Anatomy of a Cartographic Surrogate: the Portrayal of Complex Electoral Boundaries in the *Congressional District Atlas*

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Compiled and published by the Bureau of the Census, the *Congressional District Atlas* describes the boundaries of the nation's 435 congressional districts. Since its inception in 1960, the atlas has grown in length from 103 to 1,272 pages. The most noteworthy increase, between the 1987 and 1993 editions, reflects judicial pressure to equalize district population within a state as well as Department of Justice efforts to maximize the number of minority-majority districts. Single-district states like Delaware and Wyoming still consume a single printed page, and because county boundaries are documented elsewhere, a single-page map is usually adequate for states in which district boundaries do not split counties. By contrast, non-traditional borders winding through multiple counties require numerous large-scale maps efficiently formatted as telescopically nested insets. In the most recent edition, published in two volumes in 1993, Florida and Texas individually account for more pages than the entire first edition, and North Carolina's 12th district, which the Supreme Court ridiculed in *Shaw v. Reno*, stretches across 30 separate pages. Because of this parsimonious portrayal of boundaries, the atlas affords a convenient state-level descriptor of geographic complexity: the ratio of map pages to seats in the House of Representatives. Cartographic and statistical analysis of this index reveals a concentration of complex boundaries in the Southeast and other areas in which the Voting Rights Act mandates preclearance by the Justice Department. Not surprisingly, the index is a near-perfect predictor of judicial challenges to race-based redistricting.

INTRODUCTION

Temporal series of maps warrant the attention of historical geographers, historians of cartography, social historians, and historians of science and technology. Well-known examples include town plans (Reps 1965), fire-insurance atlases (Ristow 1968), and county atlases sold by subscription (Conzen 1984). For the historical geographer, these artifacts provide authored views, if not exact geometries, of past landscapes (Black 1997; Harley 1972). For cartographic scholars these same sources hold insights to nineteenth-century commercial cartography (Ristow 1985). Equally valuable are temporal series of topographic quadrangle maps, which afford detailed snapshots of streets, boundaries, terrain, and place names as well as raw data for examining the evolution and impact of federal-state cartographic cost sharing and improved land-survey technology (Monmonier 1985). At smaller scales, federal maps of weather, land cover, and hazard zones reflect evolving scientific understanding as well as increasing awareness of government's role in environmental protection and growth management (Monmonier 1997). Because the volume of carto-

graphic activity can be a meaningful surrogate for a geographic phenomenon, scholars might usefully compile time-series counts for relevant maps.

This paper views the Census Bureau's *Congressional District Atlas* (U.S. Bureau of the Census 1960–95) as a cartographic surrogate for the complexity of electoral boundaries. (A *cartographic surrogate* may be defined as a map or atlas that in its presence, size, number, or level of detail serves as a significant indicator of the existence or pervasiveness of a social, political, economic, or biophysical phenomenon.) As a complement to special census tabulations for congressional districts, the atlas provides an official, standardized description of the nation's 435 congressional districts and their boundaries. The Bureau of the Census published the first atlas in 1960, before Supreme Court decisions in *Baker v. Carr*, other landmark redistricting cases, and the Voting Rights Act of 1965 led to radical new approaches to spatially structuring the nation's voting districts. Subsequent editions of the atlas captured the impacts of the court's one-person-one-vote doctrine of the 1960s, the expanded minority voting rights initiatives of the 1980s and early 1990s, and the court's more recent retreat from geographically complex districts crafted to elect more African Americans and Hispanics to the House of Representatives. Because these evolving one-person-one-vote districts would have been difficult to construct and draw several decades earlier, the atlas also reflects the effect on redistricting of spatially more refined (block-level) data and high-interaction geographic information systems.

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CONTRASTS AND TIME LINES

Three and a half decades have witnessed an extraordinary evolution in the atlas's size and level of detail. The first edition, issued in June 1960 for the 86th Congress, contained a mere 99 pages of maps, plus a short preface and table of contents. Each of the fifty states, even those with only one representative, merited at least one page. A single county-unit map was sufficient for most other states as well: split counties were comparatively rare before *Baker v. Carr*, and most congressional district boundaries typically followed county lines. Noteworthy exceptions include California, with additional map pages for Los Angeles, Oakland, San Diego, and San Francisco; Massachusetts, with separate pages for Boston, Fall River, Lynn, and Somerville complementing a four-page town-level statewide treatment; and New York, with a one-page statewide map and nine pages covering the state's larger cities and urban counties. Thirteen other states with large urban centers required multiple maps: Connecticut, Illinois, Louisiana, Maryland, Michigan, Minnesota, Missouri, New Hampshire, New Jersey, Ohio, Pennsylvania, Rhode Island, and Washington.

By contrast, the twelfth edition, published in 1993 for the 103rd Congress (1993–95), is a mammoth two-volume set with 1,272 pages, most with at least one map. As in the 1960 version, states with a single House member warrant only one page, whereas all other states require at least one page each for a statewide map, a map key, and lists of counties and selected municipalities included wholly or partly within each district. In addition, one or more inset maps provide detailed descriptions of district boundaries at the subcounty level. Treatments of states with more than one representative range in size from 4 pages for Rhode Island and West Virginia to 189 pages for Texas. Additional pages portray the District of Columbia, American Samoa, Guam, and the Virgin Islands, which have nonvoting delegates in the House of Representatives, and Puerto Rico, which has a nonvoting "resident commissioner."

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The preface of the 1960 edition noted that redistricting based on the new census would soon alter many of the boundaries shown. "When the majority of these changes have been accomplished," an anonymous author

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wrote, "a revised edition of this atlas may be published" (p. iii). Use of "may" seems deliberate: that the atlas had become a regular Census Bureau publication was not apparent until the 1968 edition, for the 91st Congress, described itself as "the fourth in this series" and applied the label "edition" to the three previous versions (p. 2). In addition to the two-volume 1993 edition, the Bureau of the Census issued packets of supplementary maps covering states with boundaries changed for the 104th (1995–97) and 105th (1997–99) Congresses. And in late 1998 the Bureau published an electronic, compact disk version covering all states for the 105th Congress; maps are formatted like those in the 1993 edition, and users can view PDF files on the screen as well as print the entire atlas or individual pages.

"The 1966 edition, 25 percent larger than its immediate predecessor, heralded a period of expansion that saw the atlas double in size by the end of the decade."

As the upper part of Figure 1 illustrates, the atlas grew in spurts, with new editions two to six years apart. The 1964 edition, which reflects boundary adjustments in response to the 1960 census, was not much larger than the earlier version. The 1966 edition, 25 percent larger than its immediate predecessor, heralded a period of expansion that saw the atlas double in size by the end of the decade. Another major increase is apparent in the 1973 edition, which was 65 percent larger than its 1970, pre-reapportionment counterpart. A third spurt, starting in 1983, reflects substantial and steady growth during the late 1980s. Even so, none of the pre-1990 revisions is as revolutionary as the two-volume atlas published in 1993.

Equally revealing are the publication dates: the Census Bureau issued a new atlas or supplement for every Congress between the 89th (1965–67) and the 95th (1977–79) Congresses as well as for the 98th (1983–85)

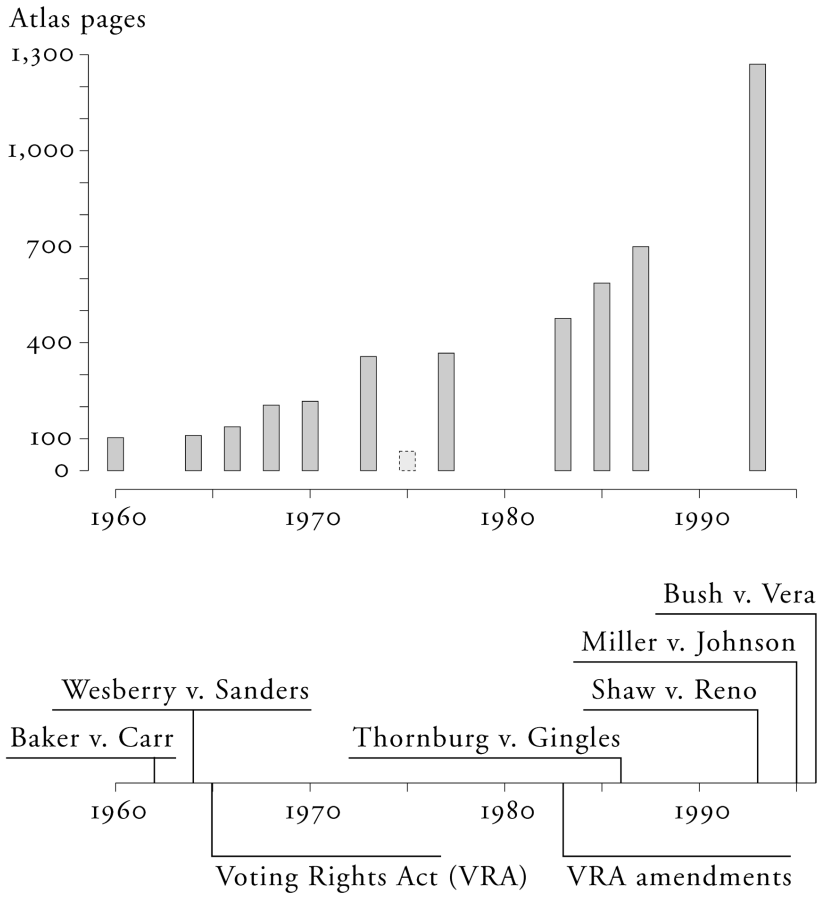

Figure 1. Temporal trend in the size of the twelve editions of the Congressional District Atlas *reflects significant legislation and Supreme Court decisions on redistricting. The 1975 edition was a supplement, with maps for only three states.*

through the 100th (1987–89) Congress. What's apparent is a steadily growing need for cartographic detail from the mid 1960s through the mid 1970s as well as during the mid 1980s.

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Students of American constitutional history will recognize the pattern immediately. In normal times, the Census Bureau would issue a new edition of the atlas in a year ending in three (e.g., 1973, 1983, 1993), to document changes resulting from the most recent decennial census, and a revised edition or supplement two years later, to reflect a few court-ordered adjustments as well as new districts for Maine, which redraws its boundaries two years later than other states (Benenson 1993). The time line in the lower part of Figure 1 helps explain several obvious exceptions to this scenario. Starting in 1962 with *Baker v. Carr*, a case involving state legislative districts in Tennessee, the federal courts began to impose increasingly strict population equality on voting districts (Dixon 1969). In 1964, in *Wesberry v. Sanders*, the high court extended the one-person-one-vote doctrine to congressional districts. Several states had been adjusting district boundaries only when they gained or lost a seat, and many others tolerated wide disparities in population (Hacker 1963; Silva 1965). As a result, rural areas with shrinking populations were over-represented relative to cities and their suburbs. States that refused to honor the equal-population principle risked having their boundaries remapped by a special master appointed by a panel of federal judges (Musgrove 1977, pp. 56–59). To comply, redistricting officials often had to split counties, which forced the compilers of the *Congressional District Atlas* to add inset maps and extra pages. Additional editions of the atlas in the late 1960s and very early 1970s reflect the courts' unwillingness to wait for the next census or accept inadequate remedial revisions.

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Equally consequential is the Voting Rights Act, passed in 1965 and extended several times (Grofman and Davidson 1992). One provision of the law requires states with a history of racial discrimination to have their redistricting plans approved by the Department of Justice. As amended in 1982, the act's "preclearance" provision authorizes Justice officials to reject any plan that dilutes minority voting strength, regardless of intent. In 1986, in *Thornburg v. Gingles*, the Supreme Court ruled that the Justice Department must also consider whether members of a minority group are sufficiently numerous and clustered within an area to form a voting district in which the group is dominant. During the Bush and Clinton administrations the Department interpreted this to mean that states should maximize the number of districts in which a minority is the majority population (Issacharoff 1996). The impact of the *Gingles* decision was not widely apparent until the post-1990 remap, for which several states devised highly irregular districts, which critics (e.g., Thernstrom 1991) dubbed "racial gerrymanders." Their intricate boundaries, drawn with the aid of block-level census data and geographic information systems, required additional map pages, which greatly increased the size of the 1993 atlas. As the congressional district map excerpt in Figure 2 illustrates, a boundary that winds in and out, to exclude or capture blocks with voters of a particular race or ethnicity, demands a large-scale map if all streets are to be named.

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Arguing that appearances can be harmful, the Supreme Court subsequently sounded a retreat from remedial racial redistricting (Hammond 1997). In 1993, in *Shaw v. Reno*, the court ruled by a 5 to 4 vote that a highly contorted congressional district in North Carolina might be unconstitutional and sent the case back to a lower court; eventually North Carolina adopted a new map with more regular boundaries. In 1995, in *Miller v. Johnson*, the high court overturned a Black-majority district in Georgia, and in 1996, in *Bush v. Vera*, the justices struck down three minority districts in Texas. Ordered to draw more compact districts in which race is

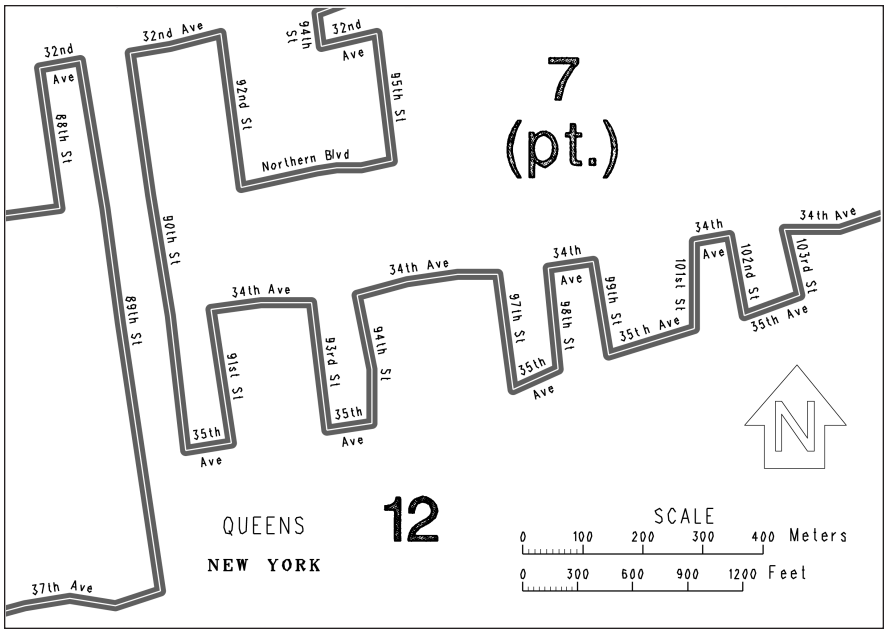

Figure 2. The sinuous boundary of New York's 12th Congressional District, crafted in 1992 to provide a second Hispanic-majority district, demands large-scale treatment. Excerpt from U.S. Bureau of the Census. 1993. Congressional District Atlas: 103rd Congress of the United States. *Washington: Government Printing Office, p. NEW YORK-47.*

not the predominant factor, several states adopted less irregular boundaries requiring fewer atlas pages. The unbound atlas supplement for the 105th Congress illustrates how increased compactness reduced Georgia's redistricting plan from 35 to 8 map pages and cut the Texas treatment from 177 to 96 map pages. Court orders or judicial threats account for equally substantial cartographic cut-backs for Florida, Louisiana, and North Carolina.

SINUOUS BORDERS AND A HIERARCHY OF INSETS

Although the temporal pattern of page counts appears to reflect the deteriorating compactness of congressional districts, the utility of the *Congressional District Atlas* as a cartographic surrogate hinges on several fundamental questions: Is a page in the 1960 atlas comparable to a page in the 1993 atlas? Are the pages comparable across the entire set of twelve editions? Does a page in the recent atlas contain, on average, at least as much information as a page in earlier editions? However the basic question is phrased, the answers are yes—fundamentally, uniformly and conservatively, yes.

Because of both subtle and radical changes in the atlas's design and layout, the answers are also complicated. Although the pages of all editions and supplements are approximately letter size (8.5 by 11 inches), it would be inaccurate to imply that a page is a page is a page. Since 1968, the atlas has included tables listing counties and selected places contained wholly or partly within each district. In the 1993 edition, the Census Bureau left some pages blank so that each state's section begins on a right-hand page. And immediately after the statewide map for each state requiring county or inset maps, the 1993 edition and its supplements include a separate page explaining the maps' symbols and noting the date their boundaries became official. But because the atlases do not mix maps with tables and standardized explanations, it was easy to compile the refined counts of map pages used later in this paper to explore spatial patterns.

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Compared to their most recent counterpart, the early atlases have a slightly cobbled-together look of a product largely compiled from other Census Bureau publications. As Figure 3 illustrates for the 1960 atlas,

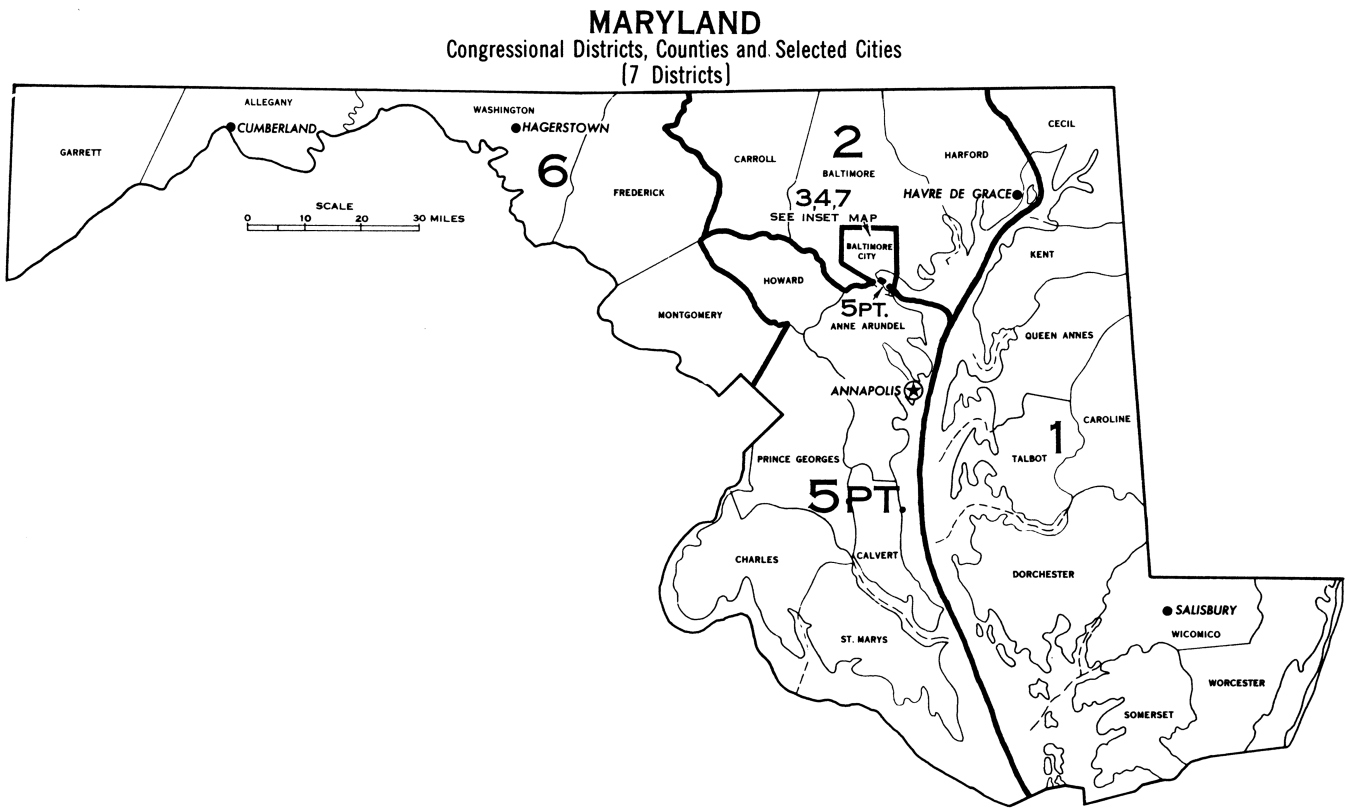

Figure 3. Statewide map of Maryland reflects enhancements of existing basemaps. But note the reference to the inset map in Figure 4. Excerpt from U.S. Bureau of the Census. 1960. Congressional District Atlas of the United States, April 1, 1960. *Washington: Government Printing Office, p. 28.*

the atlas's authors appear merely to have added thicker boundaries and district numbers to existing county-unit base maps. Notable exceptions are the detailed maps describing district boundaries that subdivide cities and metropolitan counties. Figure 4, a portion of the map for Baltimore City, illustrates the custom-lettered treatment of boundaries not available at the same scale in other Census Bureau publications.

Inset maps with a custom-tailored geographic scope are comparatively new. Although the first edition employed progressive, hierarchical enlargement—in western New York State, for example, intricate district boundaries required separate maps for Erie County as well as the county's largest city, Buffalo—before 1993 Census Bureau staff delineated insets principally to preserve political units rather than to highlight complex portions of a boundary. Because focused rectangular inset maps like the example in Figure 5 use space more efficiently than cartographic enlargements of political units or large portions thereof, the map pages of later editions of the atlas are, on average, richer and more relevantly informative than their earlier counterparts. But because the neatlines of insets follow cardinal directions, the efficient portrayal of a diagonal boundary occasionally requires a step-like succession of insets like those in Figure 6.

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Some boundaries require nested insets—essentially insets within insets—which are a key element in the system of whole-county, partial-county, and subcounty inset maps introduced in the 1993 atlas. A diagram (Appendix A) in the introduction describes two nested sequences of progressively larger-scale views: one moving from the state map to a whole-county inset to a subcounty inset, and the other from a partial-county inset to a subcounty inset (labeled Inset A) to a still larger-scale inset (labeled

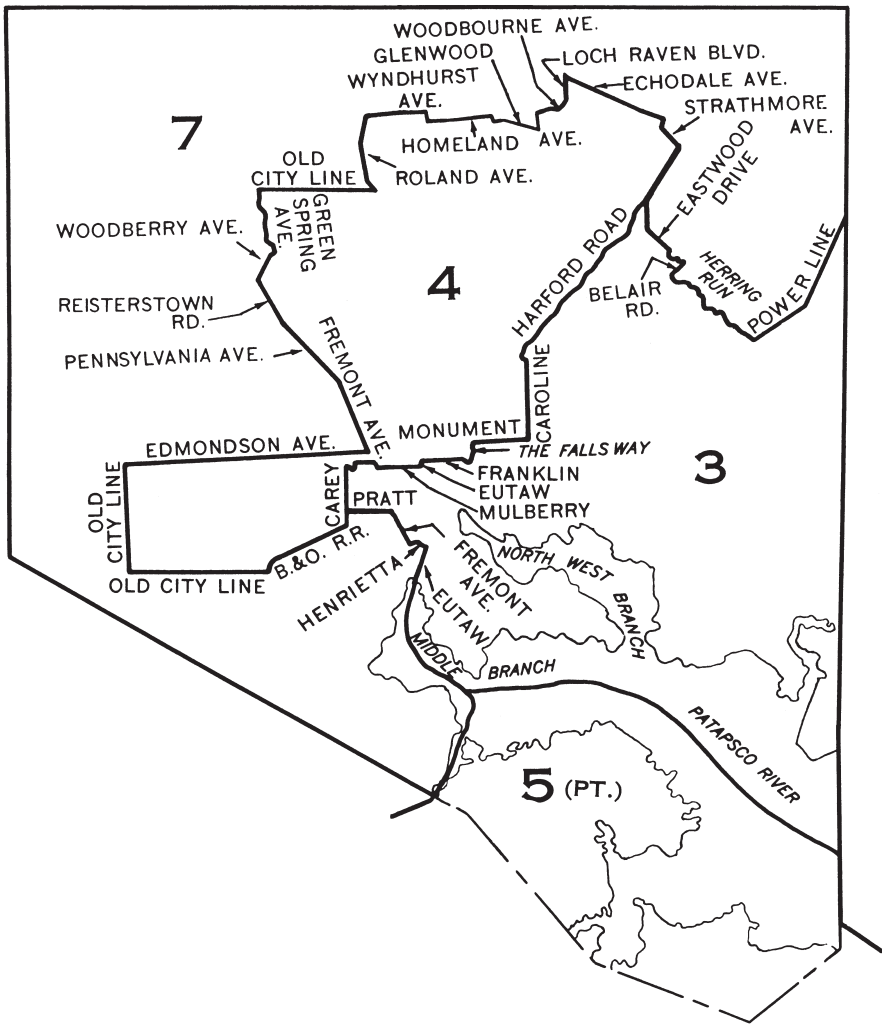

Figure 4. Divided among four districts, Baltimore City required a detailed inset map. From U.S. Bureau of the Census. 1960. Congressional District Atlas of the United States, April 1, 1960. *Washington: Government Printing Office, p. 29.*

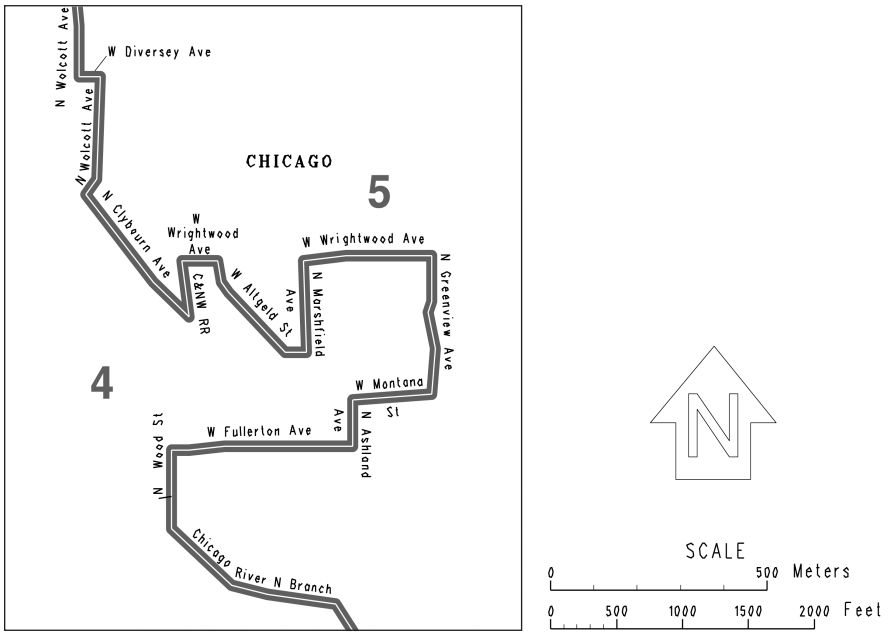

Figure 5. A rectangular inset customized to fit part of a district boundary. From U.S. Bureau of the Census. 1993. Congressional District Atlas: 103rd Congress of the United States. *Washington: Government Printing Office, p. ILLINOIS-18.*

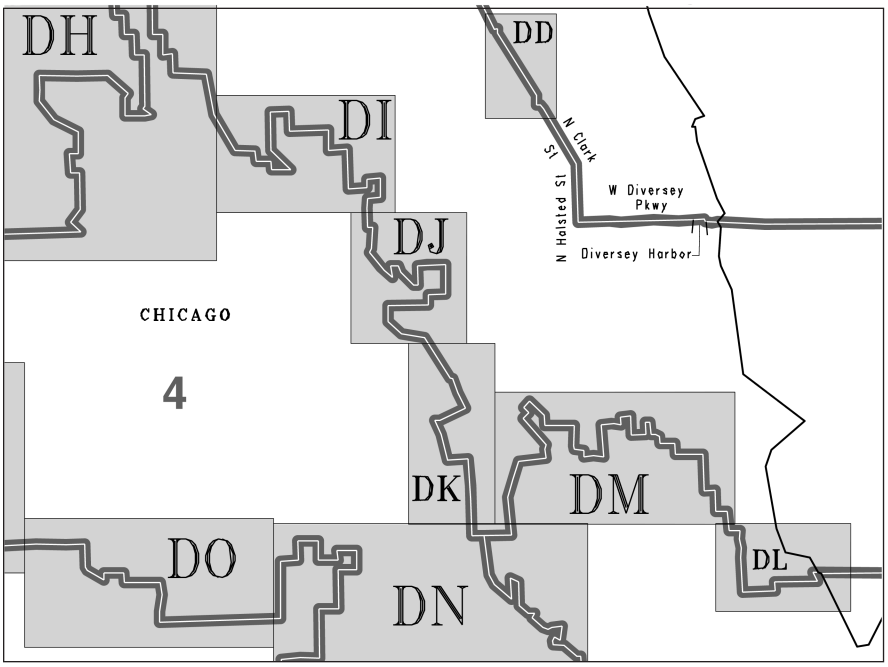

Figure 6. Because insets are bounded by meridians and parallels, an intricate boundary trending northeast or northwest might require a succession of insets, like those identified on the inset map for Cook County, Illinois. Excerpt from U.S. Bureau of the Census. 1993. Congressional District Atlas: 103rd Congress of the United States*. Washington: Government Printing Office, p. ILLINOIS-13.*

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Inset AA). Counties are organized alphabetically, with each county map followed on successive pages by its insets. A light-gray shading indicates areas covered by a more detailed view, and each inset's scale and geographic scope reflects the complexity, overall shape, and extent of the boundaries shown. Without this hierarchy of "telescoping" insets, an atlas of only 1,272 pages could not begin to cope with the intricate, *Gingles*-inspired, GIS-facilitated boundaries of post-1990 redistricting.

A CONFEDERACY OF SCRUNCHES

Because a time-series graph of page counts reflects judicial, statutory, and administrative pressures on congressional redistricting, a logical next step is to search for meaningful geographic patterns by mapping the data at the state level. Two adjustments are needed: restricting the counts to map pages and dividing by the number of House members.

As the 1983 and 1993 maps in Figure 7 demonstrate, the resulting ratio of map pages to representatives shows little significant variation until the post-1990 remap, when the effects of remedial racial gerrymanders are readily apparent. (Similar maps for other, earlier editions of the atlas were equally less informative.) Most noteworthy are the high ratios on the 1993 map for Texas, Louisiana, Georgia, North Carolina, and New York, all of which had their redistricting plans overturned by the Supreme Court because of noncompact, racially motivated districts (Elving 1997; Hicks 1997). Indeed, North Carolina's District 12, denounced as "bizarre" by Justice Sandra Day O'Connor, who wrote the majority opinion in *Shaw v. Reno*, stretches across 30 separate map pages. High rates are also apparent for Florida, which chose not to fight a lower court challenge to its redistricting plan (Gruenwald 1996); Illinois, which successfully defended a remedial racial remap drawn up by a panel of federal judges but endorsed by the state legislature (Elving 1997); and South Carolina, which drew up a Black-majority district to appease the Justice Department's Voting Rights Section and fended off a

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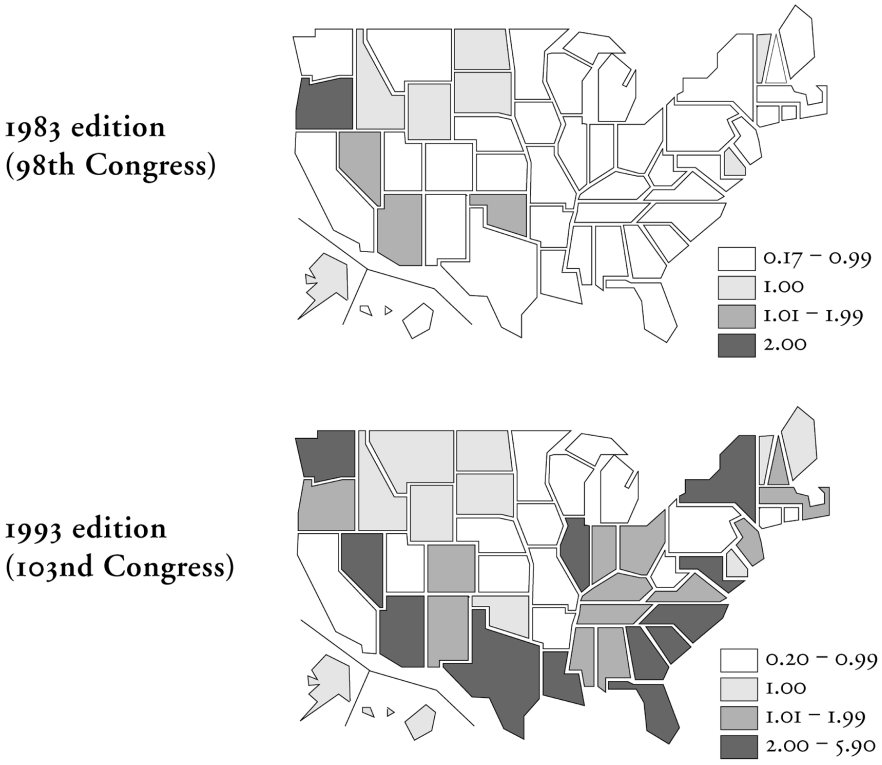

Figure 7. Ratio of map pages to House members, mapped for the 1983 and 1993 atlases.

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challenge by plaintiffs who dropped their suit when the state admitted race had been the predominant factor (Greenblatt 1997). By contrast, the map's highest category omits Virginia, which the high court told to revise its remedial racial plan (Whitley 1998), and Alabama, which had its plan challenged by Black plaintiffs who wanted a second district as well as White plaintiffs who didn't want any (Greenblatt 1997; Kaplan and Duncan 1993). Overall, the 1993 map of the pages-members ratio shows generally high rates for all states requiring statewide preclearance (Figure 8). The notable exception is Alaska, which has only one representative.

MEASURED COMPACTNESS, CORRELATED IRREGULARITY

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Although the relationship between complex, contorted boundaries and the ratio of map pages to representatives is logical as well as apparent, numerical measurements of compactness afford a further test of the atlas's value as a cartographic surrogate. I found the necessary data in the *Michigan Law Review*, in a 1993 article by Richard Pildes and Richard Niemi titled "Expressive harms, 'bizarre districts,' and voting rights: evaluating election district appearances after *Shaw v. Reno*." How unusual was the North Carolina district recently struck down by the Supreme Court? these authors asked. And what other districts might be similarly bizarre? To address these questions, they arranged for Election Data Services, a private consulting firm that advises legislatures and other clients interested in redistricting issues, to compute two shape indexes for each congressional district for the post-1980 and post-1990 remaps. The *dispersion score*, computed by dividing the area of a district by the area of the smallest circumscribed circle, distinguishes long, thin shapes from full, compact shapes. By contrast, the *perimeter score*, computed by dividing the area of a district by the area of a circle with a circumference equal to the district's perimeter, measures the efficiency of a district's boundary. Both measures

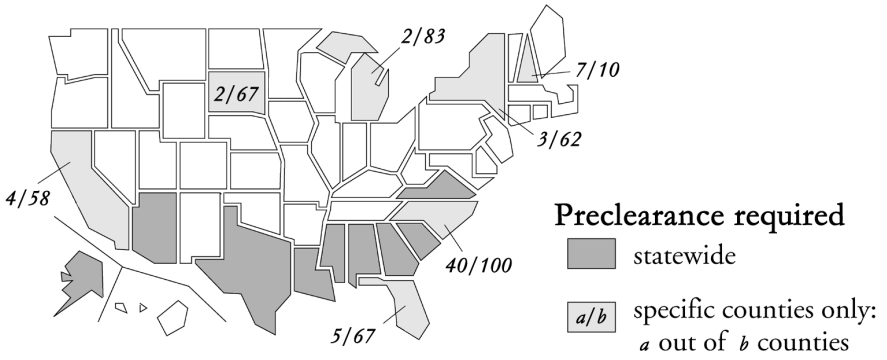

Figure 8. Map showing states requiring Department of Justice preclearance for their 1993 redistricting plans. Some states needed statewide preclearance whereas others needed approval only for a fraction of their counties with a history of discriminatory voting practices.

range downward from 1.0 for a perfectly compact, spherical district and approach 0.0 (in theory at least) for a maximally irregular district. For states with more than one district, a table lists the state means and the state minima and maxima for both indexes (Pildes and Niemi 1993, pp. 571–573). Not surprisingly, the nationwide means and minima for both indexes are lower for the 1990s than for the 1980s.

More revealing is the emergence of noteworthy correlations in the 1990s between the atlas and the state-level shape measures. As Table 1 indicates,

	Map pages / House members ratio	
	1980s	1990s
Dispersion score		
mean	0.02	–0.44
minimum	–0.07	–0.45
Perimeter score		
mean	0.03	–0.59
minimum	0.01	–0.63

Table 1. Product-moment correlations between map-pages ratio and state-level shape indexes. Based partly on measurements reported by Pildes and Niemi (1993), the correlations ignore the seven states with only one representative in the 1990s.

". . . the shape measures and the page counts are complementary, not redundant."

the ratio of map pages to House members for the 1983 atlas was largely unrelated to the shape indexes for the corresponding post-1980 congressional districts. In contrast, the correlations for the 1993 atlas and post-1990 district boundaries are not only noticeably higher but appropriately negative, indicating lower compactness scores for states with higher pages-members ratios. Even so, the correlations are modest at best. Indeed, the –0.63 linear correlation indicates that the ratio and the minimum perimeter score account for only 40 percent of each other's variance. And because the shape indexes are intercorrelated, a multiple regression (not shown) revealed that the four shape variables collectively account for no more than 43 percent of the variation in the pages-members ratio. Clearly, the shape measures and the page counts are complementary, not redundant.

Which, then, is most revealing: the shape indexes or the map pages-House members ratio? I would argue that the pages-members ratio is more useful because the numerical indexes make no distinction between a discretionary boundary set by a legislature or special master and an

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unavoidably irregular boundary fixed by a shoreline, a state boundary, or an international border. By contrast, the *Congressional District Atlas* invokes large-scale inset maps only for boundaries within the purview of redistricting officials. Although the dispersion and perimeter scores treat all edges as equal, no matter who created them or for what reason, readers who want detailed views of non-discretionary boundaries like the Mississippi River or the North Carolina coast must look elsewhere.

CONCLUSIONS

Changes in the design and content of the *Congressional District Atlas* are revealing in several ways: as a reflection of recent changes in the legal and political process of redistricting, as an indirect consequence of the electronic cartographic technology (block-level data, interactive GIS software) that made remedial racial gerrymandering easy, and as an example of a government agency's creatively parsimonious response to an escalatingly complex phenomenon. Continued publication of the atlas confirms the need for paper maps, at least for now, and the Census Bureau's apparent reluctance to deviate from a north-up view—other then by turning maps sideways on the page—reflects the cultural conservatism of an apparent consumer preference as well as an embedded producer practice.

That the atlas is a mirror rather than the object of controversy within the larger society ought not diminish its significance to historians of cartography, who need to probe the map's deeper connections to societal and political processes. The human impact of the atlas per se may be slight, but its contents and evolution demonstrate the pervasive role of mapping in census enumeration, redistricting, and racial politics, not to mention the embeddedness of single-member voting districts and winner-take-all elections in the American schema of territory-based representative democracy. In offering a precise, forensically detailed picture of the power of maps, the *Congressional District Atlas* has few rivals.

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How the atlas responds to the next round of redistricting will be revealing. If state legislatures, the Department of Justice, and the federal courts back away from racially-motivated redistricting, the 2003 edition should be smaller—unless, of course, political cartographers seize the courts' fixation on racially-motivated remapping as an invitation for extensive race-neutral partisan gerrymandering. Whatever the outcome, the atlas's role as cartographic surrogate seems secure. Indeed, litigants hungry for evidence and propaganda will readily realize that page counts are as convincing as the shape indexes used to attack several post-1990 redistricting plans. And because the atlas's format might continue to evolve, look for digital products yielding revealing counts measured in kilobytes rather than map pages.

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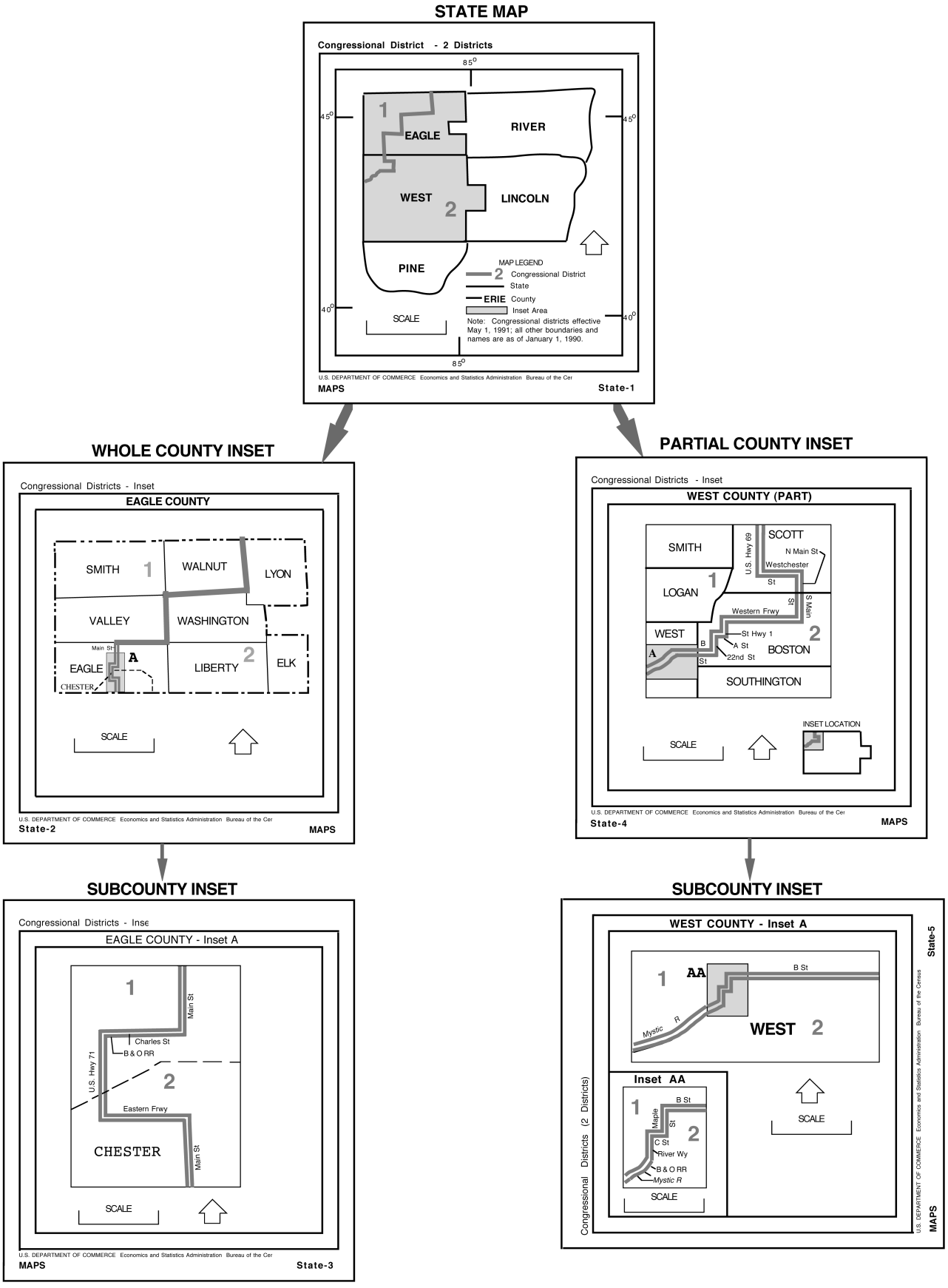
APPENDIX A


STATE MAP
Congressional District - 2 Districts
85°
45°
40°
1
EAGLE
RIVER
WEST
2
LINCOLN
PINE
MAP LEGEND
2 Congressional District
State
ERIE County
Inset Area
Note: Congressional districts effective May 1, 1991; all other boundaries and names are as of January 1, 1990.
SCALE
U.S. DEPARTMENT OF COMMERCE Economics and Statistics Administration Bureau of the Cer
MAPS
State-1
WHOLE COUNTY INSET
Congressional Districts - Inset
EAGLE COUNTY
SMITH
1
WALNUT
LYON
VALLEY
WASHINGTON
Main St
A
EAGLE
CHESTER
LIBERTY
2
ELK
SCALE
U.S. DEPARTMENT OF COMMERCE Economics and Statistics Administration Bureau of the Cer
State-2
MAPS
PARTIAL COUNTY INSET
Congressional Districts - Inset
WEST COUNTY (PART)
SMITH
SCOTT
N Main St
U.S. Hwy 69
Westchester
St
LOGAN
1
S Main
St
Western Frwy
WEST
St Hwy 1
2
B
A St
A
22nd St
BOSTON
St
SOUTHINGTON
INSET LOCATION
SCALE
U.S. DEPARTMENT OF COMMERCE Economics and Statistics Administration Bureau of the Cer
State-4
MAPS
SUBCOUNTY INSET
Congressional Districts - Inse
EAGLE COUNTY - Inset A
1
Main St
Charles St
B & O RR
U.S. Hwy 71
2
Eastern Frwy
CHESTER
Main St
SCALE
U.S. DEPARTMENT OF COMMERCE Economics and Statistics Administration Bureau of the Cer
MAPS
State-3
SUBCOUNTY INSET
WEST COUNTY - Inset A
1
AA
B St
Mystic R
WEST
2
Inset AA
1
B St
Maple St
2
C St
River Wy
B & O RR
Mystic R
SCALE
SCALE
Congressional Districts (2 Districts)
U.S. DEPARTMENT OF COMMERCE Economics and Statistics Administration Bureau of the Census
State-5
MAPS