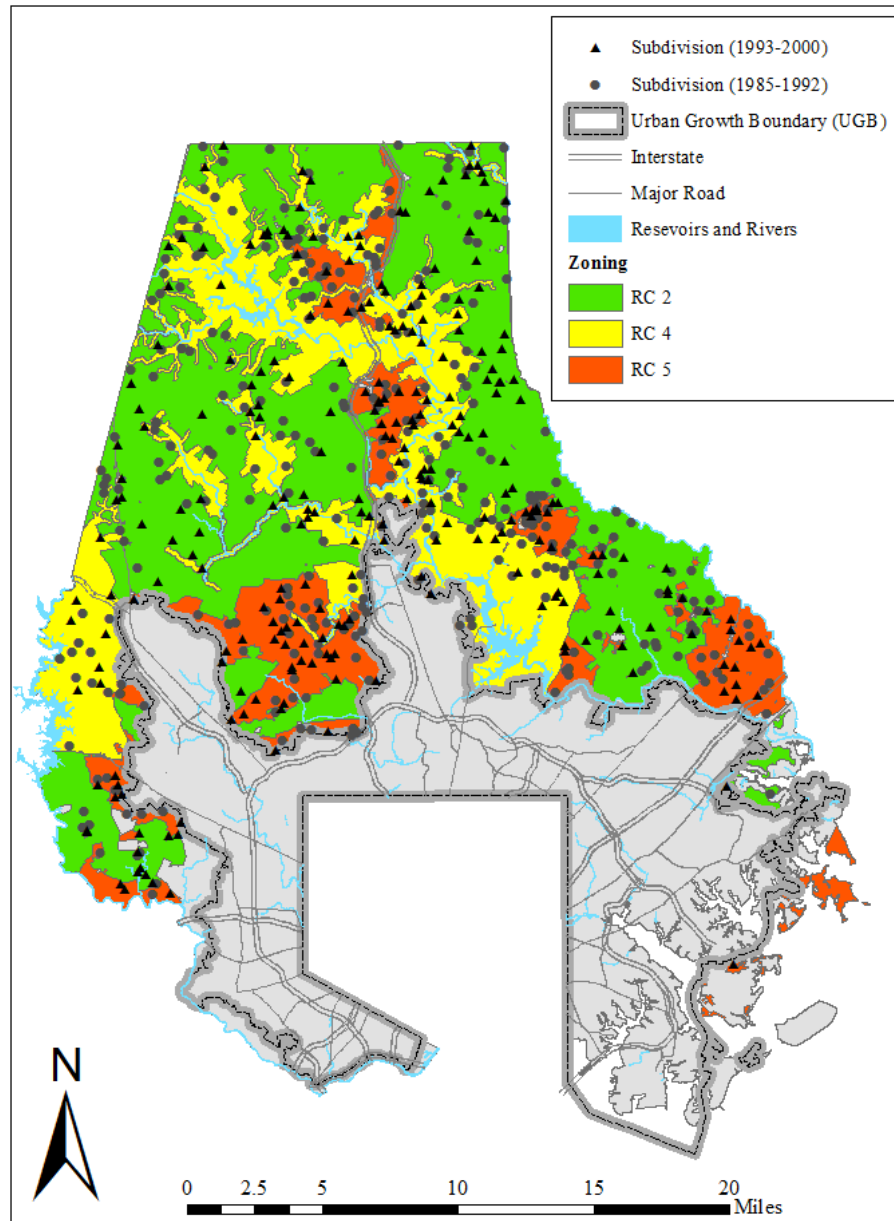




# Carroll, Baltimore, and Harford County Subdivisions 1960-2007



# Residential subdivisions in 1985-2000





# Forest Conservation Act (FCA) in Maryland

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- FCA is a statewide law in Maryland and implemented by county and local governments starting in 1993
- Purpose: Set afforestation and conservation requirements to reduce forest loss and encourage tree planting on subdivisions
- Priority areas for forest protection and restoration
  - Riparian buffers, 100-year floodplains, wetlands, steep slopes, erodible soils

# Afforestation and conservation thresholds

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- **Afforestation**

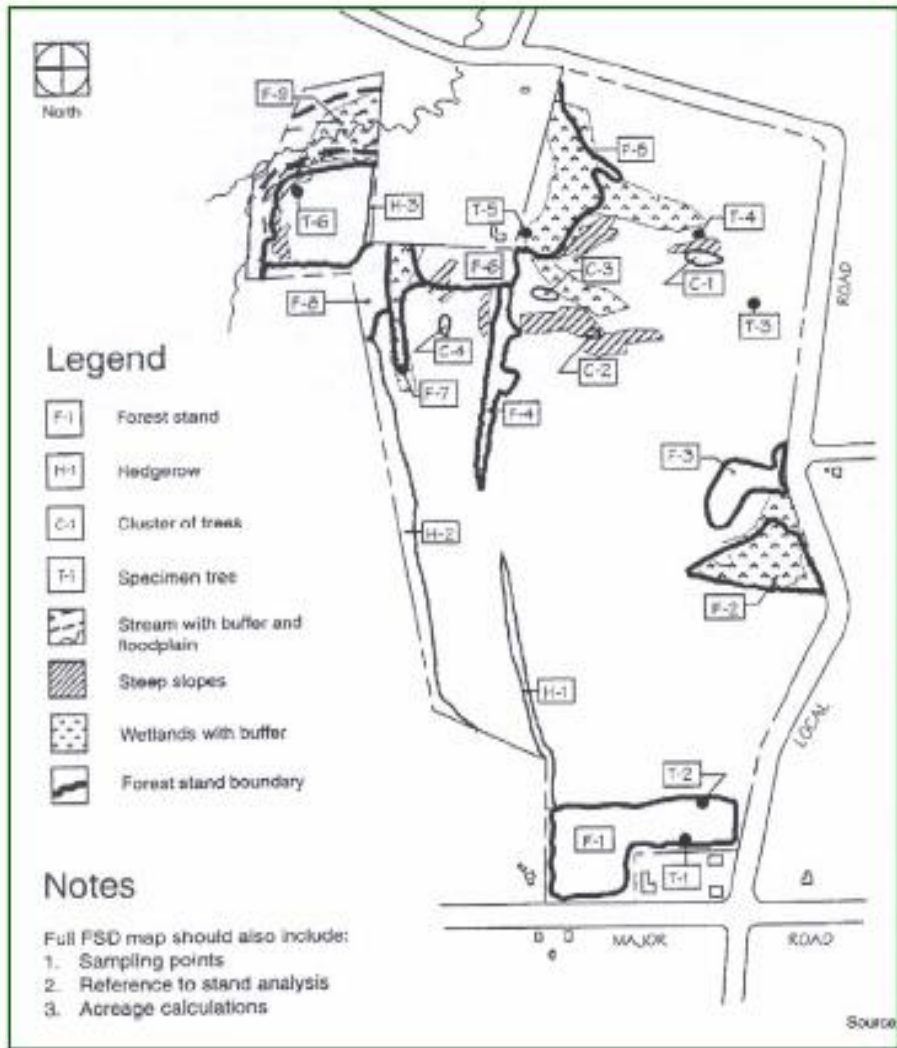
- Afforestation threshold at 20% forest cover for all parcels
- Example: Parcels with <20% existing forest cover must plant trees up to the afforestation threshold even if no trees cleared during development

- **Conservation**

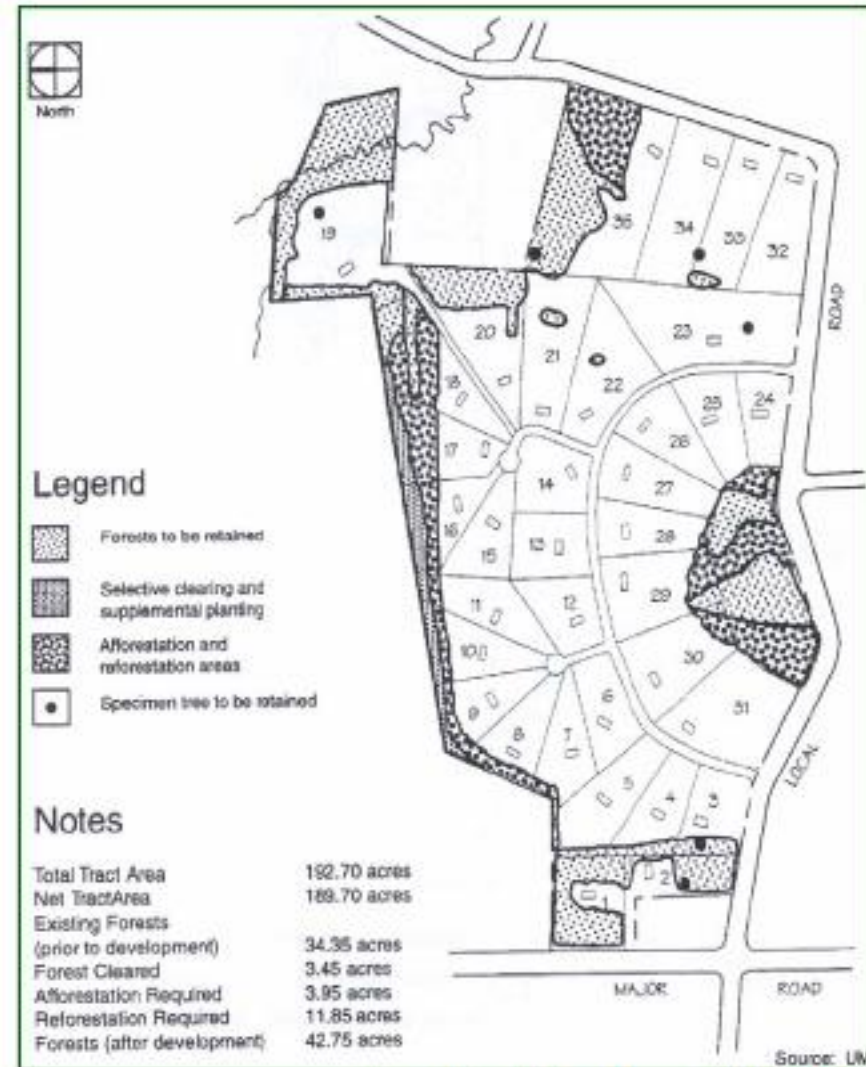
- Conservation threshold at 50% forest cover for agricultural and resource areas (RC2 & RC4 zoning) and 25% forest cover for medium residential areas (RC5 zoning)
- Example: Parcel in agricultural or resource areas that clears forest below the conservation threshold must replace forest at double the amount



# Forest Conservation Act



**Forest stand delineation**



**Forest conservation plan**

# Forest Cover Data

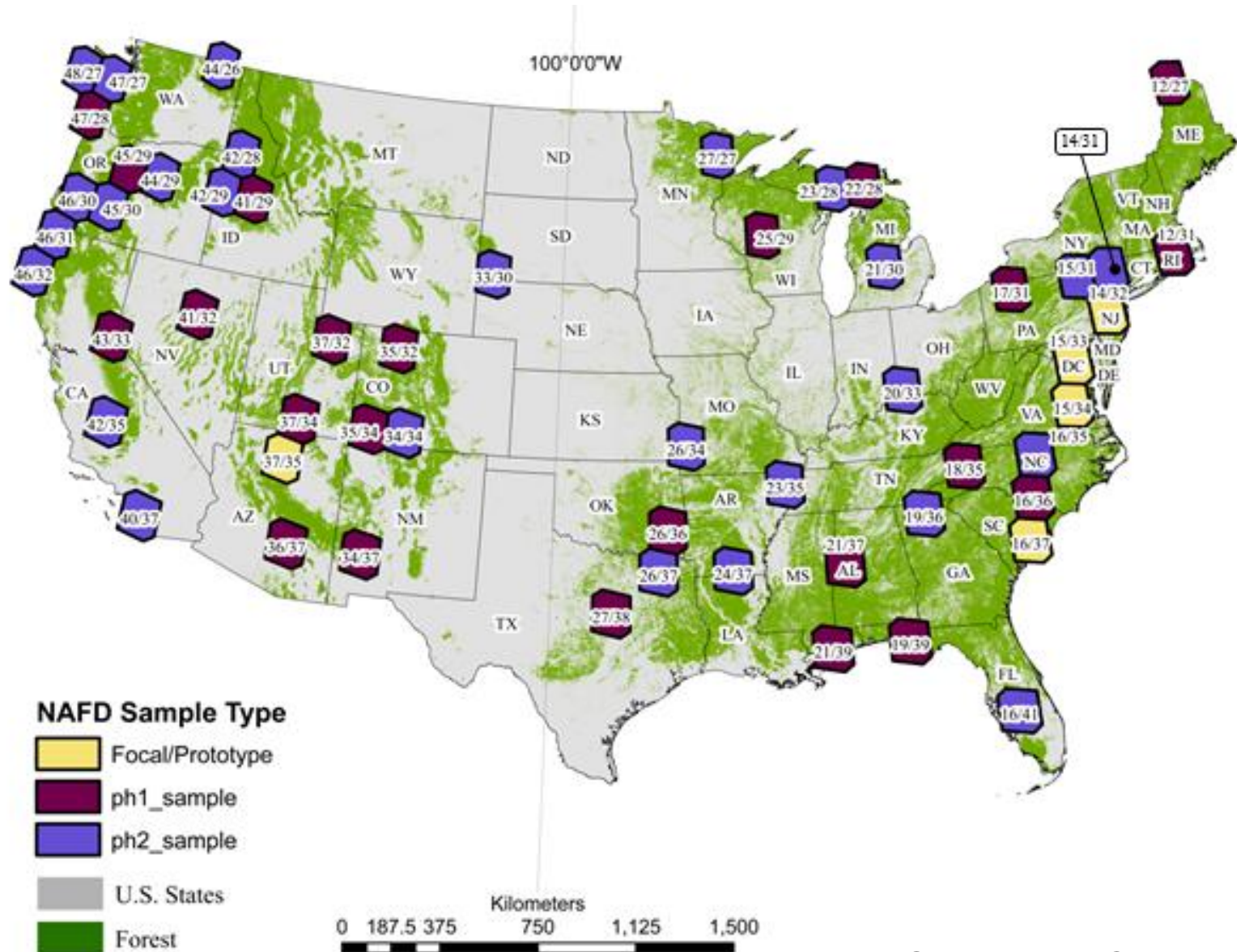
- Forest cover data in 1984-2004 for Baltimore-DC corridor
  - NASA funded North American Forest Dynamics Project (Goward et al. 2012)
  - Forest classification based on Landsat imagery at 30 meter grid cells
  - Snapshot on forest cover for 12 time periods: 1984, 1986, 1987, 1988, 1990, 1991, 1994, 1996, 1998, 2000, 2002, 2004
  - Accounts for deforestation, reforestation and afforestation
- Existing forest cover
  - % existing forest cover calculated as forest area divided by total parcel area

# Forest Cover Change

- Forest cover change (dependent variable in second stage)
  - Difference in % forest cover after development and prior to development
    - Difference in % forest cover in 1996 and prior to development for subdivisions in 1985-1992
    - Difference in % forest cover in 2004 and prior to development for subdivisions in 1993-2000
  - Example: Subdivision event in 1989 would calculate difference for % forest cover in 1996 and % forest cover in 1988 prior to development

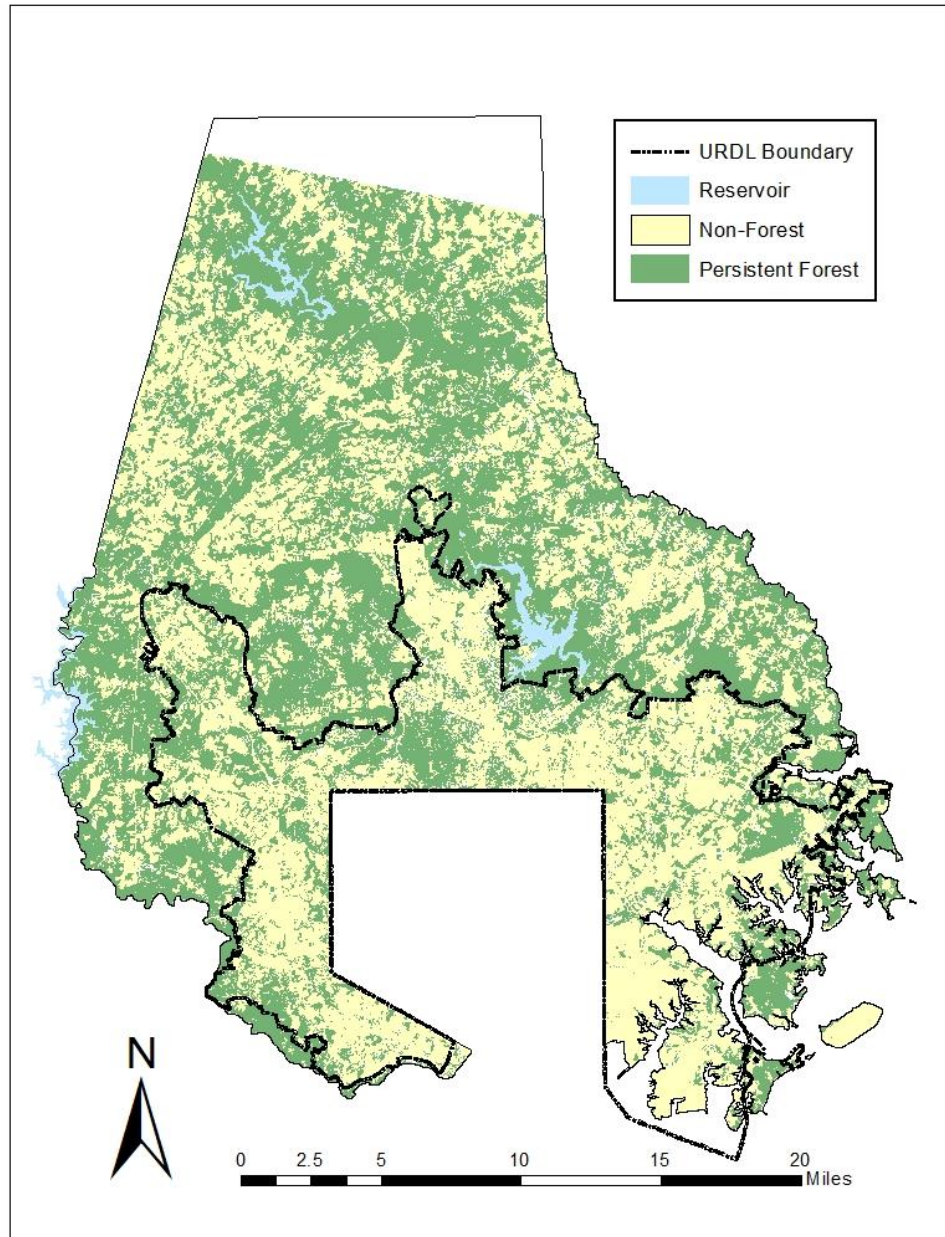


# North American Forest Dynamics Project (55 Sites) under of the North American Carbon Program



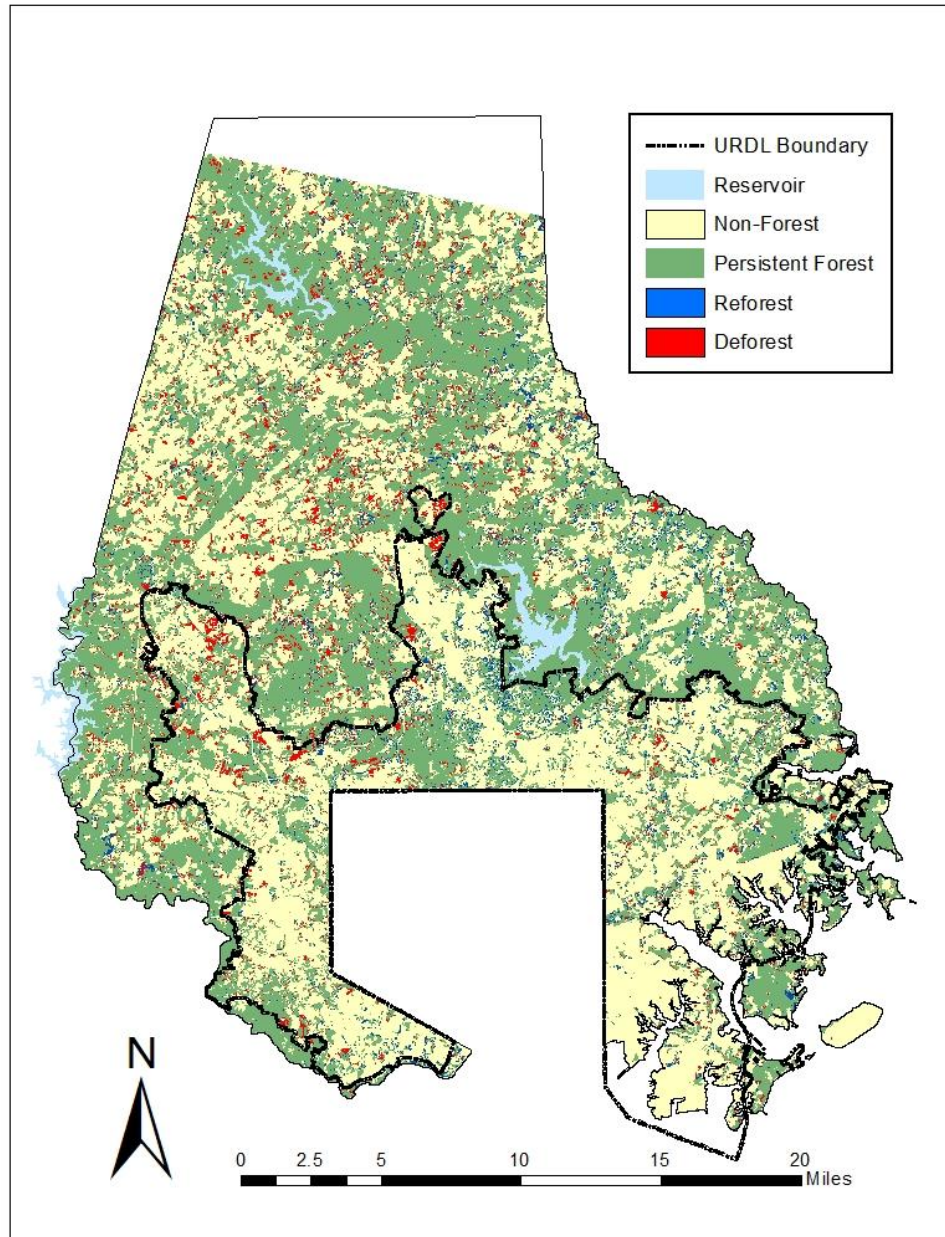
Source: NACP

# Forest Cover in 1984

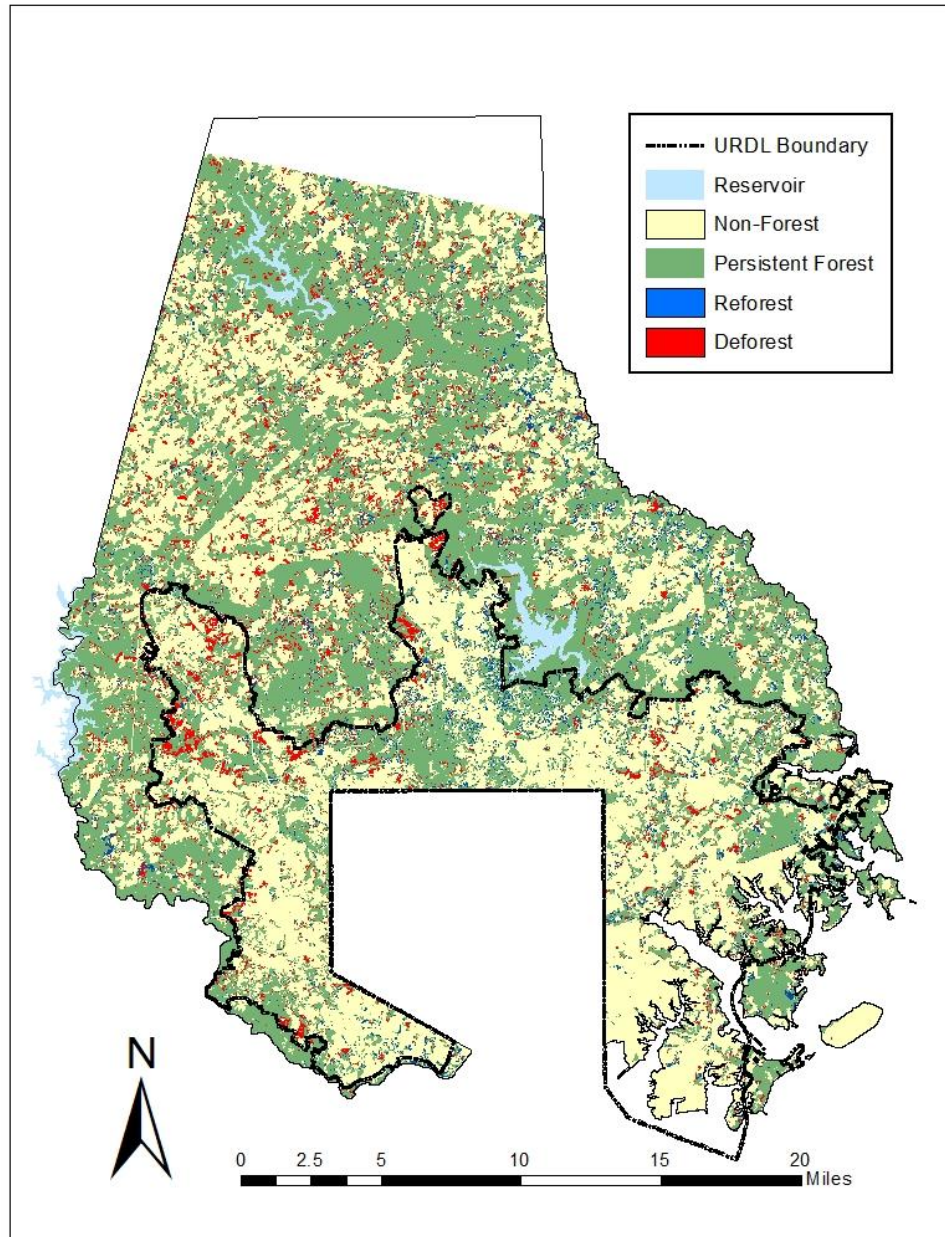




# Forest Cover in 1990

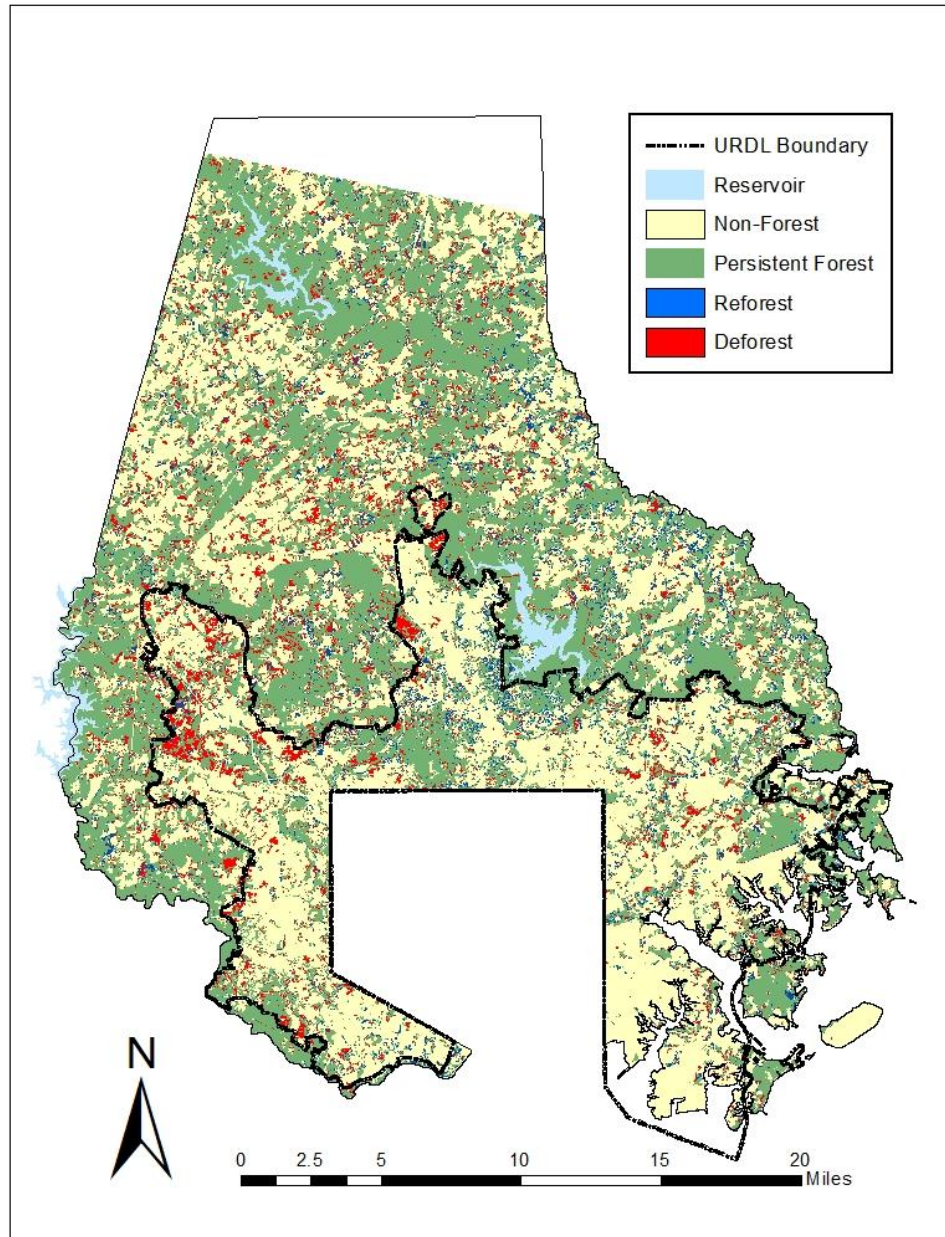


# Forest Cover in 1995

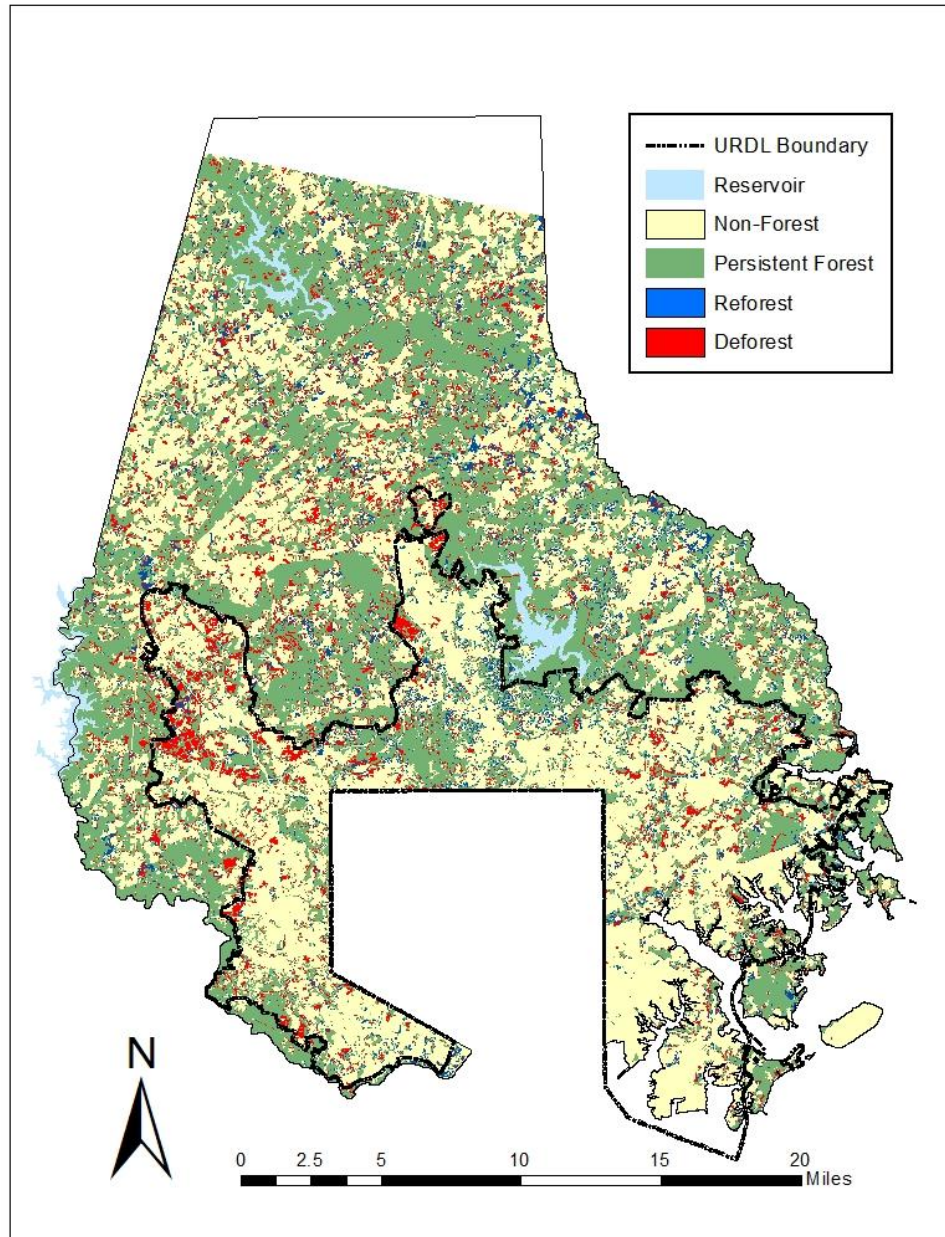




# Forest Cover in 2000

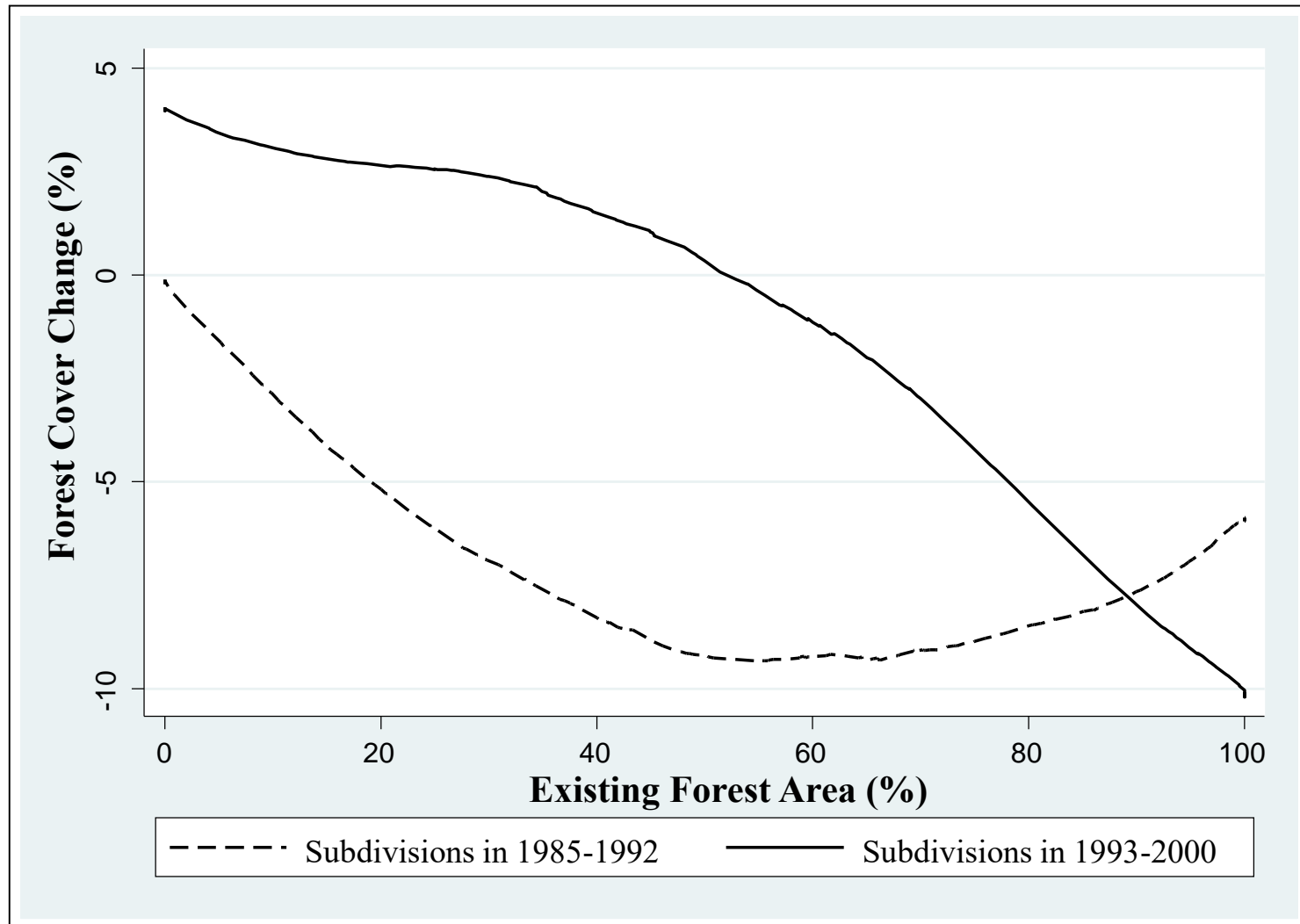


# Forest Cover in 2004





# Forest cover change on subdivisions before (1985-1992) and after (1993-2000) FCA policy



# Explanatory variables

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## **Existing forest cover**

Forest cover quintile categories (baseline = 0-20% forest cover)

## **Zoning attributes**

Zoning type (baseline = RC5 zoning)

## **Accessibility attributes**

Distance to Baltimore City

Distance to major road

## **Physical land attributes**

Parcel area

Slope

Elevation

Riparian buffer area

Existing house

## **Surrounding % land use (within 500 meter buffer)**

Protected areas

Existing residential

Existing non-residential (commercial, industrial)



# Forest Cover Change Conditional on Development in 1985-1992 and 1993-2000

Forest Cover Quintile	Forest Cover Change in 1985-1992	Forest Cover Change in 1993-2000	Difference
Forest cover 0-20%	-3.6142 (2.5552)	4.9490** (1.2769)	8.5632** (2.6788)
Forest cover 20-40%	-9.0944** (3.037)	3.1678 (1.6712)	12.2621** (3.3536)
Forest cover 40-60%	-9.959** (3.0127)	5.7351** (1.9013)	15.6941** (3.3403)
Forest cover 60-80%	-11.204** (3.8725)	-4.0878** (1.227)	7.1158* (3.5958)
Forest cover 80-100%	-7.6628** (2.7323)	-9.2863** (1.8637)	-1.6235 (3.0799)

Robust standard errors in parentheses calculated using delta method.

\*\* p<0.01, \* p<0.05

# Conclusions

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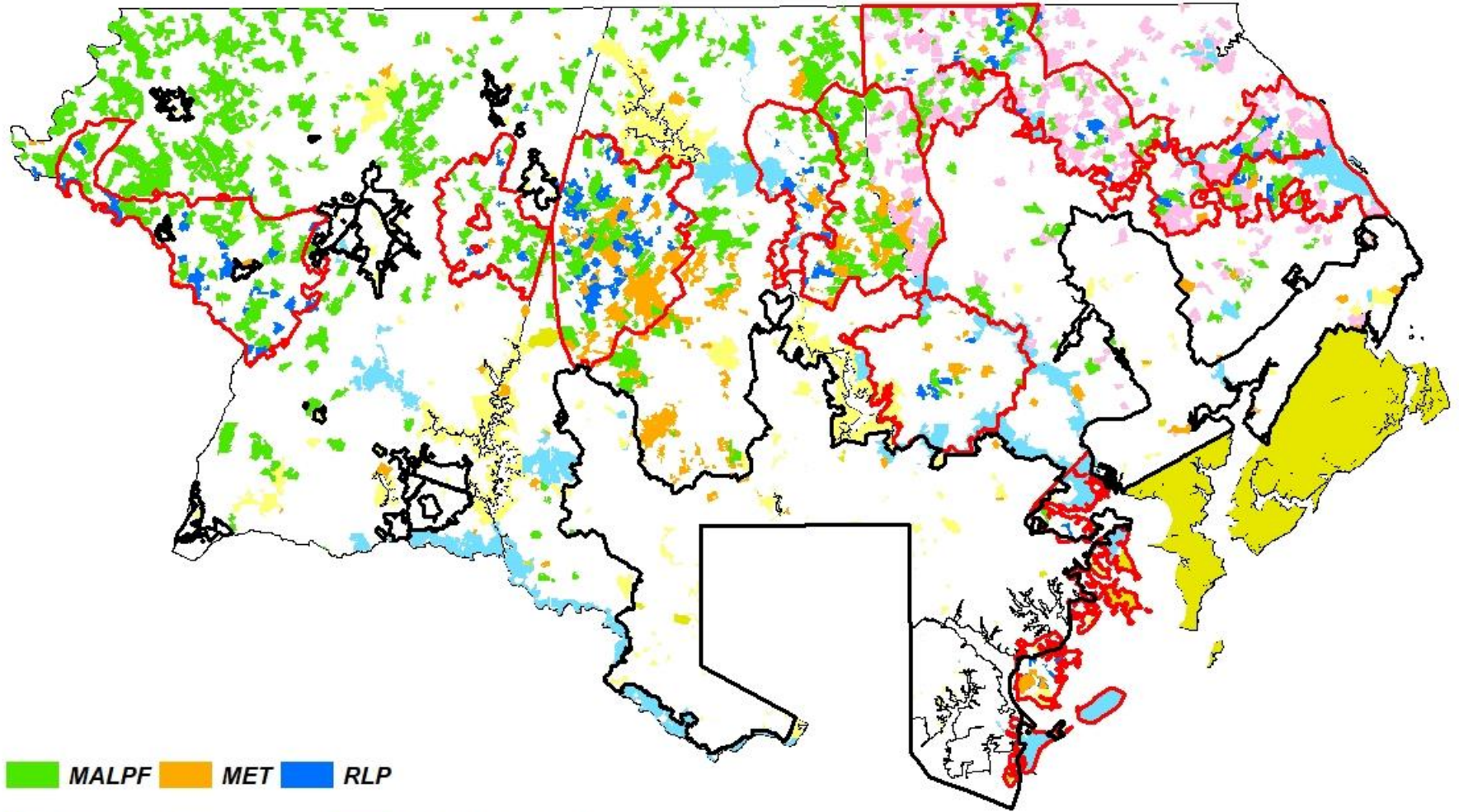
- **Before FCA policy**
  - Loss in forest cover across the range of existing forest cover
  - Prior studies often implicitly assume residential development creates a complete loss in forest cover
- **After FCA policy**
  - Overall 22% increase in forest cover on residential subdivisions relative to the amount without the FCA policy
  - Parcels with 0-60% existing forest cover have increase in forest cover
  - Most intact habitat have continued forest fragmentation (parcels with 80-100% not affected by FCA policy)
- **Opportunities for synergy between FCA and land preservation programs**
  - Target funds from easement programs (or in lieu fees) to protect high priority forested areas with intact habitat



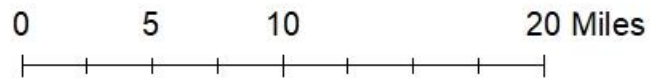
## **Future directions:**

**Modeling interactions for residential  
development and conservation programs**

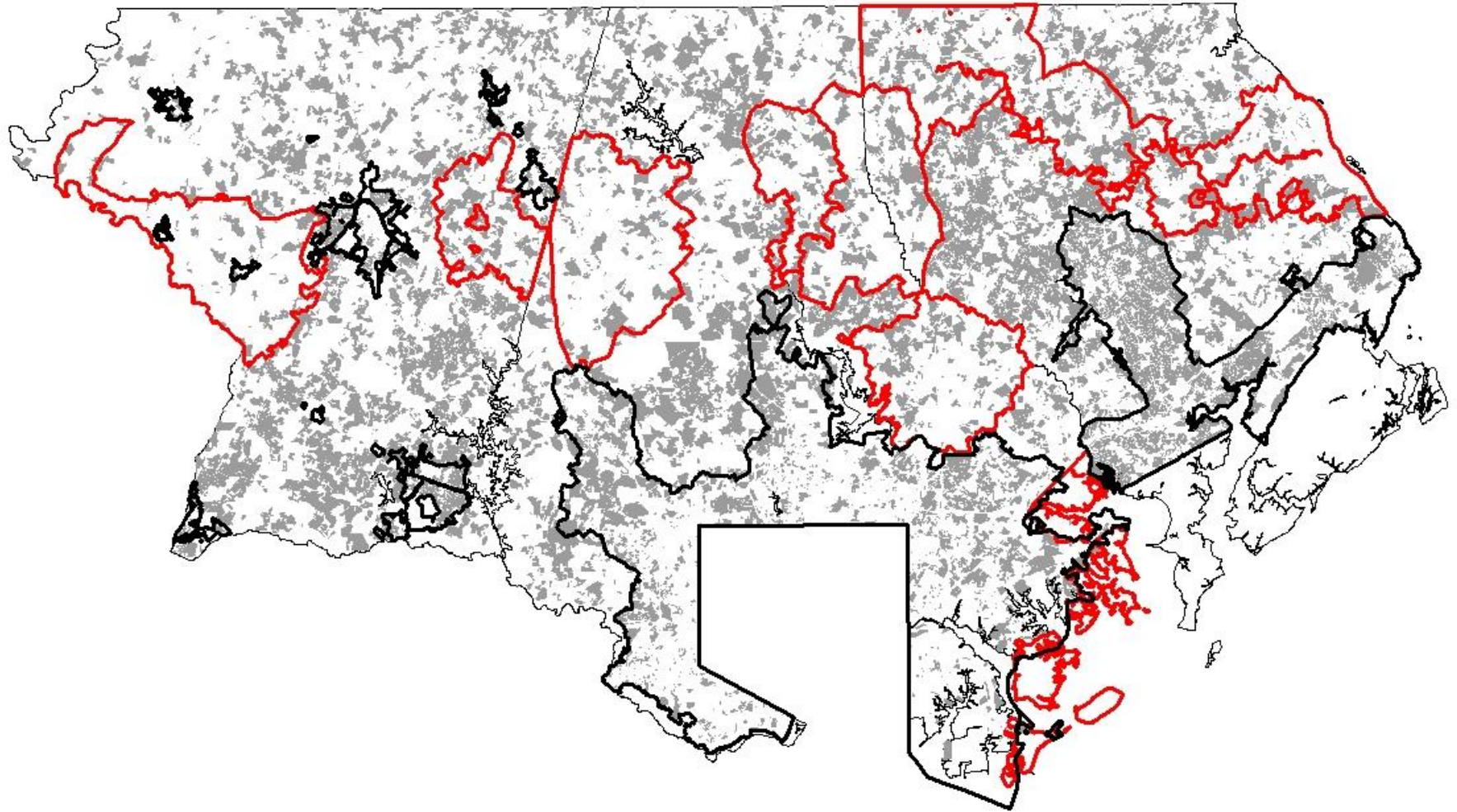
# Land conservation programs







- MALPF
- MET
- RLP
- County Lands
- DNR State Lands
- Harford County PDR
- Federal Lands
- Rural Legacy Areas Boundary
- Sewer Boundary
- County Boundary




# Residential subdivisions in 1960-2007



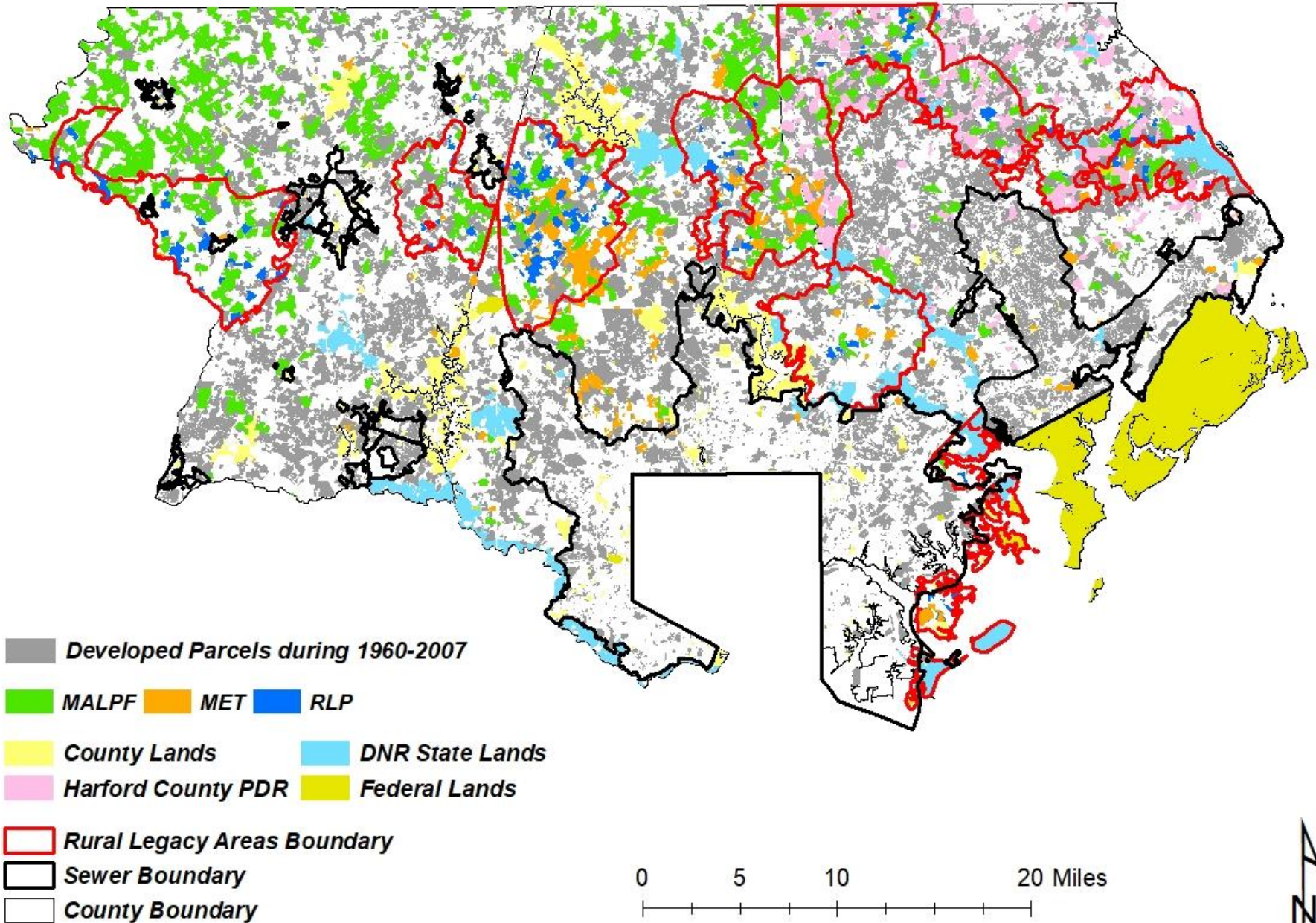
-  *Developed Parcels during 1960-2007*
-  *Rural Legacy Areas Boundary*
-  *Sewer Boundary*
-  *County Boundary*

0 5 10 20 Miles





# Interactions for conservation and development



**Thank you!**

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