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U.S. DISTRICT COURT
N.D. OF ALABAMA

IN THE UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF ALABAMA
SOUTHERN DIVISION

BOBBY SINGLETON, *et al.*,	)	
	)	
Plaintiffs,	)	
	)	
v.	)	Case No. 2:21-cv-01291-AMM
	)	
JOHN MERRILL, in his official capacity as Alabama Secretary of State,	)	THREE-JUDGE COURT
	)	
	)	
Defendant.	)	

SECRETARY OF STATE'S NOTICE OF FILING SUPPLEMENTAL EXPERT REPORTS

Defendants give notice of filing the attached supplemental expert reports of Thomas Bryan and M.V. Hood, III.

Respectfully submitted,

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CERTIFICATE OF SERVICE

I certify that on December 21, 2021, I electronically filed the foregoing notice with the Clerk of the Court using the CM/ECF system, which will send notice to all counsel of record.

s/ James W. Davis
Counsel for Secretary Merrill

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N.D. OF ALABAMA

My name is Thomas Bryan[1]. I am a professional demographer and political redistricting expert witness. I have been retained by the State of Alabama to provide analysis and support in the case of *Milligan v. Merrill* and *Caster v. Merrill*.[2] A copy of my CV was attached to earlier reports, and my earlier reports addressed my qualifications and compensation.

I am over 18 years of age and I have personal knowledge of the facts stated herein.

In this supplemental report, I provide:

1) An analysis of plans presented by plaintiff experts Mr. Bill Cooper and Dr. Moon Duchin;
2) A summary and interpretation of traditional redistricting principles;
3) A discussion and analysis of the census and DOJ definitions of "Black" population and a summary of demographic characteristics of the Duchin and Cooper Plans.
4) An analysis and evaluation of the Duchin and Cooper plans, including a:
   A. core retention analysis (CRA)
   B. incumbency; and
   C. compactness analysis.
5) Appendices
   1. Alabama Census 2020 Total and Black Population
   2. Alabama Census 2020 Total and Black Voting Age Population
   3. Demographic Statistics
   4. Core Retention Analysis; and
   5. Compactness Measures and Statistics

1) An Analysis of Dr. Duchin and Mr. Bill Cooper Plans

This report is submitted as a supplemental report in *Milligan v. Merrill* and *Caster v. Merrill*. Plaintiffs in both cases allege that Section 2 of the Voting Rights Act requires Alabama to draw two majority-black districts (the Milligan Plaintiffs also assert claims of racial gerrymandering and intentional gerrymandering). The *Milligan* plaintiffs present a plan in their complaint ("the Hatcher plan") that significantly changes the representational landscape of the state and deviates far from a "least change" approach. Plaintiffs submitted, among other experts, the reports of Dr. Moon Duchin and Mr. Bill Cooper who present various demonstrative plans, each of which has a structure similar to the Hatcher plan. Dr. Duchin and Mr. Cooper have testified in numerous cases about redistricting and are known to me.

[1] https://www.linkedin.com/in/thomas-bryan-424a6912/

[2] https://redistricting.lls.edu/case/milligan-v-merrill/ and https://redistricting.lls.edu/case/caster-v-merrill/

Based on my knowledge and experience as a demographer, I conclude, among other points presented in this report, that the four alternate plans submitted by Dr. Moon Duchin and the six alternate plans submitted by Bill Mr. Cooper generally have similar features and performance as the Hatcher plan submitted as part of *Milligan v. Merrill*.

In Dr. Duchin's report, she contends,

> "it is readily possible to create two majority-Black Congressional districts in Alabama today," and that such districts "can be drawn without sacrificing traditional districting principles like population balance, contiguity, respect for political subdivisions like counties, cities, and towns, or the compactness of the districts, and with heightened respect for communities of interest."[3]

My analysis of the four Dr. Duchin plans was based only on four GIS "shapefiles" outlining each district, and four block equivalency, or assignment files. I am able to perform an assessment of core retention and compactness of Dr. Duchin's districts, but only by making assumptions and small corrections to the plans I received since there were blocks that were not assigned to districts in a way that would make them contiguous. The consequences are some slight differences in core retention and deviations being greater than one person. Dr. Duchin's four plans do appear to attempt to create two Black majority-minority districts. The answer to whether she actually did so is: it depends. In Dr. Duchin's Plan A, two districts Black total population and two districts Black VAP are majority-minority Black alone – one only very slightly. Plan A is the only plan with two Black VAP alone majority districts. In Dr. Duchin's Plan B, two districts total population are Black alone majority and two districts Black VAP are *minority* Black alone – but majority Black alone or in combination. In Dr. Duchin's Plan C and D, two districts Black total population and only one districts Black VAP are majority Black alone – but all four are majority Black alone or in combination.

In Bill Cooper's report, he states:

> "Based on the 2020 Census, it is still possible to draw two majority-Black congressional districts, while adhering to traditional redistricting principles."[4]

My analysis of the six Mr. Cooper plans began with five GIS "shapefiles" outlining his districts. I did not receive a shapefile outlining District 5. I received six block equivalency, or assignment files to complement the five outline shapefiles With the District 5 block assignments I was able to successfully create my own District 5 outline to analyze. As with Dr. Duchin's plans – whether his assertion that "it is still possible to draw two majority-Black congressional districts" is true depends. All of Mr. Cooper's plans have two districts whose Black total population is a majority

[3] Duchin Milligan report 12-10-21 FINAL Page 2.

[4] 2021-12-10 - Caster - Bill Cooper Initial Report Page 20, paragraph 46

Black alone. As with Dr. Duchin's plans – the outcome is different for Black VAP. In Districts 1, 2 and 6 Mr. Cooper presents one Black alone majority and two Black alone or in combination majority districts. In Districts 3, 4 and 5 there are no Black alone VAP majority districts. Those districts only realize their majority status if you include Black alone or in combination. In his report, Mr. Cooper's states that, "all six illustrative plans comply with traditional redistricting principles, including population equality, compactness, contiguity, respect for communities of interest, and the non-dilution of minority voting strength."[5] I will investigate this assertion in detail.

As I show visually in Map Appendix 5 to Map Appendix 8 for Dr. Duchin and Map Appendix 9 to Map Appendix 14 for Mr. Cooper – each of the ten plans try various approaches dividing the southwestern corner of Alabama, reconfiguring Districts 1 and 2 around Mobile and rearranging various intersections of Districts 6 and 7 around Birmingham. Like the Hatcher plan addressed in my earlier report, the plans presented by Cooper and Duchin break up a strong community of interest in Mobile, Baldwin, and surrounding counties. In so doing, each plan runs afoul of traditional redistricting principles. Compared to Alabama's enacted plan, compactness is sacrificed and continuity of representation is severely compromised (and differentially moreso for Alabama's Blacks) as I will show in my core retention analysis and incumbency analysis. As such, they suffer the same faults as the alternate plan proposed in *Milligan v. Merrill.* Notwithstanding the fact that most of these plans submitted are not actually majority-Black VAP in terms of using single-race Black (also known as Black alone) statistics.

[5] 2021-12-10 - Caster - Bill Cooper Initial Report Page 20, paragraph 46

2) Traditional Redistricting Principles

In addition to standards set out by the U.S Constitution and the Voting Rights Act, states may adopt their own redistricting criteria, or principles, for drawing the plans. Those criteria appear in state constitutions or statutes, or may be adopted by a legislature, chamber, or committee, or by a court that is called upon to draw a plan when the legislative process fails. The Congressional Research Service explains[6]:

> "Many of the "rules" or criteria for drawing congressional boundaries are meant to enhance fairness and minimize the impact of gerrymandering. These rules, standards, or criteria include assuring population equality among districts within the same state; protecting racial and language minorities from vote dilution while at the same time not promoting racial segregation; promoting geographic compactness and contiguity when drawing districts; minimizing the number of split political subdivisions and "communities of interest" within congressional districts; and preserving historical stability in the cores of previous congressional districts."

These traditional districting principles (or criteria) have been adopted by many states:

- *Preservation of communities of interest:* District boundaries should respect geographic areas whose residents have shared interests, such as neighborhoods and historic areas.
- *Continuity of representation.* There is a benefit to continuing the political and geographic stability of districts. This can be measured with:
  - *Preservation of districts ("core retention"):* A redrawn district should include as much of the same residential population as the former district did, as allowed by the minimum population that needs to be rebalanced.
  - Incumbents: Districts should not be drawn to include pairs of incumbents.
- *Compactness*: Districts should be geographically compact and not irregular.
- *Contiguity*: All parts of a district should be connected at some point with the rest of the district. Simply put, contiguity means that a pedestrian could walk from any point within the district to any other point within it without needing to cross the district's boundaries; and finally:
- *Preservation of counties and other political subdivisions*: District boundaries should not cross county, city, or town, boundaries to the extent practicable.

[6] https://crsreports.congress.gov/product/pdf/R/R42831/3

3) Census Race Definitions

In the field of demography, and indeed in redistricting cases, the definition of the population in question is critical. Since the foremost purpose of the census is to generate statistics for the purpose of apportionment and redistricting, it is unclear why here plaintiffs refer to undocumented voting strength statistics rather than census Black Voting Age Population. Before we proceed, we will here try to define and document the true "Black" population of the two Black districts in the plaintiff's alternative plans.

The 2010 Census allowed respondents to self-declare their ethnic and racial identification:

> In order to facilitate enforcement of the Voting Rights Act, the Census Bureau asks each person counted to identify their race and whether they are of Hispanic or Latino origin. Beginning with the 2010 Census (and continuing in 2020) the racial categories available in the Census were: White, Black, American Indian, Asian, Native Hawaiians and other Pacific Islanders, and Some Other Race. Persons of Hispanic or Latino origin might be of any race. Persons were given the opportunity to select more than one race – and that race could be in combination with Hispanic or non-Hispanic origin.[7]

The result is that the Census Bureau reports 263 different population counts for each level of Census geography in the country. A "Black" in Alabama therefore can be Black alone, or perhaps in combination with other races or possibly even also Hispanic. Since 2010, the number and proportions of multi-race populations in the United States has grown markedly.[8] An examination of Demographic Appendix 1 (page 22) "Census 2020 Alabama Black Population Total, non-Hispanic and Hispanic Combinations" reveals numerous new and important findings on who Blacks are in Alabama.

In Appendix 1 the population is reported starting in total, then progressing by row through race alone and race in combination for Alabama's Black population. Column A shows the total population and Column B shows the % of the total population for that group. Column C shows the non-Hispanic population and Column D shows the % of the total population for that group. Column E shows the Hispanic population and Column F shows the % of the total population for that group. Appendix 2 then follows the same format for the Alabama Black Voting Age Population (VAP).

[7] "How to Draw Redistricting Plans That Will Stand Up In Court", National Conference of State Legislators (NCSL), January 22, 2011, p. 17.

[8] Expert's own independent observations.

In Appendix 1 Column A (Total Population) we see that the Black or African American alone population is 1,296,162 – or 25.8% of the population. At the bottom of the table, we see the incremental impact of Black alone or in combination. When all other race combinations are added, the Black population is 1,364,736 – or 27.2% of the population. This represents an additional 68,574 Blacks, or 5.0% of the total Alabama Black population.

In Appendix 2 Column A (Voting Age Population) we see that the Black or African American alone population is 981,723 – or 25.1% of the population. At the bottom of the table, we see the incremental impact of Black alone or in combination. When all other race combinations are added, the Black population is 1,014,372 – or 25.9% of the VAP. This represents an additional 32,649 Blacks, or 3.2% of the Alabama Black VAP.

As I have shown already, precise definitions are important. Whether Dr. Duchin's and Mr. Cooper's districts are in fact majority Black depends expressly on this issue. The "alone" definition is the one most consistently used historically in VRA cases because a) a multi-race classification did not exist prior to 2000; and b) the "alone" definition has been most defensible from a political science / Gingles 2 voting behavior perspective.[9] On September 1, 2021 the DOJ published "Guidance under Section 2 of the Voting Rights Act, 52 U.S.C. 10301, for redistricting and methods of electing government bodies"[10] which states:

> "The Department's initial review will be based upon allocating any response that includes white and one of the five other race categories identified in the response. Thus, the total numbers for "Black/African American," "Asian," "American Indian/Alaska Native," "Native Hawaiian or Other Pacific Islander," and "Some other race" reflect the total of the single-race responses and the multiple responses in which an individual selected a minority race and white race. The Department will then move to the second step in its application of the census data by reviewing the other multiple-race category, which is comprised of all multiple-race responses consisting of more than one minority race. Where there are significant numbers of such responses, the Department will, as required by both the OMB guidance and judicial opinions, allocate these responses on an iterative basis to each of the component single-race categories for analysis."[11]

[9] That is because the typical sources used to conduct a racial polarization analysis treat certain racial sub-groups such as Black + Hispanic as "Other" instead of "Black."

[10] https://www.justice.gov/opa/pr/justice-department-issues-guidance-federal-statutes-regarding-redistricting-and-methods

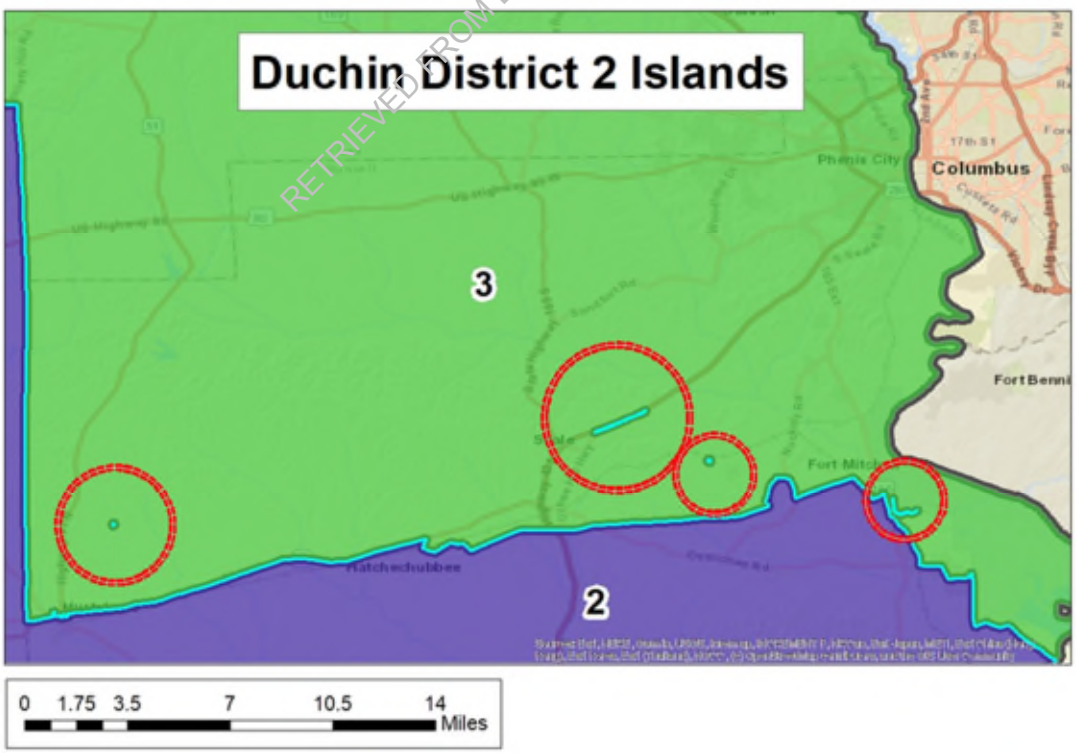
[11] *Georgia v. Ashcroft*, 539 U.S. 461, 473, n.1 (2003).

In order to facilitate analysis that reflects current DOJ guidance, we will include analysis containing both Black alone or in combination (hereafter referred to as the "All Black" definition in this report as appropriate.

Duchin Demographics

The work product I received reflecting Dr. Duchin's work was a series of shapefiles and block correspondence files related to four plans, "A", "B", "C" and "D". I did not receive a report, data dictionary or any technical documentation with which to quality control and assess Dr. Duchin's work. A visual assessment of the shapefiles I was provided uncovered numerous small "islands", that is: geography from one district that is detached and is wholly contained in another district. I identified at least eight such blocks in Plan A, two such blocks in Plan B, eight such blocks in Plan C (that had no population effect) and 20 such blocks in Plan D. Several such instances are shown in Duchin Demographics Figure 1 (below) where several pieces of District 2 are actually in District 3. While these are numerically small relative to the whole number of blocks in Alabama, they result in plans that no longer have minimum deviation. In order to perform my population and other analyses, these blocks needed to be re-assigned to their correct districts. This demographic analysis (and the associated deviations) as well as the subsequent core retention analyses, incumbency and compactness analyses reflect Dr. Duchin's plan with corrections to the misplaced blocks.

Duchin Demographics Figure 1



In Plan A, Dr. Duchin presents two districts with slender majority Black VAP alone populations: D2 at 50.01% and D7 at 50.30% (Duchin Demographic Characteristics Appendices Table 3.2) and a two-person population deviation from 717,753 to 717,755 (Duchin Demographics Figure 2 below and Characteristics Appendices Table 3.1).

Duchin Demographics Figure 2

VAP	18+	18+ WNH	18+ BNH	18+ AllBlack	% Black Alone	% All Black
1	557,494	425,092	76,068	80,825	13.64%	14.50%
2	560,170	237,130	280,126	287,750	50.01%	51.37%
3	558,614	378,616	128,785	133,849	23.05%	23.96%
4	561,369	465,805	43,452	46,618	7.74%	8.30%
5	556,861	398,844	83,246	89,223	14.95%	16.02%
6	560,355	422,468	82,198	86,546	14.67%	15.44%
7	562,303	236,589	282,857	289,561	50.30%	51.50%
Grand Total	3,917,166	2,564,544	976,732	1,014,372	24.93%	25.90%

In Plan B, Dr. Duchin presents two districts with minority Black VAP alone populations: D2 at 49.7% and D7 at 49.1% (Duchin Demographic Characteristics Appendices Table 3.4). In Plan B, District 2 has a Black alone or in combination 51.1% majority and District 7 a has a Black alone or in combination 50.2% majority. Duchin Plan B features a 14-person population deviation from 717,747 to 717,761 (Duchin Demographic Characteristics Appendices Table 3.3) – likely the result of re-assigning misplaced blocks.

In Plan C, Dr. Duchin presents one minority Black VAP alone district: D2 at 48.7% and one majority Black VAP alone district: D7 at 52.3% (Duchin Demographic Characteristics Appendices Table 3.6). In Plan C, District 2 has a Black alone or in combination 50.1% majority and District 7 has a Black alone or in combination 53.5% majority. Duchin Plan C features a 1-person population deviation from 717,754 to 717,755 (Duchin Demographic Characteristics Appendices Table 3.5). There was no impact of misplaced blocks on population deviation in Plan C.

In Plan D, Dr. Duchin presents one minority Black VAP alone district: D2 at 48.7% and one majority Black VAP alone district: D7 at 50.5% (Duchin Demographic Characteristics Appendices Table 3.8). In Plan D, District 2 has a Black alone or in combination 50.1% majority and District 7 a has a Black alone or in combination 53.5% majority. Duchin Plan D features a 23-person population deviation from 717,743 to 717,766 (Duchin Demographic Characteristics Appendices Table 3.7) - likely the result of re-assigning misplaced blocks.

Cooper Demographics

My first order of business was to assess Mr. Cooper's statement that he is able to create two majority Black districts. I address whether he adheres to traditional redistricting criteria separately. My analytic process was to join the illustrative plans equivalency files in my GIS to the 2020 Alabama Census block file, with reported 2020 Census characteristics. I then summarized demographic characteristics for districts 1-7 in each of his six plans. The results of that exercise are shown in my "Cooper Demographic Characteristics Appendix" Tables 3.9 to 3.20.

The population statistics for his Plans 1, 2 and 3 are verified. For Cooper Plan 1, I show in Cooper Demographic Characteristics Table 3.10 that purported Black majority District 2 is 48.7% reported as Black alone, while District 7 is a majority with 52.0% Black alone and 53.3% Black alone or in combination ("All Black"). Plan 1 is a 2-person deviation, from 717,755 to 717,753.

For Cooper Plan 2, I show in Cooper Demographic Characteristics Table 3.12 that purported Black majority District 2 is 49.5% reported as Black alone, while District 7 is a majority with 52.6% Black alone and 53.8% Black alone or in combination ("All Black"). Plan 2 is a 2-person deviation, from 717,755 to 717,753.

For Cooper Plan 3, I show in Cooper Demographic Characteristics Table 3.14 that purported Black majority District 2 is 49.0% reported as Black alone , while District 7 is a Black alone minority at 48.9% and a bare Black majority at 50.09% when measured as Black alone or in combination ("All Black"). Plan 3 is a 3-person deviation, from 717,755 to 717,752.

For Cooper Plan 4, I examined Figure 17 (from Cooper's report - shown below, reporting population and racial characteristics for his Plan 4). He reports the total population by district incorrectly (comparing to Cooper Demographic Characteristics Table 3.15) while he reports the VAP population 18+ correctly (comparing to Cooper Demographic Characteristics Table 3.16). With correct population statistics, Plan 4 is a 2-person deviation, from 717,755 to 717,753.

Figure 17

Illustrative Plan 4 – 2020 Census

District	Population	18+ Pop	% 18+ AP Black	% 18+ NH White
1	717753	557046	17.23%	73.87%
2	717752	561374	50.07%	43.92%
3	717755	564004	25.10%	67.19%
4	717755	556215	6.73%	82.75%
5	717755	561685	18.66%	70.63%
6	717755	554035	12.93%	77.83%
7	717754	562807	50.09%	42.53%

For Cooper Plan 5, I examined Figure 19 (from Cooper's report - shown below, reporting population for his Plan 5). He reports the total population by district total population incorrectly (comparing to Cooper Demographic Appendix Table 3.17) and also the VAP population 18+ incorrectly (comparing to Cooper Demographic Appendix Table 3.18). Inexplicably - while both of his populations are reported incorrectly, his reported %18+ AP Black and % 18+ NH White correctly. With correct population statistics, Plan 5 is a 2-person deviation, from 717,755 to 717,753.

Figure 19

Illustrative Plan 5 – 2020 Census

District	Population	18+ Pop	% 18+ AP Black	% 18+ NH White
1	717754	557535	17.12%	74.18%
2	717755	557677	50.24%	43.20%
3	717754	564281	24.52%	67.49%
4	717754	556133	6.10%	83.50%
5	717754	561187	18.66%	70.63%
6	717754	552286	14.16%	77.64%
7	717754	568067	50.09%	42.02%

For Cooper Plan 6, I examined Figure 21 (from Cooper's report - shown below, reporting population for his Plan 6) shows the total population correctly (comparing to Cooper Map Appendix Table 3.19) but the VAP population 18+ is reported incorrectly (comparing to Cooper Map Appendix Table 3.20). Notably - while his VAP 18+ population is reported incorrectly, his reported %18+ AP Black and % 18+ NH White are reported correctly.

Figure 21

Illustrative Plan 6 – 2020 Census

District	Population	18+ Pop	% 18+ AP Black	% 18+ NH White
1	717753	557535	15.83%	75.27%
2	717755	557677	51.28%	42.36%
3	717753	564281	24.77%	67.22%
4	717754	556133	5.63%	83.83%
5	717755	561187	18.66%	70.63%
6	717755	552286	13.58%	78.31%
7	717754	568067	51.09%	41.08%

Curiously, the VAP 18+ population shown in Cooper's Figure 19 for Plan 5 and Cooper's Figure 21 for Plan 6 are exactly identical – but the % 18+ AP Black and % 18+ NH White in each table are notably different. In summary – none of Cooper's plans actually have two majority-BVAP districts when measured using "Black Alone."

4) Analysis and Evaluation of Plans

Next, I analyze and evaluate the Duchin and Cooper plans using the following traditional redistricting principles:

A. core retention analysis (CRA)
B. incumbency; and
C. compactness.

A. Core Retention Analysis

Having already presented my core retention analysis methodology in my *Milligan v. Merrill* and *Caster v. Merrill* report, I move straight to my CRA here. Three analyses follow:

1) Alabama 2011 v Alabama 2021 enacted
2) Alabama 2011 v Duchin
3) Alabama 2011 v Cooper

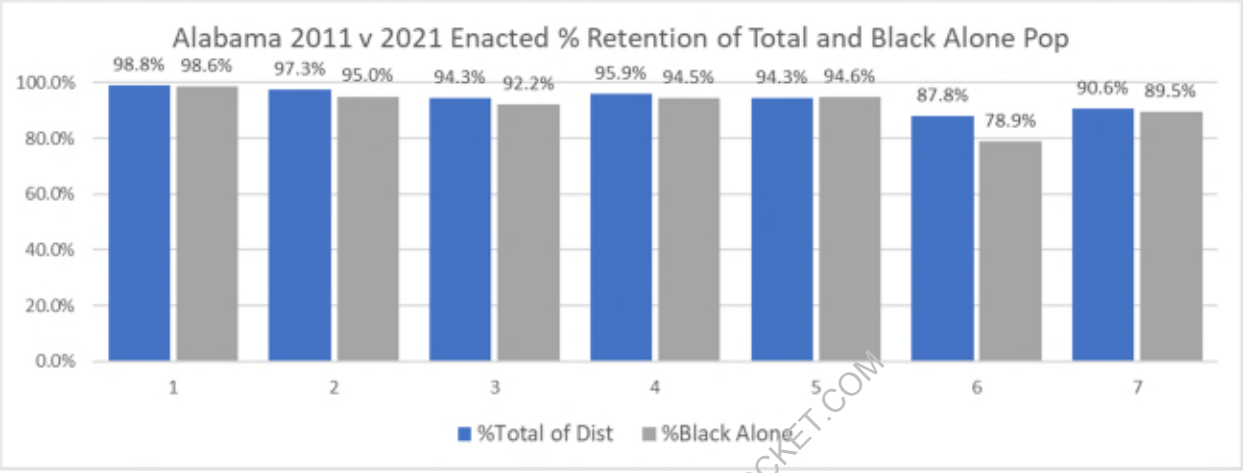
In CRA Figure 1 (Alabama 2011 v Alabama 2021 enacted) below, I show the population who were retained (did not change districts: 4,730,181, or 94.1%) and the number of Black alone who were retained (did not change districts: 1,182,872, or 91.8%). These figures are very high and reflect the outcome of a plan that was created with "least changes".

CRA Figure 1 Alabama 2021 Enacted Plan for Total and Black Alone Population

Alabama Enacted	Total Population	Black Alone Population
Number Retained	4,730,181	1,182,872
Percent Retained	94.1%	91.8%
Number Displaced	294,098	105,287
Grand Total	5,024,279	1,288,159

In Figure 2, it can be seen that core retention of the total population and the Black population by the State of Alabama 2021 enacted plan compared to the 2011 existing Alabama plan is significant, consistent and comparable, which should have been expected given the least change approach of the 2021 plan.

Core Retention Figure 2 Total and Black Population: 2011 Existing v 2021 Enacted Plans



I refer here to Duchin Core Retention Analyses Appendix, CRA Figures 1-8. The first of each pair of figures compares core retention of the total population (in blue) against core retention of the Black alone population (in grey) for the plan. The second of each pair of figures compares core retention of the Black alone population from the enacted Alabama plan (in grey) with the core retention of the Black alone population from the Duchin plan. Across each of the charts, two themes prevail. First – by comparing the core retention of the Duchin plans with the core retention of the enacted Alabama plan (above) – the total core retention of the Alabama plan is higher (often significantly) than all of the districts in all of the Duchin plans. Second, comparing the core retention of the Black alone population specifically – the core retention of Alabama's enacted plan is significantly higher than the Duchin plans. In comparing to total retention of the Alabama Plan with the Duchin plans in Figures 3-6 below, the Alabama Plan performs substantially better.

Core Retention Figure 3: Duchin Plan A

Duchin A	Total Population	Black Alone Population
Number Retained	2,933,247	812,954
Percent Retained	58.4%	63.1%
Number Displaced	2,091,032	475,205
Grand Total	5,024,279	1,288,159

Core Retention Figure 4: Duchin Plan B

Duchin B	Total Population	Black Alone Population
Number Retained	2,653,587	722,913
Percent Retained	52.8%	56.1%
Number Displaced	2,370,692	565,246
Grand Total	5,024,279	1,288,159

Core Retention Figure 5: Duchin Plan C

Duchin C	Total Population	Black Alone Population
Number Retained	2,627,546	735,536
Percent Retained	52.3%	57.1%
Number Displaced	2,396,733	552,623
Grand Total	5,024,279	1,288,159

Core Retention Figure 6: Duchin Plan D

Duchin D	Total Population	Black Alone Population
Number Retained	2,934,915	810,768
Percent Retained	58.4%	62.9%
Number Displaced	2,089,364	477,391
Grand Total	5,024,279	1,288,159

Next I refer to the Cooper Core Retention Analyses Appendix, CRA Figures 9-20. First – by comparing the core retention of the Cooper plans with the core retention of the enacted Alabama plan (above) – the total core retention of the Alabama plan is again higher than all of the districts in all of the Cooper plans. Second, comparing the core retention of the Black alone population specifically – the core retention of Alabama's enacted plan is again significantly higher than the Cooper plans. In comparing the total retention of the Alabama Plan with the Cooper plans in Figures 7-12 below, the Alabama Plan again performs substantially better.

Core Retention Figure 7: Cooper Plan 1

Cooper 1	Total Population	Black Alone Population
Number Retained	2,816,220	704,968
Percent Retained	56.1%	54.7%
Number Displaced	2,208,059	583,191
Grand Total	5,024,279	1,288,159

Core Retention Figure 8: Cooper Plan 2

Cooper 2	Total Population	Black Alone Population
Number Retained	3,345,670	839,589
Percent Retained	66.6%	65.2%
Number Displaced	1,678,609	448,570
Grand Total	5,024,279	1,288,159

Core Retention Figure 9: Cooper Plan 3

Cooper 3	Total Population	Black Alone Population
Number Retained	3,088,005	760,612
Percent Retained	61.5%	59.0%
Number Displaced	1,936,274	527,547
Grand Total	5,024,279	1,288,159

Core Retention Figure 10: Cooper Plan 4

Cooper 4	Total Population	Black Alone Population
Number Retained	3,481,340	866,040
Percent Retained	69.3%	67.2%
Number Displaced	1,542,939	422,119
Grand Total	5,024,279	1,288,159

Core Retention Figure 11: Cooper Plan 5

Cooper 5	Total Population	Black Alone Population
Number Retained	3,239,080	793,146
Percent Retained	64.5%	61.6%
Number Displaced	1,785,199	495,013
Grand Total	5,024,279	1,288,159

Core Retention Figure 12: Cooper Plan 6

Cooper 6	Total Population	Black Alone Population
Number Retained	3,038,598	738,170
Percent Retained	60.5%	57.3%
Number Displaced	1,985,681	549,989
Grand Total	5,024,279	1,288,159

Clearly, the State of Alabama's newly enacted 2021 plan registers consistently and significantly higher levels of core retention for both total and Black population than the Duchin or Cooper plans. This superior record for the State's Plan reflects the advantage of a least change approach: simply adjusting existing boundaries where necessary, instead of completely redrawing all districts, as plaintiffs did. Overall, the differences in core retention shows the significant incremental loss of the continuity of representation borne disproportionally by Alabama's Black population in both Duchin and Cooper's plans.

B. Incumbency Analysis

The current residential address of congressional incumbents were geocoded on 11-14-2021. This file is acknowledged to be highly confidential and will be maintained as such throughout the analysis. Alabama's enacted plan respects incumbents. The Duchin and Cooper plans do not, and pack incumbents as follows:

- Duchin Plan A puts Rep. Sewell, Rep. Palmer and Rep. Rogers in District 6 and Rep. Moore and Rep. Carl in proposed District 1 leaving D2, D3 and D7 unrepresented

- Duchin Plan B puts Rep. Sewell and Rep. Rogers in District 6 and Rep. Moore and Rep. Carl in proposed District 1 leaving D2 and D7 unrepresented

- Duchin Plan C puts Rep. Sewell and Rep. Rogers in District 6 and Rep. Moore and Rep. Carl in proposed District 1 leaving D2 and D7 unrepresented

- Duchin Plan D puts Rep. Palmer and Rogers in District 6 and Rep. Moore and Rep. Carl in proposed District 1 leaving D2 and D3 unrepresented

- Cooper Plan 1, 2, 3, 4 and 6 pairs Rep. Moore and Rep. Carl in proposed District 1 and leaves District 2 unrepresented.

C. Compactness

In Table 1 below we assess the State of Alabama compactness by district, by method. Within each method, the higher the score the better. Using District 5 as an example, it scores highest in Polsby-Popper, Schwartzberg and Convex Hull, but in fact performs the worst in Reock. This table enables us to assess the performance of individual districts across methods. This illustrates exactly why it is beneficial to look at multiple, highly regarded methods when performing compactness analysis. Since the values within each method are similar (but are in fact mathematically different) it is not possible to summarize accurately across plans. In order to compare the Alabama enacted plan with the plaintiff plan, we summarize the compactness scores by method.

In Table 1 we see the existing scores by district, by compactness measure. The scores shaded in green are the "best" in each measure, that is: most compact. The scores shaded in red are the poorest, that is: least compact. Not all districts are ranked the same in each measure, which is why we use multiple measures and examine each individually as well as in aggregate. The last column "Total" is simply a sum of the scores across plans for that district and is designed to provide a final summary ranking of the compactness of each district. The last row "Sum" is simply a sum of the scores for all districts in the plan for that measure. This is calculated to enable a summary comparison of metrics from one plan to another. A higher score in "Sum" means that by that measure, that plan is more compact. For this exercise, we interpret whichever plan has the majority of high scores to be the "more compact" plan. Table 1 is the compactness scores for the existing Alabama 116th congressional plan and serves as a basis for comparison.

Compactness Table 1 Alabama Existing (2011) 116th Plan Compactness Scores

District	Polsby-Popper	Schwartzberg	Reock	Convex_Hull	Total
1	0.16	0.40	0.42	0.71	1.70
2	0.22	0.47	0.49	0.74	1.93
3	0.22	0.47	0.36	0.73	1.79
4	0.18	0.43	0.36	0.62	1.59
5	0.29	0.53	0.22	0.77	1.82
6	0.14	0.37	0.43	0.69	1.63
7	0.13	0.36	0.38	0.62	1.49
Sum	1.34	3.04	2.66	4.90	
Average	0.19	0.43	0.38	0.70	

In Table 2 below the results pass the "eyeball test" that is: you can just look at District 2 and see that it has simple geometry. It has numerous straight segments and is compact in the sense it fits nicely in its circumscribing circle. But some details in the table are not intuitive. The districts with significant lengths of riparian boundaries tend to score poorly (and are hard to see from a statewide map). Smaller river segments have greater sinuosity, thus greater lengths. Districts 1, 4, 6, and 7 have long lengths of river boundaries. District 5 has numerous straight line segments but suffers from being elongated (that is, it fits poorly in a circle).

Compactness Table 2 Alabama 2021 Enacted Plan Compactness Scores

District	Polsby-Popper	Schwartzberg	Reock	Convex_Hull	Total
1	0.20	0.44	0.40	0.71	1.75
2	0.26	0.51	0.50	0.76	2.02
3	0.25	0.50	0.36	0.77	1.88
4	0.19	0.44	0.36	0.61	1.60
5	0.32	0.56	0.30	0.80	1.98
6	0.15	0.39	0.31	0.68	1.55
7	0.19	0.44	0.43	0.68	1.74
Sum	1.55	3.28	2.67	5.01	
Average	0.22	0.47	0.38	0.72	

In Compactness Table 2 (above), we first note that by looking at the "Sum" and "Average" rows at the bottom - compactness scores are higher in each measure than the 2011 congressional plan. Next I look at individual districts. Each method ranks each district differently. Polsby-Popper and Schwartzberg and Convex-Hull ranks D5 as being the best, while Reock ranks D2 highest. In looking at the last column "Total" we see that D2 actually prevails as the most compact district. My interpretation is that the highest ranking districts are comparable, but that D4, D6 and D7 are least compact – due in part to a significant amount of border being waterways at the Bankhead Lake intersection.

In Compactness Table 3 (below), we see the average compactness scores for the 2011 Existing Plan, the 2021 Enacted Plan, Duchin Plans A-D and Cooper Plans 1-6. Outside of Cooper Plan 4, the remaining Cooper Plans all have inferior compactness scores to the Duchin Plans, the 2011 Existing Plan and the 2021 Enacted Plan. Only Cooper Plan 4 has comparable scores to the other plans. Consistent with her direction and commitment to deliver plans with improved compactness scores, Dr. Duchin's Plans A-D almost always show higher compactness scores than the enacted Alabama plan on average. However, I note that in all four of Dr. Duchin's plans, Districts 1 and 2 (one of her purported majority-BVAP districts) were made far less compact. Details of compactness scores by plan and by district are presented in Appendix 5.

Compactness Table 3 Total and Average Compactness Scores by Plan by Method

Plan	Average Compactness Scores					
	Polsby-Popper	Schwartzberg	Reock	Convex_Hull	Total	Average
2011 Existing Plan	0.19	0.43	0.38	0.70	1.71	0.43
2021 Enacted Plan	0.22	0.47	0.38	0.72	1.79	0.45
Duchin Plan A	0.26	0.50	0.39	0.76	1.90	0.48
Duchin Plan B	0.28	0.52	0.38	0.76	1.94	0.48
Duchin Plan C	0.26	0.49	0.35	0.75	1.85	0.46
Duchin Plan D	0.25	0.49	0.41	0.74	1.90	0.47
Cooper Plan 1	0.18	0.42	0.34	0.66	1.60	0.40
Cooper Plan 2	0.18	0.41	0.34	0.65	1.58	0.40
Cooper Plan 3	0.18	0.42	0.34	0.68	1.63	0.41
Cooper Plan 4	0.21	0.46	0.33	0.72	1.72	0.43
Cooper Plan 5	0.18	0.42	0.29	0.67	1.57	0.39
Cooper Plan 6	0.16	0.39	0.30	0.64	1.49	0.37

Conclusion

Based on my knowledge and experience as a demographer, I conclude, among other points presented in this report, that the four alternate plans submitted by Dr. Moon Duchin and the six alternate plans submitted by Bill Mr. Cooper generally have similar features and performance as the Hatcher plan submitted as part of *Milligan v. Merrill.* In my review, I have assessed the demographics of their plans. Each presented plan has either minority Black alone districts where they are represented to be a majority, or extremely slender Black majorities where Blacks are reported alone or in combination. I have assessed the core retention and incumbency impact of their plans – and arrive at the conclusion that each of their proposed plans significantly disrupts the continuity of representation. My analysis of compactness shows that Dr. Duchin's plans perform generally better *on average* than the enacted State of Alabama plans, although some districts are significantly less compact than Alabama's, and significantly better than Bill Cooper's plans. In the hierarchy of redistricting criteria priorities, I assess the benefit of this accomplishment as being more than offset by the significant detrimental impact to the continuity of representation.

DECLARATION

* * * * *

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

/s Thomas Bryan
Thomas Bryan

December 20, 2021
Date

Appendix 1 and Appendix 2

Alabama Census 2020

Total and Black Population and Voting Age Population

Appendix Table 1: Census 2020 Alabama Black Population Total, non-Hispanic and Hispanic Combinations (through 3 races, excluding 4-, 5- and 6-race Black combinations)

Race	Total (A)	% of Total (B)	AL non-Hisp (C)	% of Total (D)	AL Hispanic (E)	% of Total (F)
Total, Hispanic or Latino:	5,024,279		4,760,232		264,047	
Population of one race:	**4,767,326**	**94.89%**	**4,575,614**	**91.07%**	**191,712**	**3.82%**
Black or African American alone	1,296,162	25.80%	1,288,159	25.64%	8,003	0.16%
Population of two races:	**243,473**	**4.85%**	**175,750**	**3.50%**	**67,723**	**1.35%**
White; Black or African American	45,429	0.90%	43,911	0.87%	1,518	0.03%
Black or African American; American Indian and Alaska Native	6,301	0.13%	6,012	0.12%	289	0.01%
Black or African American; Asian	2,049	0.04%	1,939	0.04%	110	0.00%
Black or African American; Native Hawaiian and Other Pacific Islander	492	0.01%	456	0.01%	36	0.00%
Black or African American; Some Other Race	5,421	0.11%	2,983	0.06%	2,438	0.05%
Population of three races:	**12,093**	**0.24%**	**8,085**	**0.16%**	**4,008**	**0.08%**
White; Black or African American; American Indian and Alaska Native	4,493	0.09%	3,986	0.08%	507	0.01%
White; Black or African American; Asian	972	0.02%	899	0.02%	73	0.00%
White; Black or African American; Native Hawaiian and Other Pacific Islander	172	0.00%	165	0.00%	7	0.00%
White; Black or African American; Some Other Race	1,441	0.03%	573	0.01%	868	0.02%
Black or African American; American Indian and Alaska Native; Asian	124	0.00%	115	0.00%	9	0.00%
Black or African American; American Indian and Alaska Native; Native Hawaiian and Other Pacific Islander	13	0.00%	13	0.00%	0	0.00%
Black or African American; American Indian and Alaska Native; Some Other Race	146	0.00%	72	0.00%	74	0.00%
Black or African American; Asian; Native Hawaiian and Other Pacific Islander	145	0.00%	129	0.00%	16	0.00%
Black or African American; Asian; Some Other Race	86	0.00%	43	0.00%	43	0.00%
Black or African American; Native Hawaiian and Other Pacific Islander; Some Other Race	27	0.00%	20	0.00%	7	0.00%
Total "All Black"	1,364,736	27.2%	1,350,192	26.9%	14,544	0.3%

Appendix Table 2: Census 2020 Alabama Black Voting Age Population, non-Hispanic and Hispanic Combinations (through 3 races, excluding 4-, 5- and 6-race Black combinations)

Race	VAP (A)	% of VAP (B)	AL non-Hisp (C)	% of Total (D)	AL Hispanic (E)	% of Total (F)
Total:	3,917,166		3,750,310		166,856	
Population of one race:	3,751,169	95.76%	3,630,366	92.68%	120,803	3.08%
Black or African American alone	981,723	25.06%	976,732	24.93%	4,991	0.13%
Population of two races:	158,371	4.04%	114,790	2.93%	43,581	1.11%
White; Black or African American	18,106	0.46%	17,569	0.45%	537	0.01%
Black or African American; American Indian and Alaska Native	4,692	0.12%	4,530	0.12%	162	0.00%
Black or African American; Asian	1,130	0.03%	1,075	0.03%	55	0.00%
Black or African American; Native Hawaiian and Other Pacific Islander	262	0.01%	250	0.01%	12	0.00%
Black or African American; Some Other Race	3,470	0.09%	2,024	0.05%	1,446	0.04%
Population of three races:	6,741	0.17%	4,620	0.12%	2,121	0.05%
White; Black or African American; American Indian and Alaska Native	2,714	0.07%	2,452	0.06%	262	0.01%
White; Black or African American; Asian	325	0.01%	295	0.01%	30	0.00%
White; Black or African American; Native Hawaiian and Other Pacific Islander	75	0.00%	69	0.00%	6	0.00%
White; Black or African American; Some Other Race	721	0.02%	344	0.01%	377	0.01%
Black or African American; American Indian and Alaska Native; Asian	80	0.00%	73	0.00%	7	0.00%
Black or African American; American Indian and Alaska Native; Native Hawaiian and Other Pacific Islander	12	0.00%	12	0.00%	0	0.00%
Black or African American; American Indian and Alaska Native; Some Other Race	103	0.00%	55	0.00%	48	0.00%
Black or African American; Asian; Native Hawaiian and Other Pacific Islander	82	0.00%	76	0.00%	6	0.00%
Black or African American; Asian; Some Other Race	51	0.00%	31	0.00%	20	0.00%
Black or African American; Native Hawaiian and Other Pacific Islander; Some Other Race	14	0.00%	11	0.00%	3	0.00%
	1,014,372	25.9%	1,006,083	25.7%	8,289	0.2%

Appendix 3

Demographic Statistics

Duchin Demographic Characteristics Appendices

Demo Table 3.1 Duchin A/1 Plan Total Population by District

Total	Total	Total WNH	Total BNH	Total AllBlack	% Black Alone	% All Black
1	717,755	530,359	102,437	113,641	14.27%	15.83%
2	717,753	283,942	371,192	384,289	51.72%	53.54%
3	717,754	470,805	169,766	181,041	23.65%	25.22%
4	717,754	580,258	56,773	65,053	7.91%	9.06%
5	717,753	494,360	107,916	120,513	15.04%	16.79%
6	717,755	529,401	106,570	115,701	14.85%	16.12%
7	717,755	282,226	373,505	384,498	52.04%	53.57%
Grand Total	5,024,279	3,171,351	1,288,159	1,364,736	25.64%	27.16%

Demo Table 3.2 Duchin A/1 Plan Voting Age Population by District

VAP	18+	18+ WNH	18+ BNH	18+ AllBlack	% Black Alone	% All Black
1	557,494	425,092	76,068	80,825	13.64%	14.50%
2	560,170	237,130	280,126	287,750	50.01%	51.37%
3	558,614	378,616	128,785	133,849	23.05%	23.96%
4	561,369	465,805	43,452	46,618	7.74%	8.30%
5	556,861	398,844	83,246	89,223	14.95%	16.02%
6	560,355	422,468	82,198	86,546	14.67%	15.44%
7	562,303	236,589	282,857	289,561	50.30%	51.50%
Grand Total	3,917,166	2,564,544	976,732	1,014,372	24.93%	25.90%

Demo Table 3.3 Duchin B/2 Plan Total Population by District

Total	Total	Total WNH	Total BNH	Total AllBlack	% Black Alone	% All Black
1	717,755	522,208	111,765	123,212	15.57%	17.17%
2	717,747	286,446	368,917	381,685	51.40%	53.18%
3	717,754	475,597	157,033	168,050	21.88%	23.41%
4	717,754	559,661	73,794	83,363	10.28%	11.61%
5	717,754	501,110	106,126	118,450	14.79%	16.50%
6	717,754	538,606	107,002	115,727	14.91%	16.12%
7	717,761	287,723	363,522	374,249	50.65%	52.14%
Grand Total	5,024,279	3,171,351	1,288,159	1,364,736	25.64%	27.16%

Demo Table 3.4 Duchin B/2 Plan Voting Age Population by District

VAP	18+	18+ WNH	18+ BNH	18+ AllBlack	% Black Alone	% All Black
1	557,925	419,553	82,867	87,789	14.85%	15.73%
2	559,639	238,414	278,233	285,757	49.72%	51.06%
3	554,846	379,886	118,640	123,622	21.38%	22.28%
4	561,555	449,925	57,160	60,957	10.18%	10.86%
5	558,269	405,054	81,575	87,433	14.61%	15.66%
6	562,302	431,428	82,111	86,156	14.60%	15.32%
7	562,630	240,284	276,146	282,658	49.08%	50.24%
Grand Total	3,917,166	2,564,544	976,732	1,014,372	24.93%	25.90%

Demo Table 3.5 Duchin C/3 Plan Total Population by District

Total	Total	Total WNH	Total BNH	Total AllBlack	% Black Alone	% All Black
1	717,755	522,208	111,765	123,212	15.57%	17.17%
2	717,754	289,745	360,867	374,504	50.28%	52.18%
3	717,754	495,006	137,977	147,884	19.22%	20.60%
4	717,754	558,619	74,959	84,592	10.44%	11.79%
5	717,754	501,110	106,126	118,450	14.79%	16.50%
6	717,754	537,006	108,396	116,947	15.10%	16.29%
7	717,754	267,657	388,069	399,147	54.07%	55.61%
Grand Total	5,024,279	3,171,351	1,288,159	1,364,736	25.64%	27.16%

Demo Table 3.6 Duchin C/3 Plan Voting Age Population by District

VAP	18+	18+ WNH	18+ BNH	18+ AllBlack	% Black Alone	% All Black
1	557,925	419,553	82,867	87,789	14.85%	15.73%
2	558,296	240,839	271,735	279,466	48.67%	50.06%
3	557,436	395,711	104,994	109,507	18.84%	19.64%
4	560,320	448,121	57,932	61,822	10.34%	11.03%
5	558,269	405,054	81,575	87,433	14.61%	15.66%
6	561,933	429,840	83,191	87,153	14.80%	15.51%
7	562,987	225,426	294,438	301,202	52.30%	53.50%
Grand Total	3,917,166	2,564,544	976,732	1,014,372	24.93%	25.90%

Demo Table 3.7 Duchin D/4 Plan Total Population by District

Total	Total	Total WNH	Total BNH	Total AllBlack	% Black Alone	% All Black
1	717,754	524,074	109,203	120,617	15.21%	16.80%
2	717,743	293,437	361,146	373,996	50.32%	52.11%
3	717,766	470,813	169,769	181,044	23.65%	25.22%
4	717,758	577,451	58,904	67,208	8.21%	9.36%
5	717,754	494,360	107,916	120,514	15.04%	16.79%
6	717,754	530,127	106,528	115,850	14.84%	16.14%
7	717,750	281,089	374,693	385,507	52.20%	53.71%
Grand Total	5,024,279	3,171,351	1,288,159	1,364,736	25.64%	27.16%

Demo Table 3.8 Duchin D/4 Plan Voting Age Population by District

VAP	18+	18+ WNH	18+ BNH	18+ AllBlack	% Black Alone	% All Black
1	557,306	420,597	80,748	85,617	14.49%	15.36%
2	560,550	244,174	273,051	280,531	48.71%	50.05%
3	558,625	378,623	128,788	133,852	23.05%	23.96%
4	561,082	463,597	44,941	48,118	8.01%	8.58%
5	556,862	398,844	83,246	89,224	14.95%	16.02%
6	560,350	423,518	81,688	86,117	14.58%	15.37%
7	562,391	235,191	284,270	290,913	50.55%	51.73%
Grand Total	3,917,166	2,564,544	976,732	1,014,372	24.93%	25.90%

Cooper Demographic Characteristics Appendices

Demo Table 3.9 Cooper Plan 1 Total Population by District

Total	Total	Total WNH	Total BNH	Total AllBlack	% Black Alone	% All Black
1	717,755	519,402	114,500	125,921	15.95%	17.54%
2	717,754	296,502	360,821	374,344	50.27%	52.15%
3	717,753	480,776	159,008	170,200	22.15%	23.71%
4	717,753	578,566	42,278	49,664	5.89%	6.92%
5	717,755	490,094	127,177	140,711	17.72%	19.60%
6	717,754	543,840	97,384	105,638	13.57%	14.72%
7	717,755	262,171	386,991	398,258	53.92%	55.49%
Grand Total	5,024,279	3,171,351	1,288,159	1,364,736	25.64%	27.16%

Demo Table 3.10 Cooper Plan 1 Voting Age Population by District

VAP	18+	18+ WNH	18+ BNH	18+ AllBlack	% Black Alone	% All Black
1	557,084	417,122	84,427	89,315	15.16%	16.03%
2	559,442	246,011	272,494	280,226	48.71%	50.09%
3	563,119	388,487	121,753	126,853	21.62%	22.53%
4	555,541	462,235	32,246	35,033	5.80%	6.31%
5	561,688	396,725	98,352	104,784	17.51%	18.66%
6	556,122	431,641	73,815	77,568	13.27%	13.95%
7	564,170	222,323	293,645	300,593	52.05%	53.28%
Grand Total	3,917,166	2,564,544	976,732	1,014,372	24.93%	25.90%

Demo Table 3.11 Cooper Plan 2 Total Population by District

Total	Total	Total WNH	Total BNH	Total AllBlack	% Black Alone	% All Black
1	717,754	527,338	105,942	117,087	14.76%	16.31%
2	717,754	290,887	366,946	380,668	51.12%	53.04%
3	717,755	484,853	154,728	165,918	21.56%	23.12%
4	717,753	578,557	42,286	49,672	5.89%	6.92%
5	717,755	490,094	127,177	140,711	17.72%	19.60%
6	717,754	539,570	100,519	108,823	14.00%	15.16%
7	717,754	260,052	390,561	401,857	54.41%	55.99%
Grand Total	5,024,279	3,171,351	1,288,159	1,364,736	25.64%	27.16%

Demo Table 3.12 Cooper Plan 2 Voting Age Population by District

VAP	18+	18+ WNH	18+ BNH	18+ AllBlack	% Black Alone	% All Black
1	558,142	423,469	78,495	83,257	14.06%	14.92%
2	558,446	241,724	276,361	284,132	49.49%	50.88%
3	562,845	391,308	118,598	123,667	21.07%	21.97%
4	555,526	462,211	32,251	35,038	5.81%	6.31%
5	561,688	396,725	98,352	104,784	17.51%	18.66%
6	555,856	428,525	75,934	79,736	13.66%	14.34%
7	564,663	220,582	296,741	303,758	52.55%	53.79%
Grand Total	3,917,166	2,564,544	976,732	1,014,372	24.93%	25.90%

Demo Table 3.13 Cooper Plan 3 Total Population by District

Total	Total	Total WNH	Total BNH	Total AllBlack	% Black Alone	% All Black
1	717,753	511,922	123,303	134,814	17.18%	18.78%
2	717,752	294,080	362,654	375,131	50.53%	52.26%
3	717,755	461,692	180,129	192,055	25.10%	26.76%
4	717,755	572,170	48,794	56,846	6.80%	7.92%
5	717,755	490,094	127,177	140,711	17.72%	19.60%
6	717,755	559,769	82,871	90,801	11.55%	12.65%
7	717,754	281,624	363,231	374,378	50.61%	52.16%
Grand Total	5,024,279	3,171,351	1,288,159	1,364,736	25.64%	27.16%

Demo Table 3.14 Cooper Plan 3 Voting Age Population by District

VAP	18+	18+ WNH	18+ BNH	18+ AllBlack	% Black Alone	% All Black
1	557,048	411,457	90,976	95,952	16.3%	17.23%
2	559,299	243,465	273,796	281,155	49.0%	50.27%
3	562,300	373,557	137,843	143,328	24.51%	25.49%
4	559,374	459,861	37,581	40,853	6.72%	7.30%
5	561,688	396,725	98,352	104,784	17.51%	18.66%
6	554,093	442,194	62,690	66,090	11.31%	11.93%
7	563,364	237,285	275,494	282,210	48.90%	50.09%
Grand Total	3,917,166	2,564,544	976,732	1,014,372	24.93%	25.90%

Demo Table 3.15 Cooper Plan 4 Total Population by District

Total	Total	Total WNH	Total BNH	Total AllBlack	% Black Alone	% All Black
1	717,755	511,931	123,302	134,814	17.18%	18.78%
2	717,754	296,302	361,738	374,421	50.40%	52.17%
3	717,755	467,658	177,875	189,506	24.78%	26.40%
4	717,754	574,711	44,983	53,175	6.27%	7.41%
5	717,755	490,094	127,181	140,715	17.72%	19.60%
6	717,753	545,020	90,058	98,264	12.55%	13.69%
7	717,753	285,635	363,022	373,841	50.58%	52.08%
Grand Total	5,024,279	3,171,351	1,288,159	1,364,736	25.64%	27.16%

Demo Table 3.16 Cooper Plan 4 Voting Age Population by District

VAP	18+	18+ WNH	18+ BNH	18+ AllBlack	% Black Alone	% All Black
1	557,046	411,464	90,975	95,952	16.33%	17.23%
2	561,374	246,580	273,612	281,106	48.74%	50.07%
3	564,004	378,979	136,284	141,564	24.16%	25.10%
4	556,215	460,255	34,314	37,427	6.17%	6.73%
5	561,685	396,723	98,356	104,788	17.51%	18.66%
6	554,035	431,203	67,861	71,633	12.25%	12.93%
7	562,807	239,340	275,330	281,902	48.92%	50.09%
Grand Total	3,917,166	2,564,544	976,732	1,014,372	24.93%	25.90%

Demo Table 3.17 Cooper Plan 5 Total Population by District

Total	Total	Total WNH	Total BNH	Total AllBlack	% Black Alone	% All Black
1	717,755	514,622	123,163	134,338	17.16%	18.72%
2	717,753	291,792	361,041	374,068	50.30%	52.12%
3	717,753	469,547	173,095	184,789	24.12%	25.75%
4	717,755	580,984	40,577	47,972	5.65%	6.68%
5	717,755	490,094	127,177	140,711	17.72%	19.60%
6	717,755	543,873	98,673	107,484	13.75%	14.98%
7	717,753	280,439	364,433	375,374	50.77%	52.30%
Grand Total	5,024,279	3,171,351	1,288,159	1,364,736	25.64%	27.16%

Demo Table 3.18 Cooper Plan 5 Voting Age Population by District

VAP	18+	18+ WNH	18+ BNH	18+ AllBlack	% Black Alone	% All Black
1	559,475	415,036	90,860	95,759	16.24%	17.12%
2	557,367	240,759	272,489	280,044	48.89%	50.24%
3	561,513	378,950	132,404	137,702	23.58%	24.52%
4	555,656	463,965	31,100	33,887	5.60%	6.10%
5	561,688	396,725	98,352	104,784	17.51%	18.66%
6	555,380	431,220	74,623	78,632	13.44%	14.16%
7	566,087	237,889	276,904	283,564	48.92%	50.09%
Grand Total	3,917,166	2,564,544	976,732	1,014,372	24.93%	25.90%

Demo Table 3.19 Cooper Plan 6 Total Population by District

Total	Total	Total WNH	Total BNH	Total AllBlack	% Black Alone	% All Black
1	717,753	523,036	112,105	123,620	15.62%	17.22%
2	717,755	284,951	371,006	383,336	51.69%	53.41%
3	717,753	467,450	174,977	186,767	24.38%	26.02%
4	717,754	583,071	37,270	44,637	5.19%	6.22%
5	717,755	490,094	127,181	140,715	17.72%	19.60%
6	717,755	549,028	94,457	103,086	13.16%	14.36%
7	717,754	273,721	371,163	382,575	51.71%	53.30%
Grand Total	5,024,279	3,171,351	1,288,159	1,364,736	25.64%	27.16%

Demo Table 3.20 Cooper Plan 6 Voting Age Population by District

VAP	18+	18+ WNH	18+ BNH	18+ AllBlack	% Black Alone	% All Black
1	556,657	419,023	83,203	88,108	14.95%	15.83%
2	560,712	237,522	280,152	287,511	49.96%	51.28%
3	562,748	378,272	133,985	139,377	23.81%	24.77%
4	555,444	465,620	28,496	31,290	5.13%	5.63%
5	561,685	396,723	98,356	104,788	17.51%	18.66%
6	556,812	436,032	71,672	75,591	12.87%	13.58%
7	563,108	231,352	280,868	287,707	49.88%	51.09%
Grand Total	3,917,166	2,564,544	976,732	1,014,372	24.93%	25.90%

Alabama Demographic Characteristics Appendices

Demo Table 3.21 Alabama Enacted Plan Total Population by District

Total	Total	Total WNH	Total BNH	Total AllBlack	% Black Alone	% All Black
1	717,754	455,278	185,771	196,827	25.9%	27.4%
2	717,755	426,142	216,019	228,648	30.1%	31.9%
3	717,754	473,307	175,783	187,284	24.5%	26.1%
4	717,754	573,666	51,314	59,655	7.1%	8.3%
5	717,754	491,054	123,355	136,782	17.2%	19.1%
6	717,754	491,446	137,209	145,897	19.1%	20.3%
7	717,754	260,458	398,708	409,643	55.5%	57.1%
Grand Total	5,024,279	3,171,351	1,288,159	1,364,736	25.6%	27.2%

Demo Table 3.22 Alabama Enacted Plan Voting Age Population by District

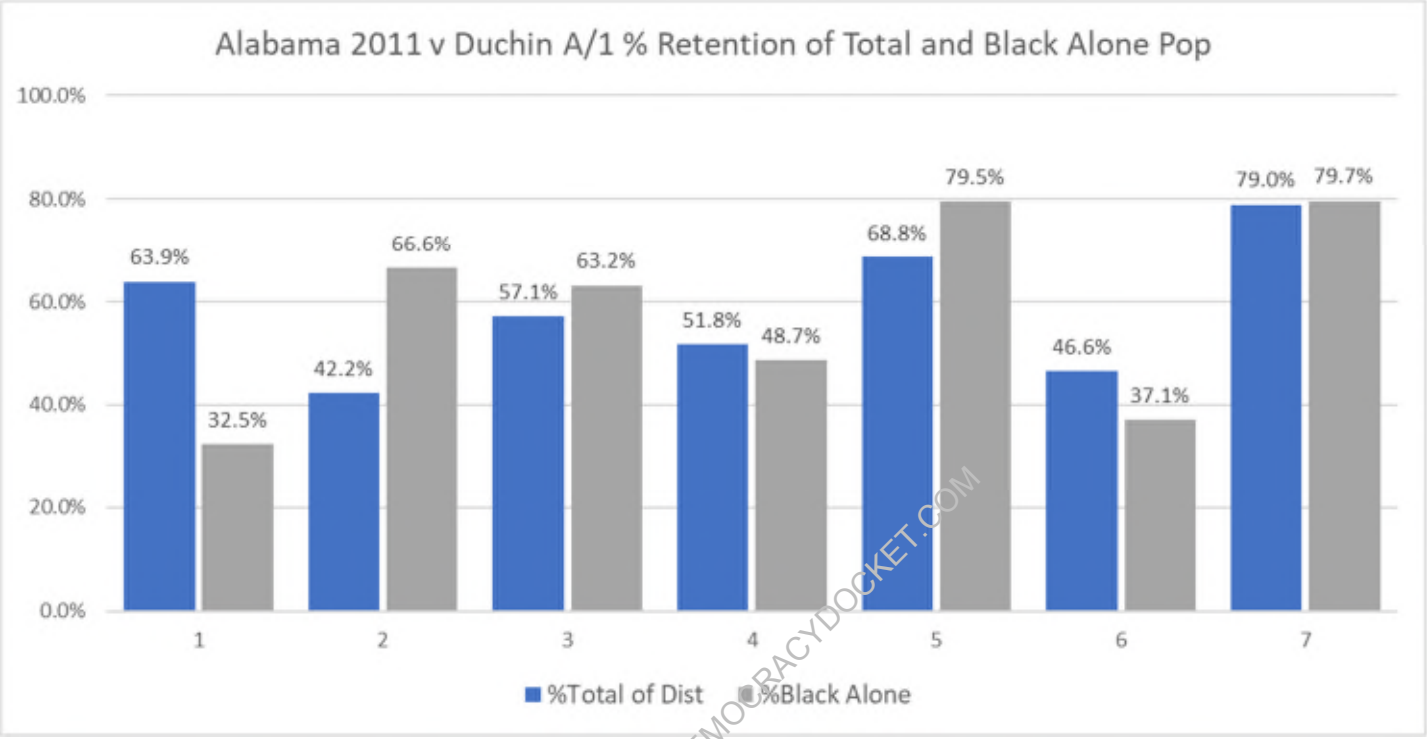
VAP	18+	18+ WNH	18+ BNH	18+ AllBlack	% Black Alone	% All Black
1	557,535	367,960	137,354	142,777	24.6%	25.6%
2	557,677	345,900	161,893	167,971	29.0%	30.1%
3	564,281	382,226	135,659	141,011	24.0%	25.0%
4	556,133	458,324	39,507	42,819	7.1%	7.7%
5	561,187	397,809	95,014	101,339	16.9%	18.1%
6	552,286	393,028	100,385	104,551	18.2%	18.9%
7	568,067	219,297	306,920	313,904	54.0%	55.3%
Grand Total	3,917,166	2,564,544	976,732	1,014,372	24.9%	25.9%

Appendix 4

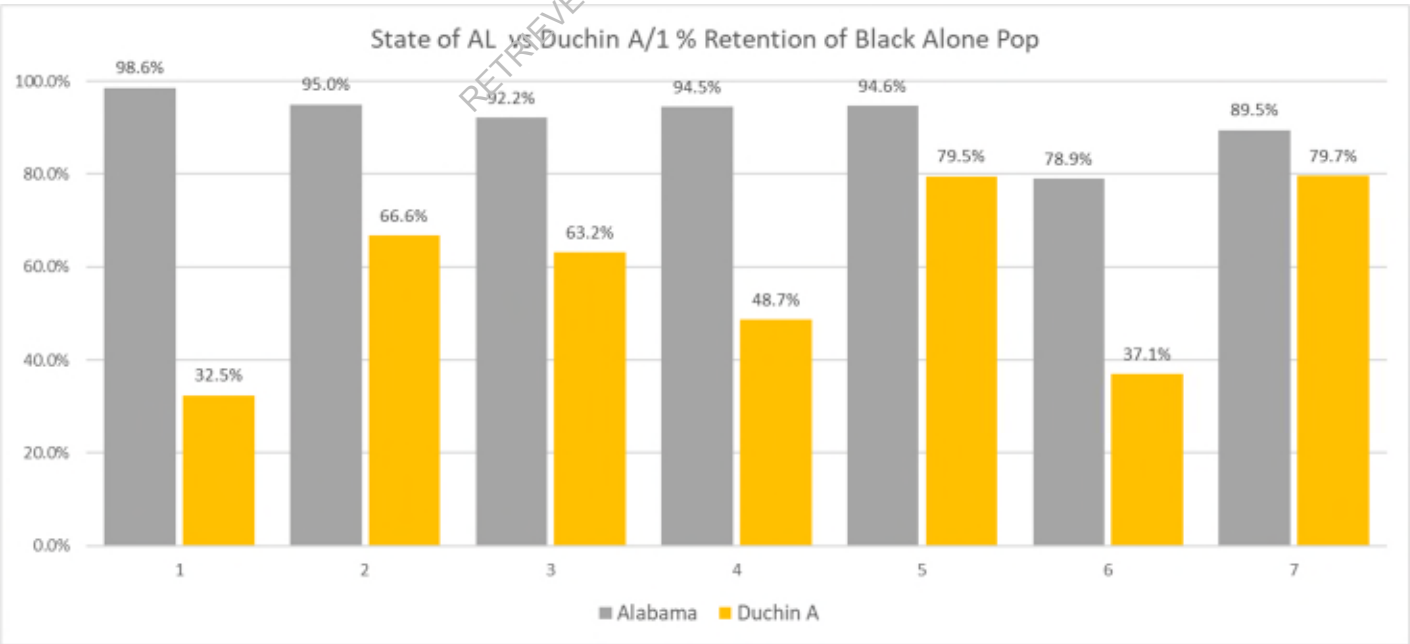
Core Retention Analysis

Duchin CRA Charts Appendix

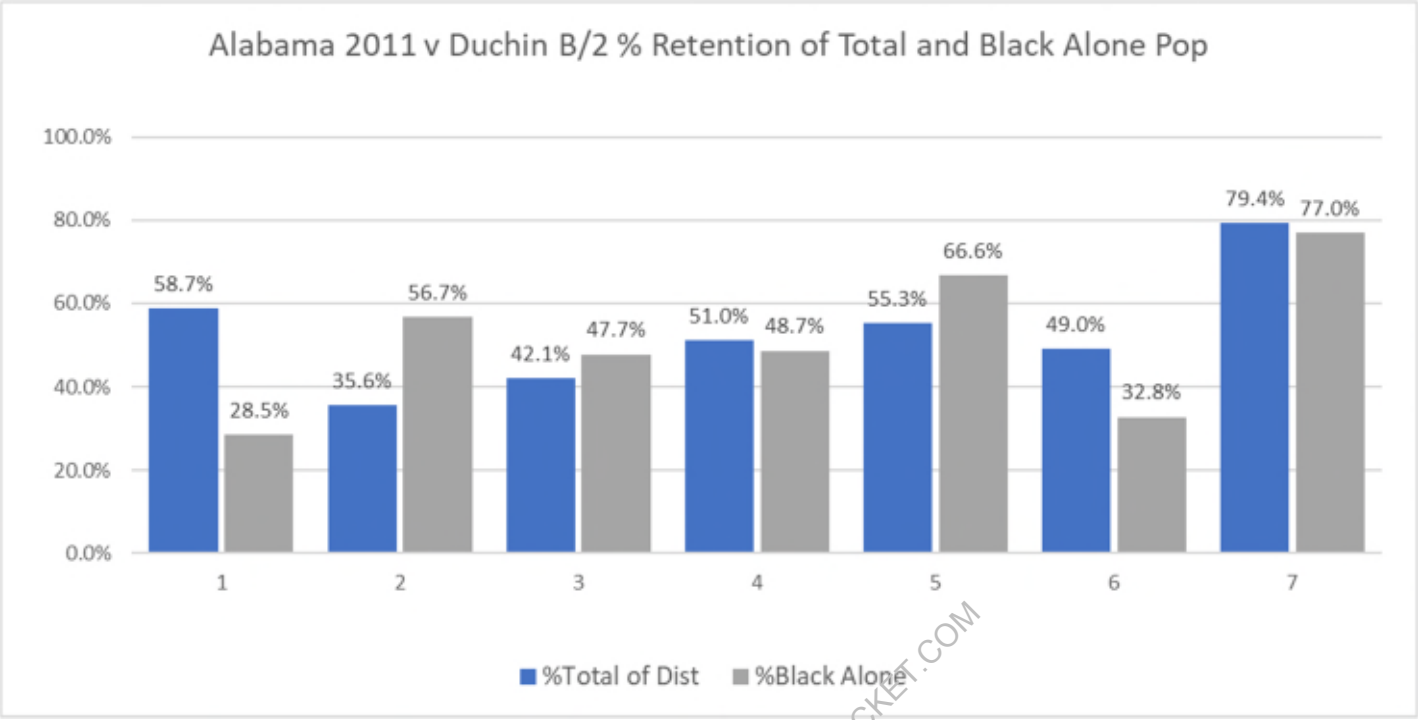
CRA Figure 4.1 Core Retention of Total and Black Population: 2011 Existing v Duchin A



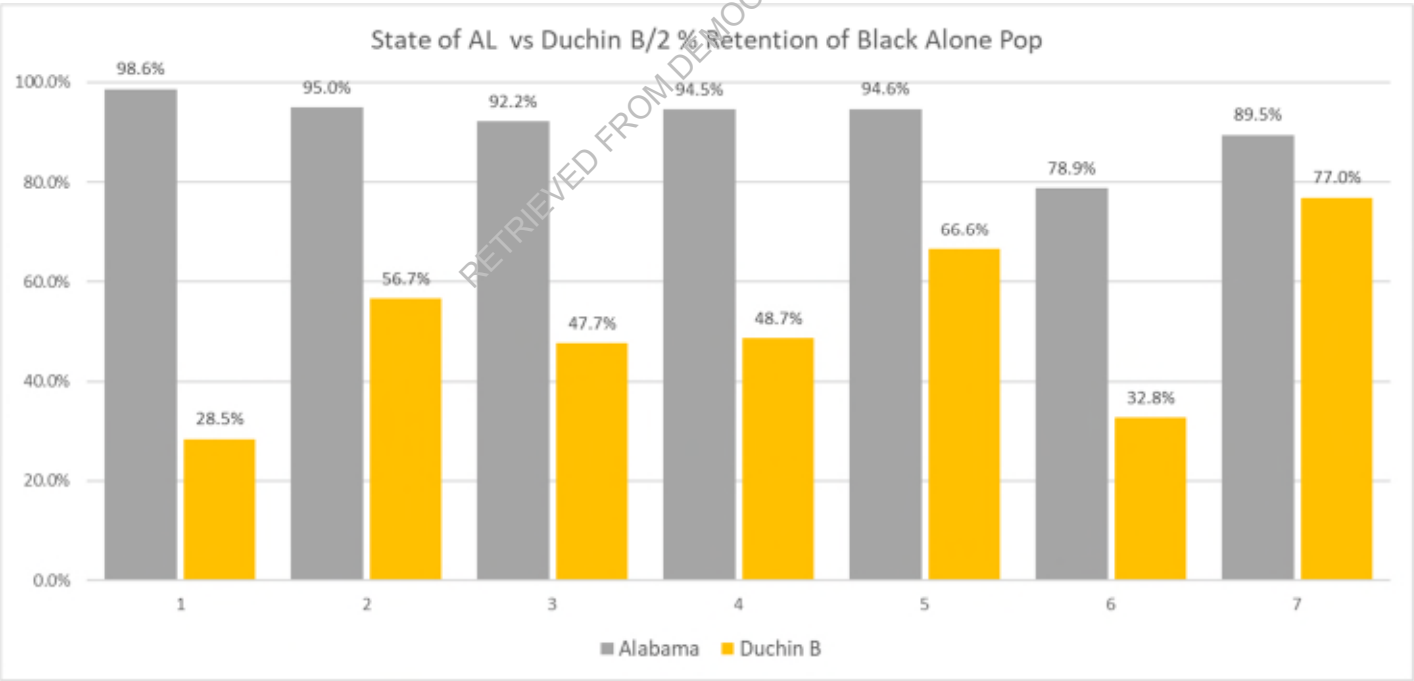
CRA Figure 4.2 Core Retention of Black Alone Population: 2021 Enacted v Duchin A



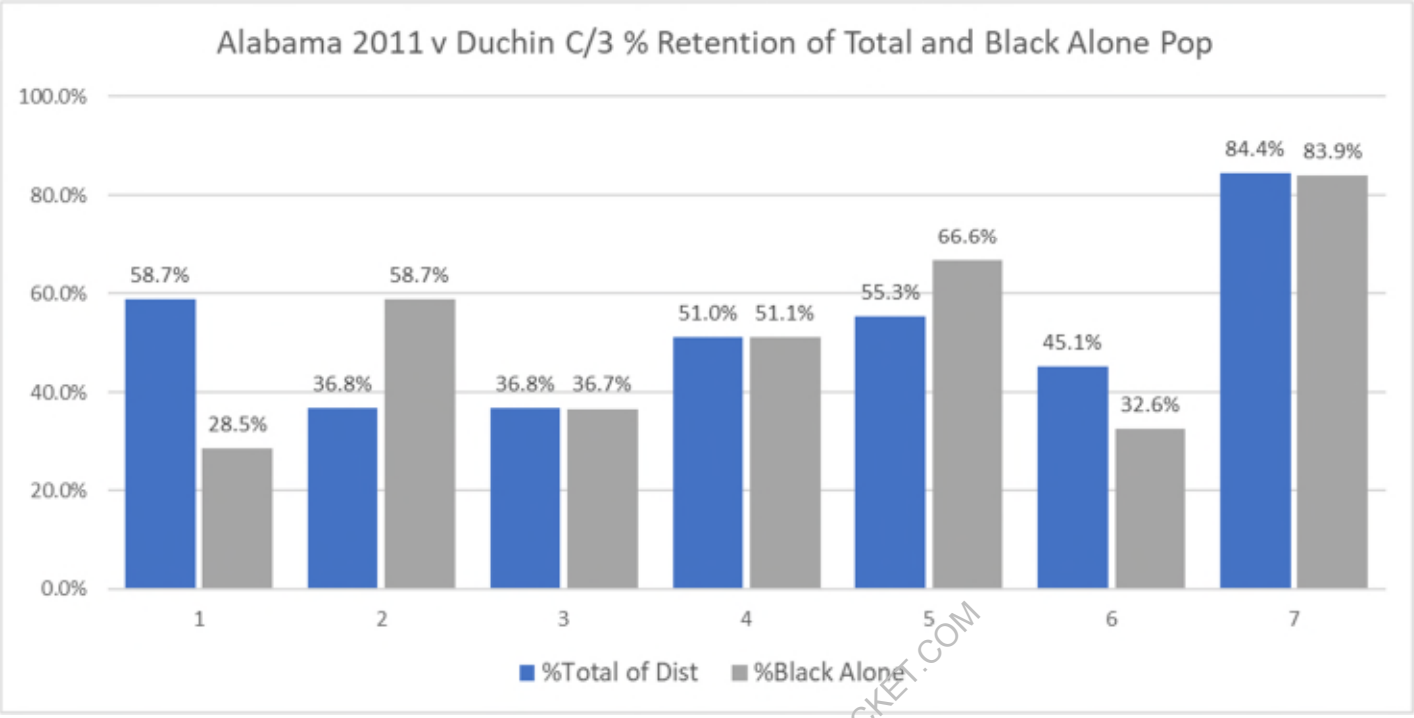
CRA Figure 4.3 Core Retention of Total and Black Population: 2011 Existing v Duchin B



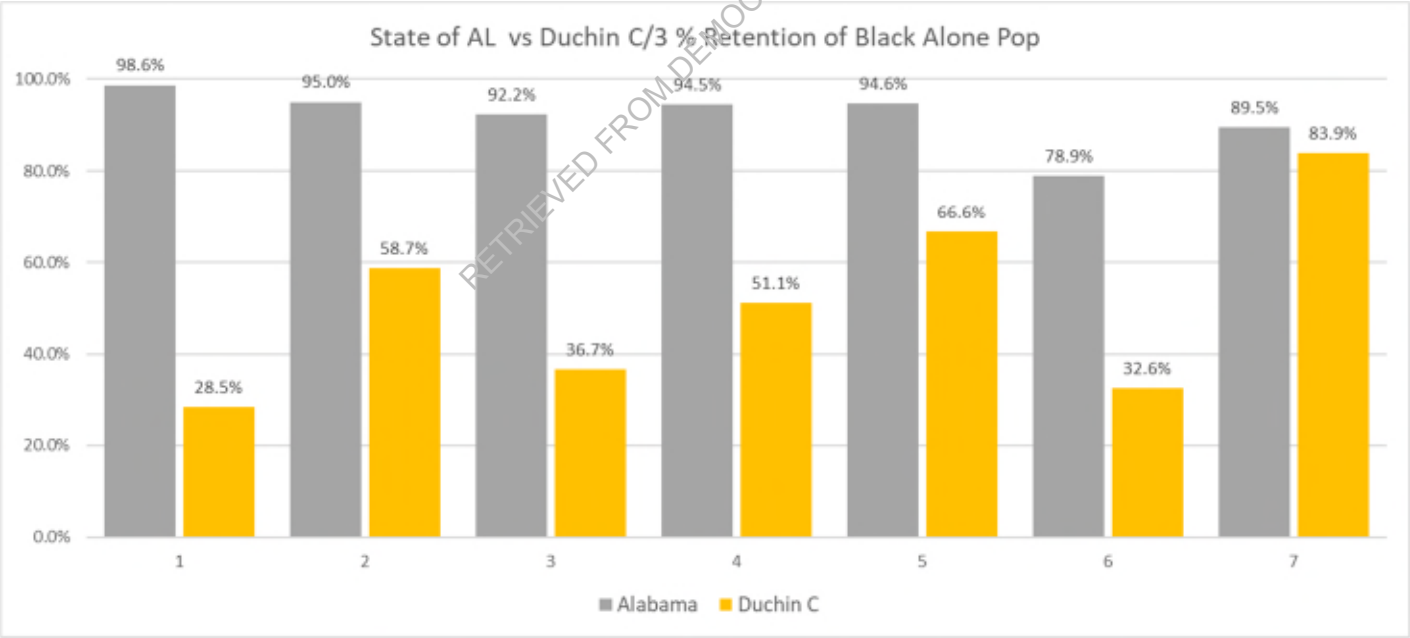
CRA Figure 4.4 Core Retention of Black Alone Population: 2021 Enacted v Duchin B



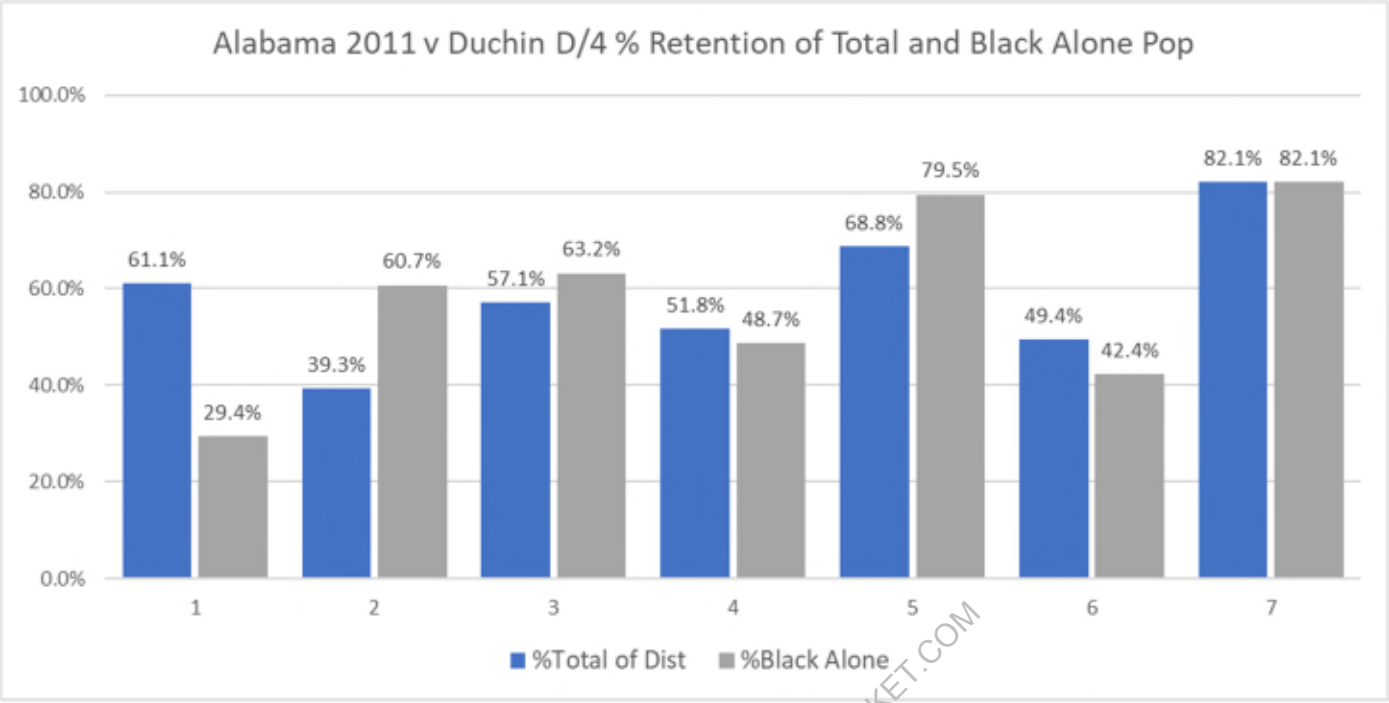
CRA Figure 4.5 Core Retention of Total and Black Population: 2011 Existing v Duchin C



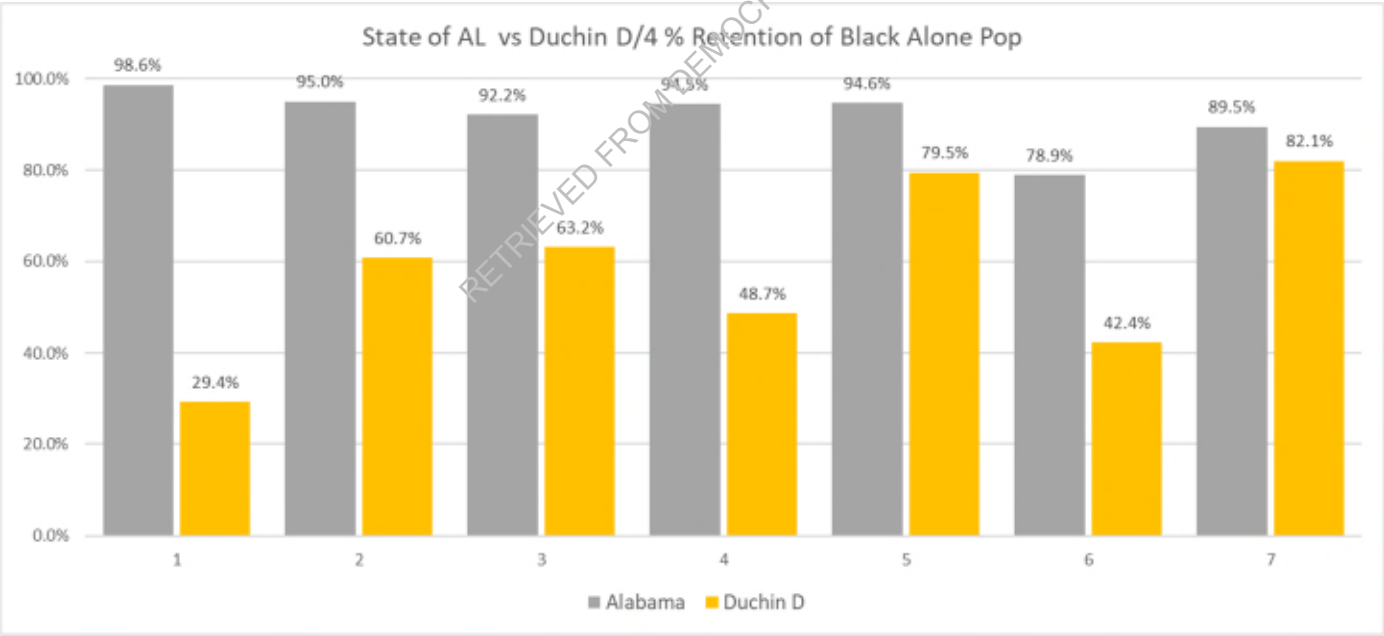
CRA Figure 4.6 Core Retention of Black Alone Population: 2021 Enacted v Duchin C



CRA Figure 4.7 Core Retention of Total and Black Population: 2011 Existing v Duchin D

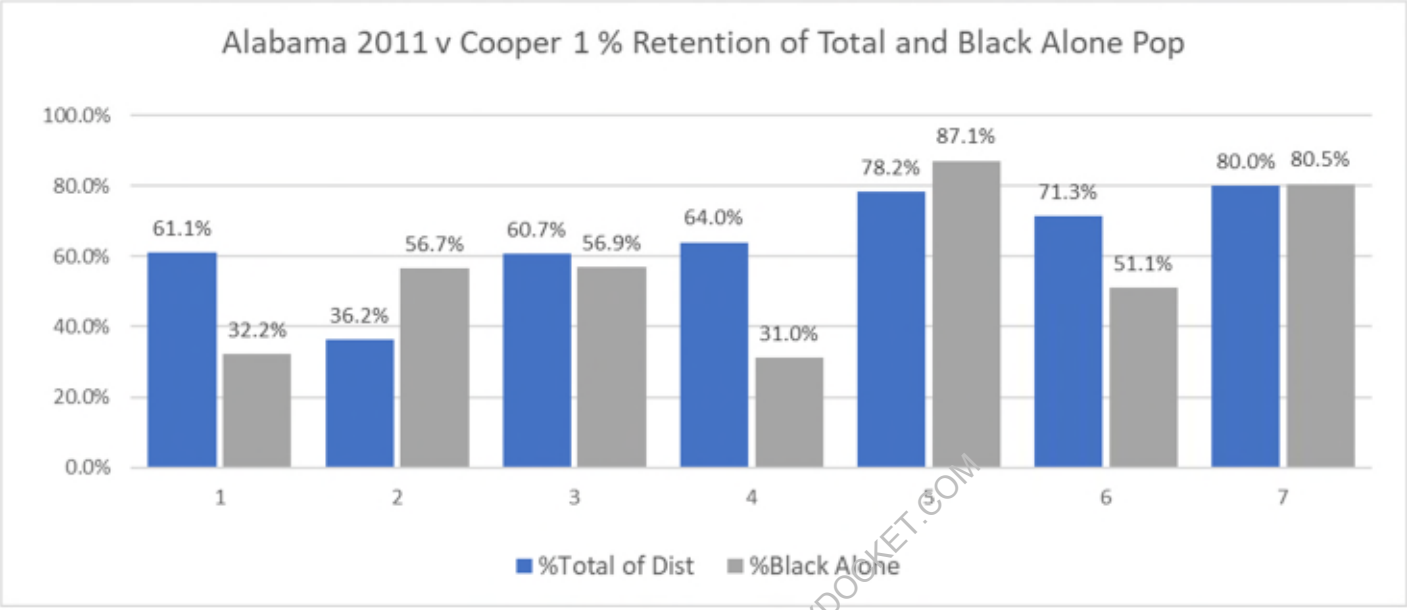


CRA Figure 4.8 Core Retention of Black Alone Population: 2021 Enacted v Duchin D

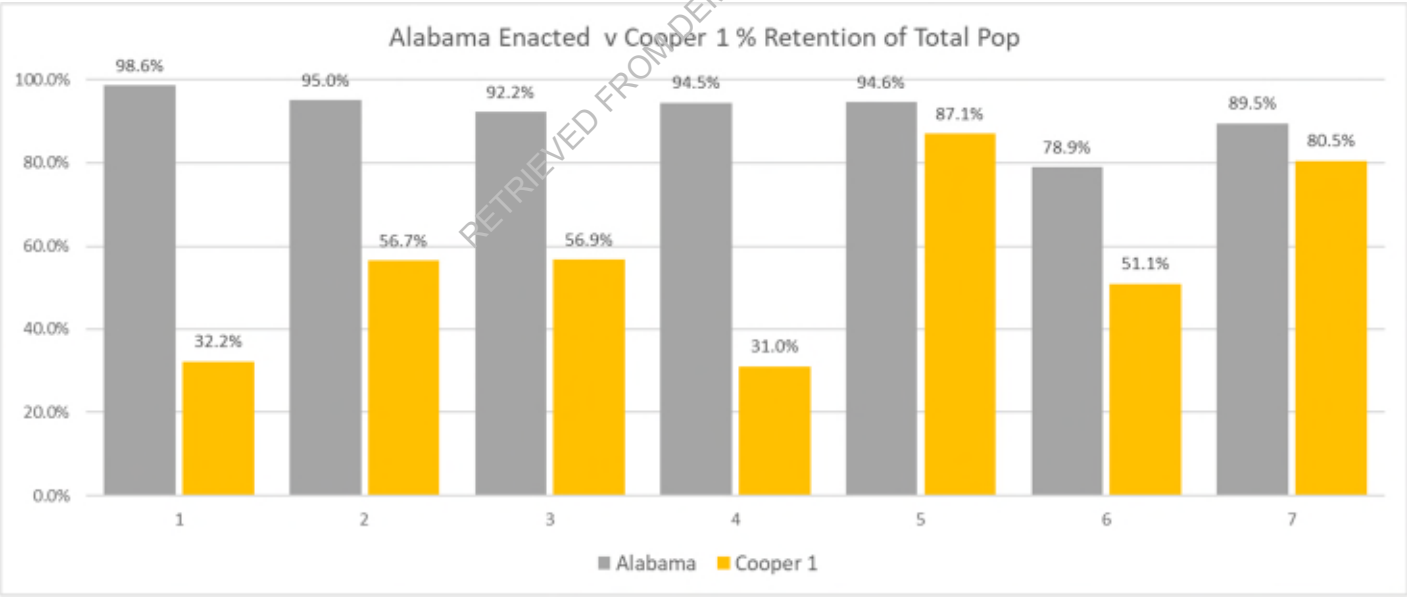


Cooper CRA Charts Appendix

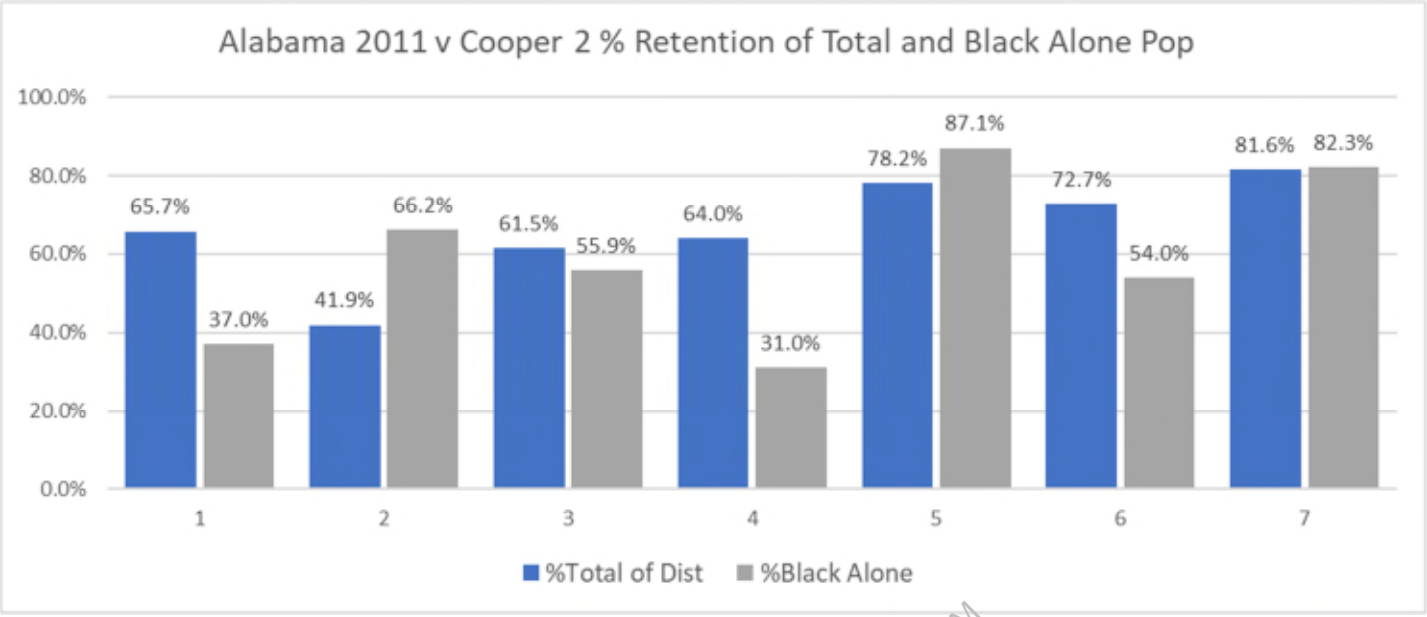
CRA Figure 4.9 Core Retention of Total and Black Population: 2011 Existing v Cooper 1



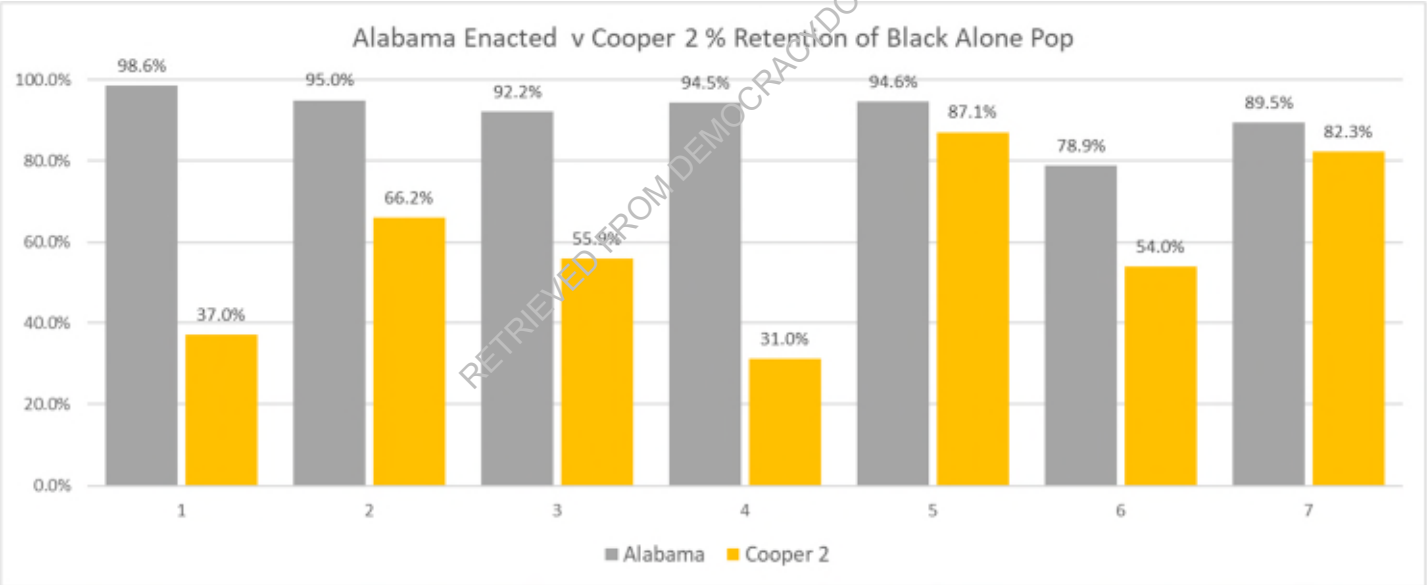
CRA Figure 4.10 Core Retention of Black Alone Population: 2021 Enacted v Cooper 1



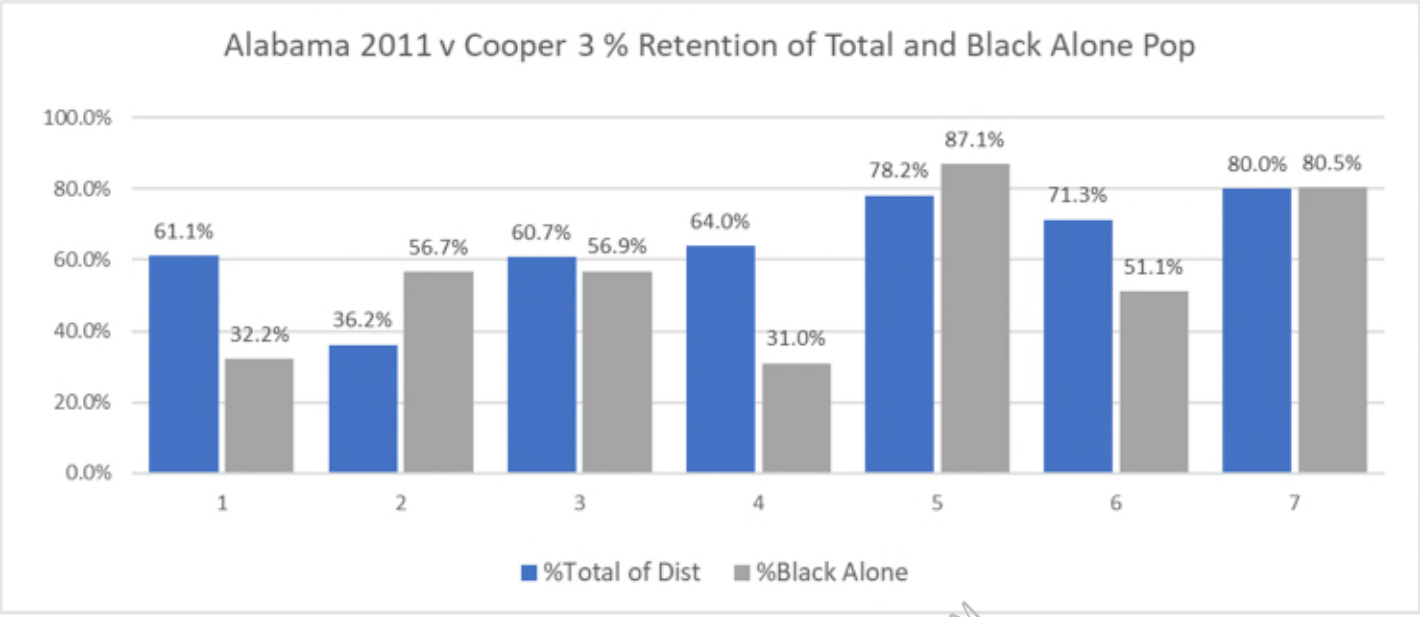
CRA Figure 4.11 Core Retention of Total and Black Population: 2011 Existing v Cooper 2



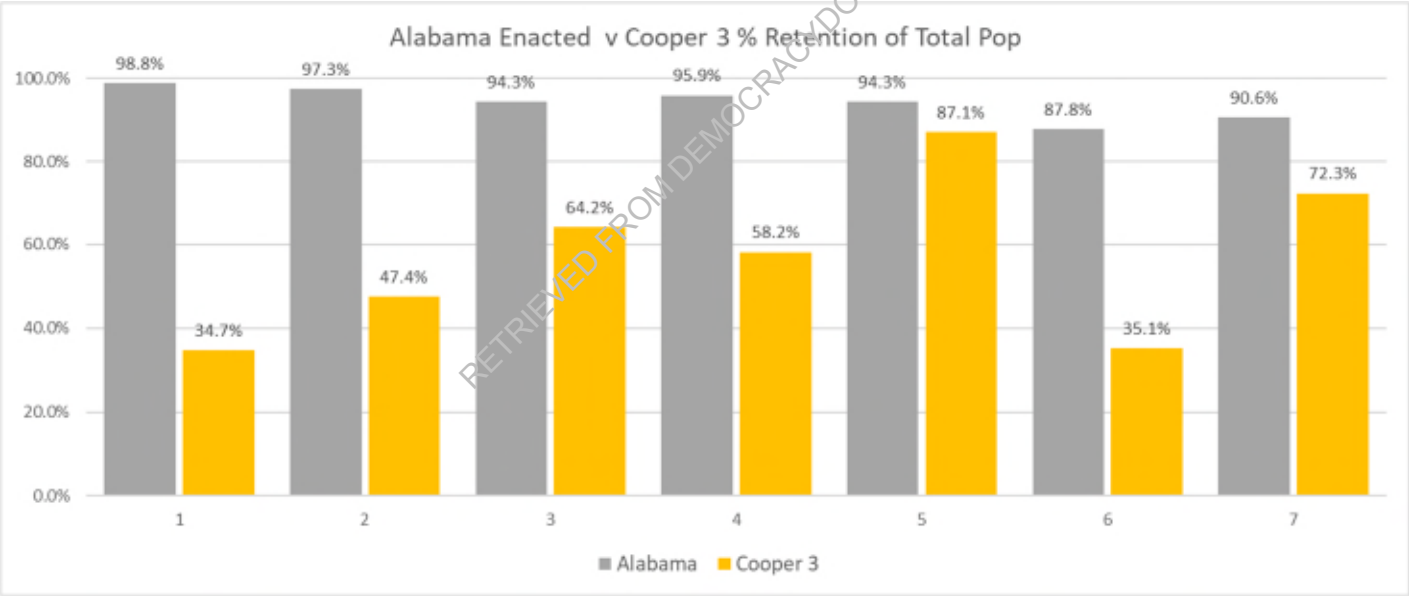
CRA Figure 4.12 Core Retention of Black Alone Population: 2021 Enacted v Cooper 2



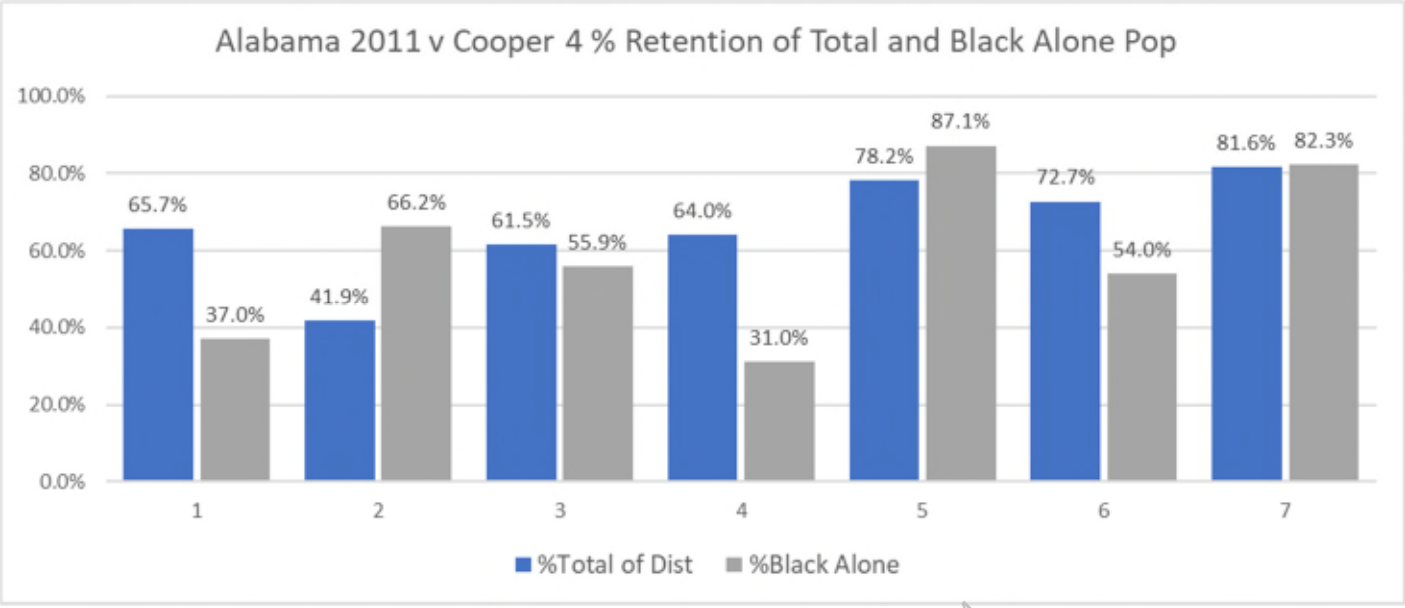
CRA Figure 4.13 Core Retention of Total and Black Population: 2011 Existing v Cooper 3



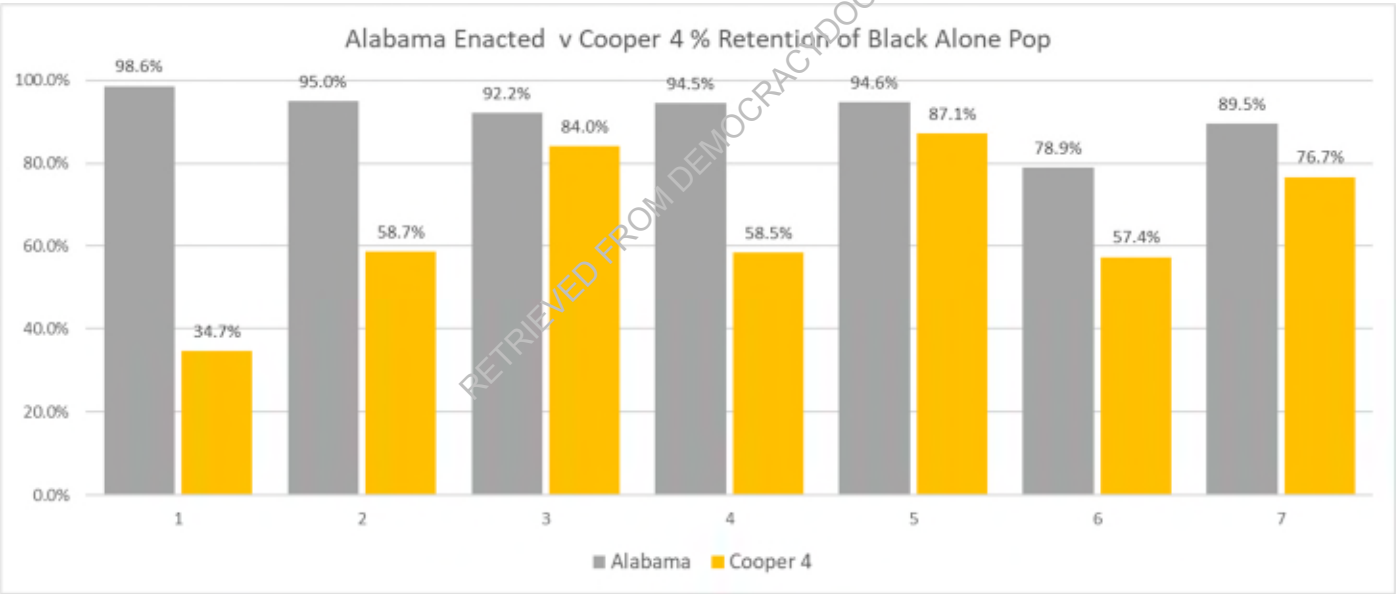
CRA Figure 4.14 Core Retention of Black Alone Population: 2021 Enacted v Cooper 3



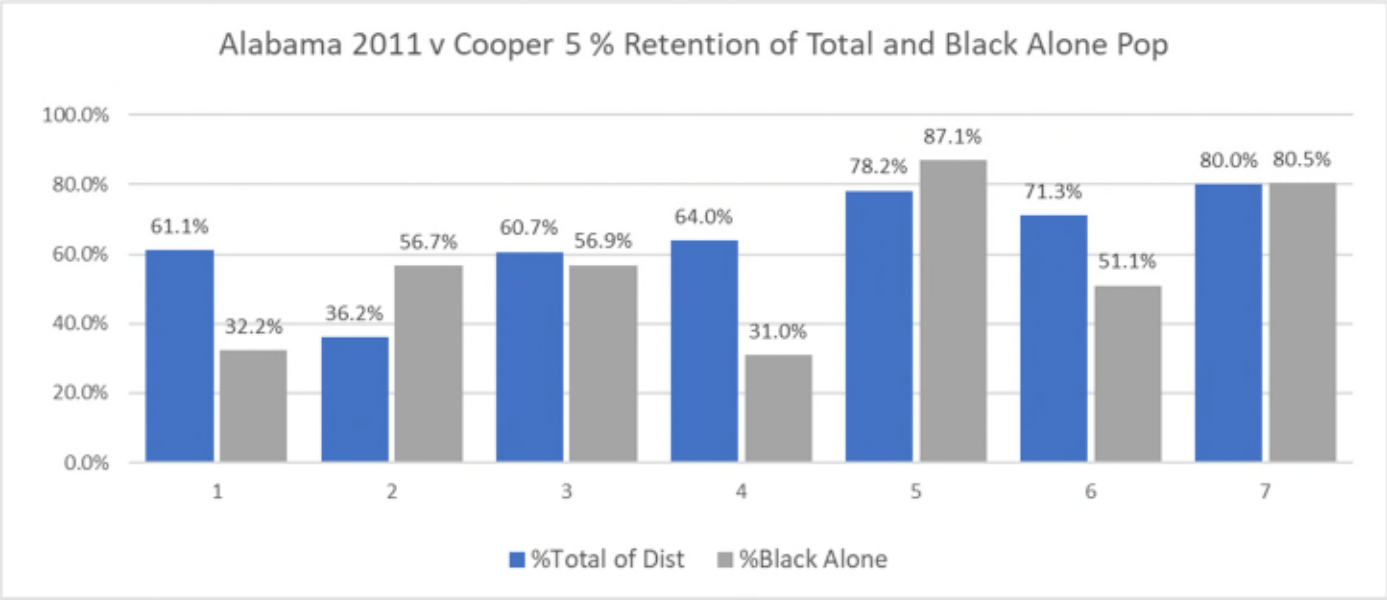
CRA Figure 4.15 Core Retention of Total and Black Population: 2011 Existing v Cooper 4



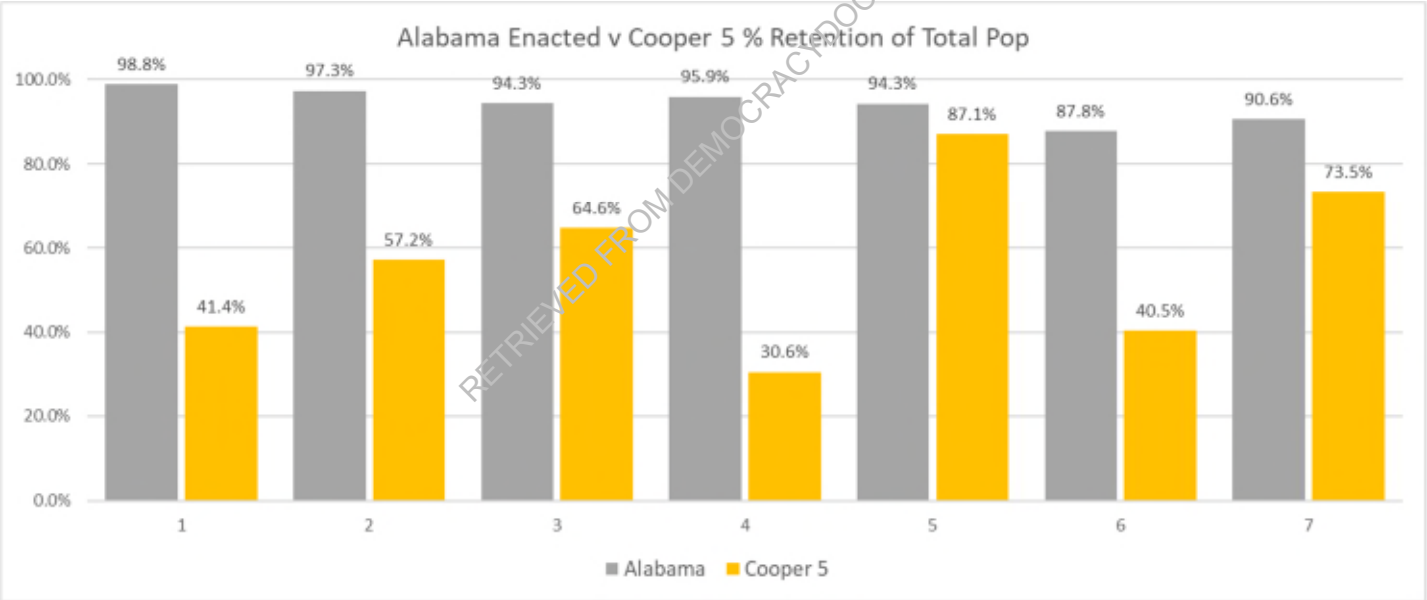
CRA Figure 4.16 Core Retention of Black Alone Population: 2021 Enacted v Cooper 4



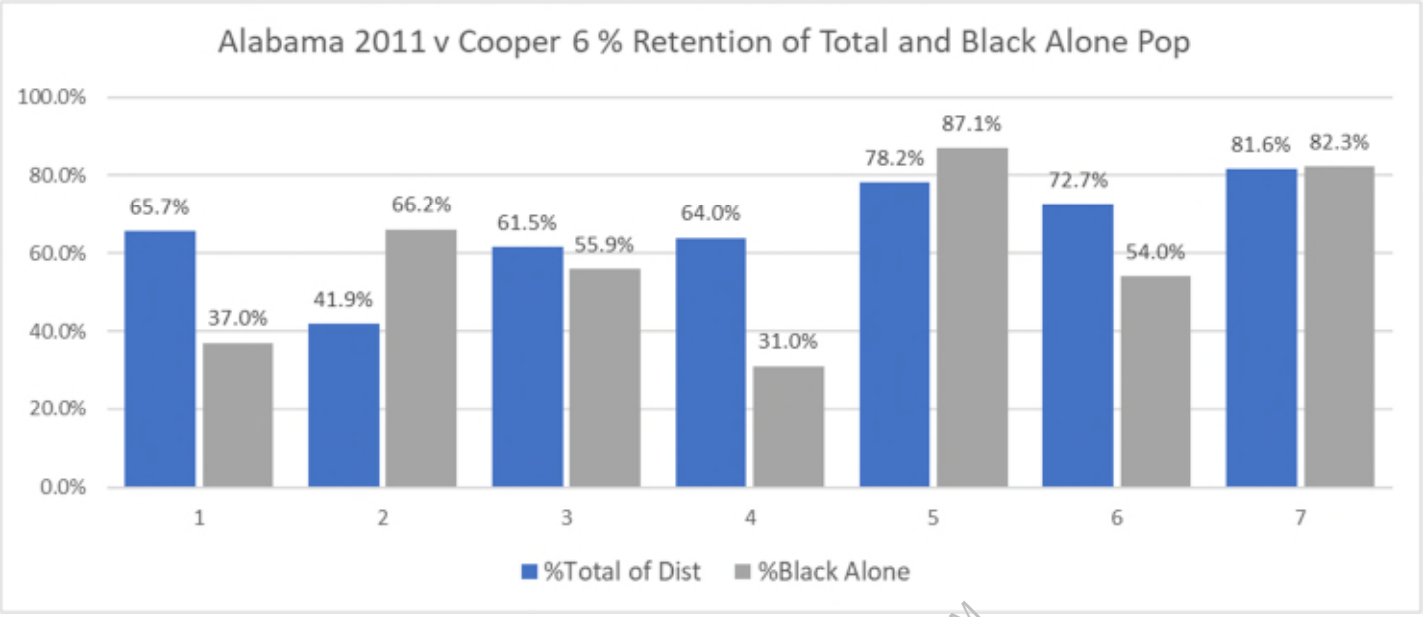
CRA Figure 4.17 Core Retention of Total and Black Population: 2011 Existing v Cooper 5



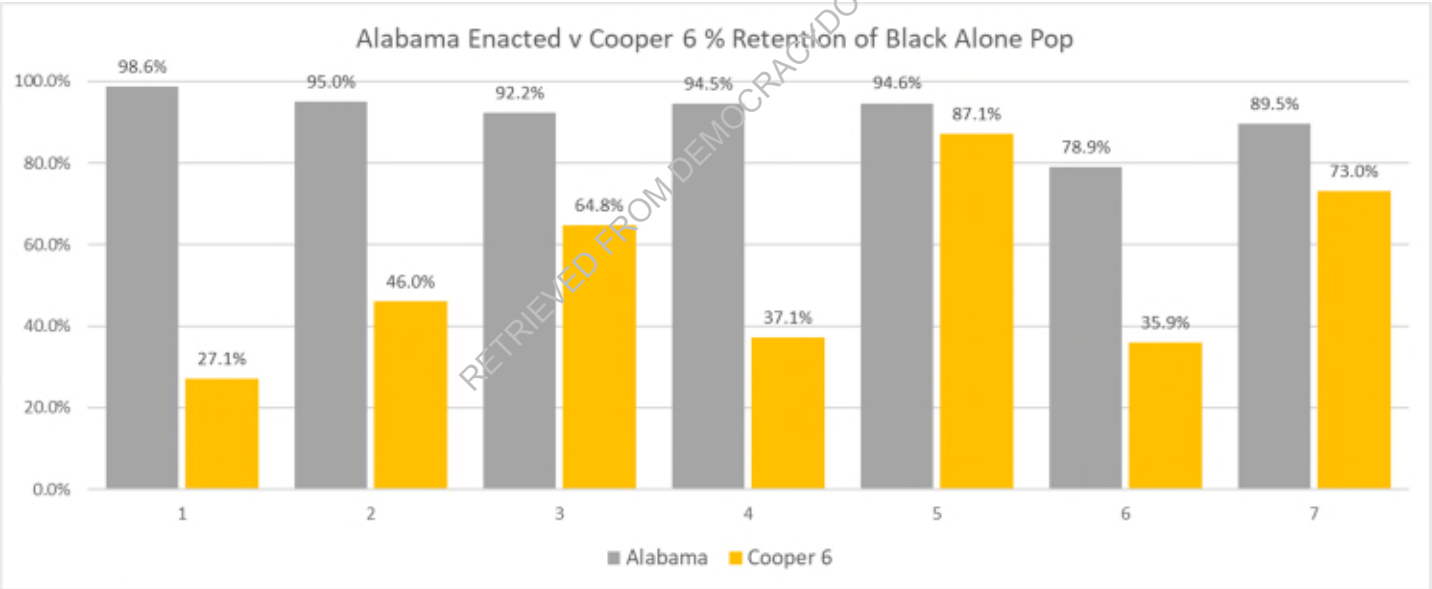
CRA Figure 4.18 Core Retention of Black Alone Population: 2021 Enacted v Cooper 5



CRA Figure 4.19 Core Retention of Total and Black Population: 2011 Existing v Cooper 6



CRA Figure 4.20 Core Retention of Black Alone Population: 2021 Enacted v Cooper 6



Duchin CRA Tables Appendix

CRA Figure 4.21 Core Retention of Total and Black Population: 2011 Existing v Duchin A

Existing District	Plan A	Total	Black Alone
1	1	463,862	61,173
	2	262,414	127,258
1 Total		**726,276**	**188,431**
2	1	253,893	41,264
	2	292,791	141,120
	3	146,782	29,478
2 Total		**693,466**	**211,862**
3	2	69,467	33,265
	3	419,791	117,749
	5	23,274	985
	6	222,600	34,439
3 Total		**735,132**	**186,438**
4	4	363,807	22,850
	5	171,102	3,314
	6	103,436	14,999
	7	64,637	5,756
4 Total		**702,982**	**46,919**
5	4	237,725	26,734
	5	523,377	103,617
5 Total		**761,102**	**130,351**
6	3	151,181	22,539
	4	116,222	7,189
	6	344,904	44,549
	7	128,403	45,853
6 Total		**740,710**	**120,130**
7	2	93,081	69,549
	6	46,815	12,583
	7	524,715	321,896
7 Total		**664,611**	**404,028**
Grand Total		**5,024,279**	**1,288,159**

CRA Figure 4.22 Core Retention of Total and Black Population: 2011 Existing v Duchin B

Existing District	Plan B	Total	Black Alone
1	1	426,387	53,764
	2	299,042	134,417
	7	847	250
1 Total		**726,276**	**188,431**
2	1	291,368	58,001
	2	247,146	120,086
	3	154,952	33,775
2 Total		**693,466**	**211,862**
3	2	61,399	29,929
	3	309,507	88,989
	5	23,274	985
	6	340,952	66,535
3 Total		**735,132**	**186,438**
4	4	358,795	22,832
	5	273,214	18,304
	6	6,336	27
	7	64,637	5,756
4 Total		**702,982**	**46,919**
5	4	339,836	43,514
	5	421,266	86,837
5 Total		**761,102**	**130,351**
6	3	253,295	34,269
	6	362,812	39,375
	7	124,603	46,486
6 Total		**740,710**	**120,130**
7	2	110,160	84,485
	4	19,123	7,448
	6	7,654	1,065
	7	527,674	311,030
7 Total		**664,611**	**404,028**
Grand Total		**5,024,279**	**1,288,159**

CRA Figure 4.23 Core Retention of Total and Black Population: 2011 Existing v Duchin C

Existing District	Plan C	Total	Black Alone
1	1	426,387	53,764
	2	280,808	130,395
	7	19,081	4,272
1 Total		**726,276**	**188,431**
2	1	291,368	58,001
	2	255,316	124,383
	3	146,782	29,478
2 Total		**693,466**	**211,862**
3	2	120,582	55,859
	3	270,254	68,358
	5	23,274	985
	6	321,022	61,236
3 Total		**735,132**	**186,438**
4	4	358,795	23,997
	5	273,214	18,304
	6	39,094	601
	7	31,879	4,017
4 Total		**702,982**	**46,919**
5	4	339,836	43,514
	5	421,266	86,837
5 Total		**761,102**	**130,351**
6	3	300,718	40,141
	6	334,363	39,203
	7	105,629	40,786
6 Total		**740,710**	**120,130**
7	2	61,048	50,230
	4	19,123	7,448
	6	23,275	7,356
	7	561,165	338,994
7 Total		**664,611**	**404,028**
Grand Total		**5,024,279**	**1,288,159**

CRA Figure 4.24 Core Retention of Total and Black Population: 2011 Existing v Duchin D

Existing District	Plan D	Total	Black Alone
1	1	443,532	55,434
	2	282,744	132,997
1 Total		**726,276**	**188,431**
2	1	274,222	53,769
	2	272,462	128,615
	3	146,782	29,478
2 Total		**693,466**	**211,862**
3	2	69,455	33,262
	3	419,803	117,752
	5	23,274	985
	6	222,600	34,439
3 Total		**735,132**	**186,438**
4	4	363,807	22,850
	5	171,102	3,314
	6	103,436	14,999
	7	64,637	5,756
4 Total		**702,982**	**46,919**
5	4	237,724	26,734
	5	523,378	103,617
5 Total		**761,102**	**130,351**
6	3	151,181	22,539
	4	116,227	9,320
	6	366,061	50,917
	7	107,241	37,354
6 Total		**740,710**	**120,130**
7	2	93,082	66,272
	6	25,657	6,173
	7	545,872	331,583
7 Total		**664,611**	**404,028**
Grand Total		**5,024,279**	**1,288,159**

Cooper CRA Tables Appendix

CRA Figure 4.25 Core Retention of Total and Black Population: 2011 Existing v Cooper 1

Existing District	Cooper Plan 1	Total	Black Alone
1	1	443,533	60,731
	2	282,743	127,700
1 Total		**726,276**	**188,431**
2	1	274,222	53,769
	2	250,986	120,127
	3	168,258	37,966
2 Total		**693,466**	**211,862**
3	2	82,220	44,014
	3	446,059	106,043
	4	23,274	985
	6	183,579	35,396
3 Total		**735,132**	**186,438**
4	3	103,436	14,999
	4	449,793	14,559
	5	122,443	13,663
	7	27,310	3,698
4 Total		**702,982**	**46,919**
5	4	165,790	16,837
	5	595,312	113,514
5 Total		**761,102**	**130,351**
6	4	54,122	808
	6	528,101	61,350
	7	158,487	57,972
6 Total		**740,710**	**120,130**
7	2	101,805	68,980
	4	24,774	9,089
	6	6,074	638
	7	531,958	325,321
7 Total		**664,611**	**404,028**
Grand Total		**5,024,279**	**1,288,159**

CRA Figure 4.26 Core Retention of Black Alone Population: 2021 Enacted v Cooper 2

Existing District	Cooper Plan 2	%Total of Dist	%Black Alone
1	1	477,256	69,685
	2	249,020	118,746
1 Total		**726,276**	**188,431**
2	1	240,498	36,257
	2	290,638	140,154
	3	162,330	35,451
2 Total		**693,466**	**211,862**
3	2	86,602	46,215
	3	451,989	104,278
	4	23,274	985
	6	173,267	34,960
3 Total		**735,132**	**186,438**
4	3	103,436	14,999
	4	449,793	14,567
	5	122,443	13,663
	7	27,310	3,690
4 Total		**702,982**	**46,919**
5	4	165,790	16,837
	5	595,312	113,514
5 Total		**761,102**	**130,351**
6	4	54,122	808
	6	538,413	64,921
	7	148,175	54,401
6 Total		**740,710**	**120,130**
7	2	91,494	61,831
	4	24,774	9,089
	6	6,074	638
	7	542,269	332,470
7 Total		**664,611**	**404,028**
Grand Total		**5,024,279**	**1,288,159**

CRA Figure 4.27 Core Retention of Total and Black Population: 2011 Existing v Cooper 3

Existing District	Cooper Plan 3	%Total of Dist	%Black Alone
1	1	426,385	65,302
	2	299,891	123,129
1 Total		**726,276**	**188,431**
2	1	291,368	58,001
	2	197,084	100,465
	3	205,014	53,396
2 Total		**693,466**	**211,862**
3	2	61,399	29,929
	3	457,340	119,693
	4	43,141	1,859
	6	173,252	34,957
3 Total		**735,132**	**186,438**
4	4	483,647	27,308
	5	122,443	13,663
	6	95,902	5,691
	7	990	257
4 Total		**702,982**	**46,919**
5	4	165,790	16,837
	5	595,312	113,514
5 Total		**761,102**	**130,351**
6	3	55,401	7,040
	6	448,391	42,223
	7	236,918	70,867
6 Total		**740,710**	**120,130**
7	2	159,378	109,131
	4	25,177	2,790
	6	210	0
	7	479,846	292,107
7 Total		**664,611**	**404,028**
Grand Total		**5,024,279**	**1,288,159**

CRA Figure 4.28 Core Retention of Total and Black Population: 2011 Existing v Cooper 4

Existing District	Cooper Plan 4	%Total of Dist	%Black Alone
1	1	426,387	65,301
	2	299,889	123,130
1 Total		**726,276**	**188,431**
2	1	291,368	58,001
	2	255,316	124,383
	3	87,977	18,126
	6	58,805	11,352
2 Total		**693,466**	**211,862**
3	2	31,005	21,141
	3	613,024	156,680
	6	91,103	8,617
3 Total		**735,132**	**186,438**
4	3	6,367	69
	4	509,535	27,431
	5	122,443	13,663
	7	64,637	5,756
4 Total		**702,982**	**46,919**
5	4	165,790	16,833
	5	595,312	113,518
5 Total		**761,102**	**130,351**
6	3	10,387	3,000
	4	42,429	719
	6	558,272	68,936
	7	129,622	47,475
6 Total		**740,710**	**120,130**
7	2	131,544	93,084
	6	9,573	1,153
	7	523,494	309,791
7 Total		**664,611**	**404,028**
Grand Total		**5,024,279**	**1,288,159**

CRA Figure 4.29 Core Retention of Total and Black Population: 2011 Existing v Cooper 5

Existing District	Cooper Plan 5	%Total of Dist	%Black Alone
1	1	496,998	78,037
	2	229,278	110,394
1 Total		**726,276**	**188,431**
2	1	220,757	45,126
	2	283,558	121,176
	3	189,151	45,560
2 Total		**693,466**	**211,862**
3	2	61,399	29,929
	3	473,201	120,495
	4	23,274	985
	6	177,258	35,029
3 Total		**735,132**	**186,438**
4	4	453,423	14,370
	5	122,443	13,663
	6	103,436	14,999
	7	23,680	3,887
4 Total		**702,982**	**46,919**
5	4	165,790	16,837
	5	595,312	113,514
5 Total		**761,102**	**130,351**
6	3	55,401	7,040
	4	54,122	808
	6	436,851	48,645
	7	194,336	63,637
6 Total		**740,710**	**120,130**
7	2	143,518	99,542
	4	21,146	7,577
	6	210	0
	7	499,737	296,909
7 Total		**664,611**	**404,028**
Grand Total		**5,024,279**	**1,288,159**

CRA Figure 4.30 Core Retention of Total and Black Population: 2011 Existing v Cooper 6

Existing District	Cooper Plan 6	%Total of Dist	%Black Alone
1	1	413,191	51,019
	2	313,085	137,412
1 Total		**726,276**	**188,431**
2	1	304,562	61,086
	2	183,890	97,380
	3	180,759	47,199
	7	24,255	6,197
2 Total		**693,466**	**211,862**
3	2	61,399	29,929
	3	481,593	120,738
	6	192,140	35,771
3 Total		**735,132**	**186,438**
4	4	473,808	17,421
	5	122,443	13,663
	6	105,133	15,001
	7	1,598	834
4 Total		**702,982**	**46,919**
5	4	165,790	16,833
	5	595,312	113,518
5 Total		**761,102**	**130,351**
6	3	55,401	7,040
	4	54,122	808
	6	415,045	43,122
	7	216,142	69,160
6 Total		**740,710**	**120,130**
7	2	159,381	106,285
	4	24,034	2,208
	6	5,437	563
	7	475,759	294,972
7 Total		**664,611**	**404,028**
Grand Total		**5,024,279**	**1,288,159**

Appendix 5

Compactness Analysis

Appendix 5 Compactness Measures

Polsby-Popper

The Polsby-Popper (PP) measure (polsby & Popper, 1991) is the ratio of the area of the district (A_D) to the area of a circle whose circumference is equal to the perimeter of the district (P_D). A district's Polsby-Popper score falls with the range of $[0, 1]$ and a score closer to 1 indicates a more compact district.

$$PP = 4\pi \times \frac{A_D}{P_D^2}$$

Circumference Equal to District Perimeter

Schwartzberg

The Schwartzberg score (S) compactness score is the ratio of the perimeter of the district (P_D) to the circumference of a circle whose area is equal to the area of the district. A district's Schwartzberg score as calculated below falls with the range of $[0,1]$ and a score closer to 1 indicates a more compact district.

$$S = \frac{1}{P_D/C} = \frac{1}{P_D/(2\pi\sqrt{A_D/\pi})}$$

Circle with Area Equivalent to the District

Source: https://fisherzachary.github.io/public/r-output.html

Appendix 5 Compactness Measures (continued)

Reock Score

The Reock Score (R) is the ratio of the area of the district A_D to the area of a minimum bounding circle (A_{MBC}) that encloses the district's geometry. A district's Reock score falls within the range of [0,1] and a score closer to 1 indicates a more compact district.

$$R = \frac{A_D}{A_{MBC}}$$

Minimum Bounding Circle of Original Gerrymander

Convex Hull

The Convex Hull score is a ratio of the area of the district to the area of the minimum convex polygon that can encloses the district's geometry. A district's Convex Hull score falls within the range of [0,1] and a score closer to 1 indicates a more compact district.

$$CH \quad \frac{A_D}{A_{MCP}}$$

Convex Hull of Original Gerrymander

Duchin Compactness Appendix

Appendix 5.1 Duchin Compactness Plan A

District	Polsby-Popper	Schwartzberg	Reock	Convex_Hull	Total
1	0.13	0.36	0.22	0.57	1.28
2	0.16	0.40	0.34	0.64	1.54
3	0.26	0.51	0.49	0.78	2.04
4	0.37	0.61	0.61	0.90	2.48
5	0.38	0.62	0.39	0.87	2.26
6	0.22	0.47	0.32	0.70	1.71
7	0.28	0.53	0.39	0.83	2.02
Sum	1.80	3.49	2.76	5.29	
Average	0.26	0.50	0.39	0.76	

Appendix 4.2 Duchin Compactness Plan B

District	Polsby-Popper	Schwartzberg	Reock	Convex_Hull	Total
1	0.16	0.39	0.20	0.58	1.33
2	0.19	0.43	0.34	0.67	1.63
3	0.23	0.48	0.35	0.67	1.73
4	0.40	0.63	0.42	0.87	2.32
5	0.53	0.73	0.50	0.93	2.69
6	0.25	0.50	0.50	0.80	2.06
7	0.23	0.48	0.31	0.77	1.80
Sum	1.98	3.64	2.64	5.30	
Average	0.28	0.52	0.38	0.76	

Appendix 4.3 Duchin Compactness Plan C

District	Polsby-Popper	Schwartzberg	Reock	Convex_Hull	Total
1	0.16	0.39	0.20	0.58	1.33
2	0.15	0.39	0.23	0.67	1.44
3	0.28	0.53	0.38	0.76	1.94
4	0.32	0.57	0.44	0.85	2.18
5	0.53	0.73	0.50	0.93	2.69
6	0.18	0.42	0.40	0.73	1.73
7	0.18	0.43	0.28	0.75	1.64
Sum	1.80	3.46	2.43	5.27	
Average	0.26	0.49	0.35	0.75	

Appendix 4.4 Duchin Compactness Plan D

District	Polsby-Popper	Schwartzberg	Reock	Convex_Hull	Total
1	0.13	0.36	0.21	0.57	1.27
2	0.15	0.39	0.34	0.62	1.50
3	0.26	0.51	0.49	0.78	2.05
4	0.36	0.60	0.60	0.89	2.46
5	0.38	0.62	0.39	0.87	2.26
6	0.19	0.44	0.33	0.67	1.62
7	0.27	0.52	0.51	0.81	2.10
Sum	1.75	3.45	2.88	5.19	
Average	0.25	0.49	0.41	0.74	

Cooper Compactness Appendix

Appendix 4.5 Cooper Compactness Plan 1

District	Polsby-Popper	Schwartzberg	Reock	Convex_Hull	Total
1	0.15	0.38	0.21	0.56	1.30
2	0.14	0.37	0.33	0.61	1.45
3	0.14	0.38	0.37	0.57	1.46
4	0.21	0.46	0.28	0.69	1.64
5	0.33	0.58	0.33	0.85	2.09
6	0.16	0.39	0.47	0.73	1.75
7	0.13	0.37	0.37	0.64	1.50
Sum	1.26	2.93	2.35	4.65	
Average	0.18	0.42	0.34	0.66	

Appendix 4.6 Cooper Compactness Plan 2

District	Polsby-Popper	Schwartzberg	Reock	Convex_Hull	Total
1	0.14	0.37	0.21	0.56	1.28
2	0.12	0.34	0.31	0.56	1.33
3	0.14	0.38	0.34	0.56	1.42
4	0.21	0.46	0.28	0.69	1.64
5	0.33	0.58	0.33	0.85	2.09
6	0.17	0.41	0.52	0.73	1.83
7	0.13	0.36	0.40	0.61	1.48
Sum	1.23	2.88	2.39	4.56	
Average	0.18	0.41	0.34	0.65	

Appendix 4.7 Cooper Compactness Plan 3

District	Polsby-Popper	Schwartzberg	Reock	Convex_Hull	Total
1	0.16	0.40	0.20	0.58	1.35
2	0.22	0.47	0.39	0.74	1.81
3	0.16	0.40	0.41	0.65	1.63
4	0.12	0.35	0.31	0.58	1.36
5	0.33	0.58	0.33	0.85	2.09
6	0.13	0.36	0.47	0.72	1.68
7	0.15	0.39	0.30	0.66	1.49
Sum	1.28	2.95	2.40	4.78	
Average	0.18	0.42	0.34	0.68	

Appendix 4.8 Cooper Compactness Plan 4

District	Polsby-Popper	Schwartzberg	Reock	Convex_Hull	Total
1	0.16	0.40	0.20	0.58	1.34
2	0.18	0.42	0.36	0.70	1.67
3	0.24	0.49	0.33	0.79	1.85
4	0.22	0.47	0.30	0.72	1.71
5	0.34	0.58	0.33	0.85	2.09
6	0.13	0.36	0.35	0.65	1.49
7	0.24	0.49	0.41	0.78	1.91
Sum	1.50	3.21	2.29	5.07	
Average	0.21	0.46	0.33	0.72	

Appendix 4.9 Cooper Compactness Plan 5

District	Polsby-Popper	Schwartzberg	Reock	Convex_Hull	Total
1	0.13	0.36	0.19	0.53	1.20
2	0.19	0.44	0.39	0.70	1.72
3	0.18	0.43	0.33	0.62	1.56
4	0.20	0.45	0.29	0.68	1.61
5	0.33	0.58	0.33	0.85	2.09
6	0.13	0.36	0.30	0.66	1.46
7	0.11	0.34	0.23	0.65	1.33
Sum	1.28	2.95	2.05	4.69	
Average	0.18	0.42	0.29	0.67	

Appendix 4.10 Cooper Compactness Plan 6

District	Polsby-Popper	Schwartzberg	Reock	Convex_Hull	Total
1	0.12	0.34	0.24	0.51	1.21
2	0.11	0.33	0.29	0.57	1.31
3	0.16	0.40	0.35	0.63	1.54
4	0.18	0.43	0.30	0.70	1.62
5	0.34	0.58	0.33	0.85	2.09
6	0.10	0.31	0.29	0.65	1.34
7	0.11	0.32	0.34	0.56	1.33
Sum	1.11	2.72	2.13	4.46	
Average	0.16	0.39	0.30	0.64	

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Map Appendix 2 (State of Alabama 2011 and 2021 Enacted Plans)

Map Appendix 3 (State of Alabama Enacted Plan Percent Black Alone VAP by VTD)

Map Appendix 4 (State of Alabama Voting Age Population by VTD)

Duchin Maps

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Map Appendix 5A (Duchin Plan A/1 Plan Percent Black Alone VAP by VTD)

Map Appendix 6 (Duchin Plan B/2 and Alabama Existing Districts)

Map Appendix 6A (Duchin Plan B/2 Plan Percent Black Alone VAP by VTD)

Map Appendix 7 (Duchin Plan C/3 and Alabama Existing Districts)

Map Appendix 7A (Duchin Plan C/3 Plan Percent Black Alone VAP by VTD)

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Map Appendix 9A (Cooper Plan 1 Plan Percent Black Alone VAP by VTD)

Map Appendix 10 (Cooper Plan 2 and Alabama Existing Districts)

Map Appendix 10A (Cooper Plan 2 Plan Percent Black Alone VAP by VTD)

Map Appendix 11 (Cooper Plan 3 and Alabama Existing Districts)

Map Appendix 11A (Cooper Plan 3 Plan Percent Black Alone VAP by VTD)

Map Appendix 12 (Cooper Plan 4 and Alabama Existing Districts)

Map Appendix 12A (Cooper Plan 4 Plan Percent Black Alone VAP by VTD)

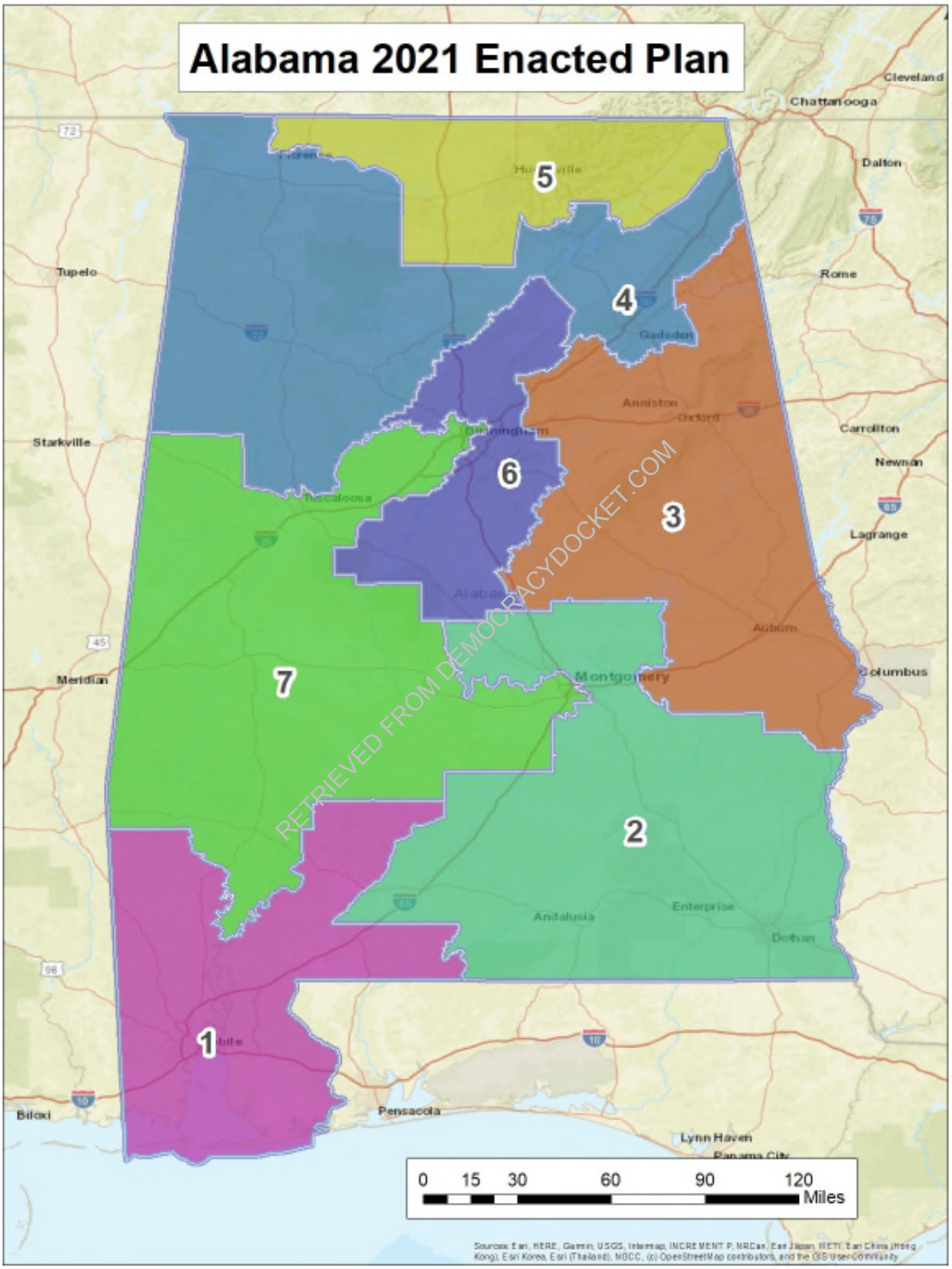
Map Appendix 13 (Cooper Plan 5and Alabama Existing Districts)

Map Appendix 13A (Cooper Plan 5 Plan Percent Black Alone VAP by VTD)

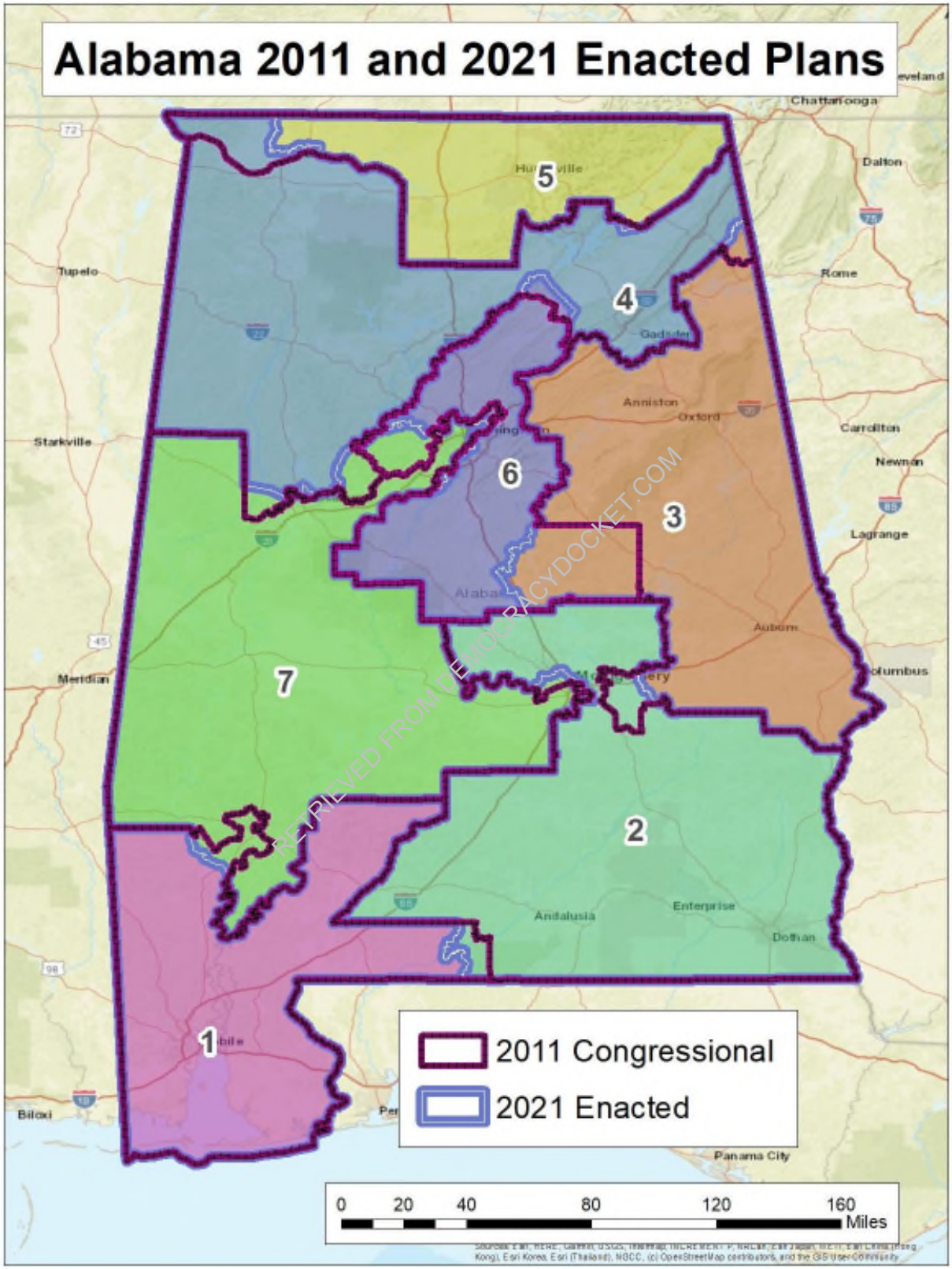
Map Appendix 14 (Cooper Plan 6 and Alabama Existing Districts)

Map Appendix 14A (Cooper Plan 6 Plan Percent Black Alone VAP by VTD)

Map Appendix 1 (State of Alabama 2021 Enacted Plan)

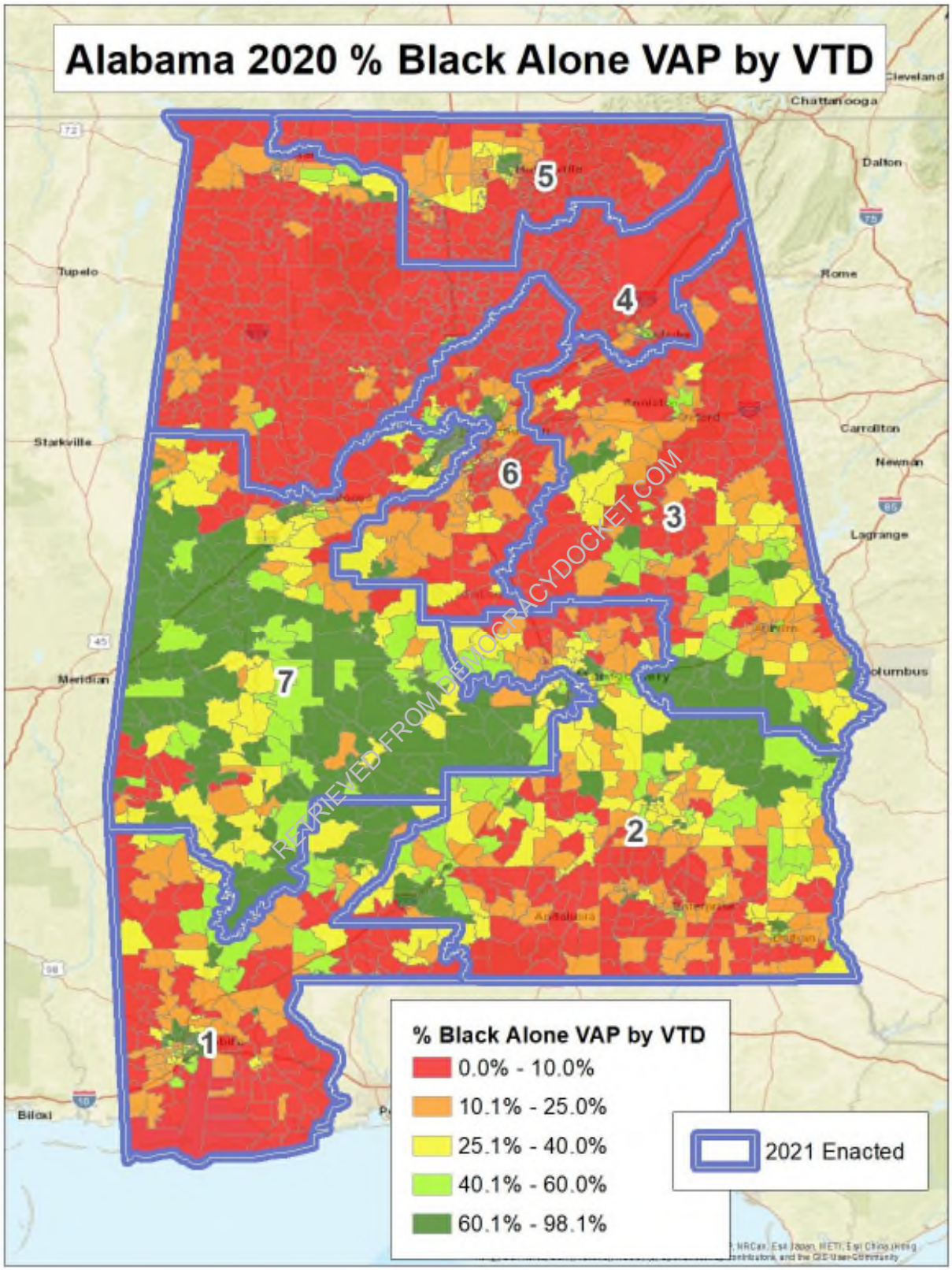


Map Appendix 2 (State of Alabama 2011 and 2021 Enacted Plans)

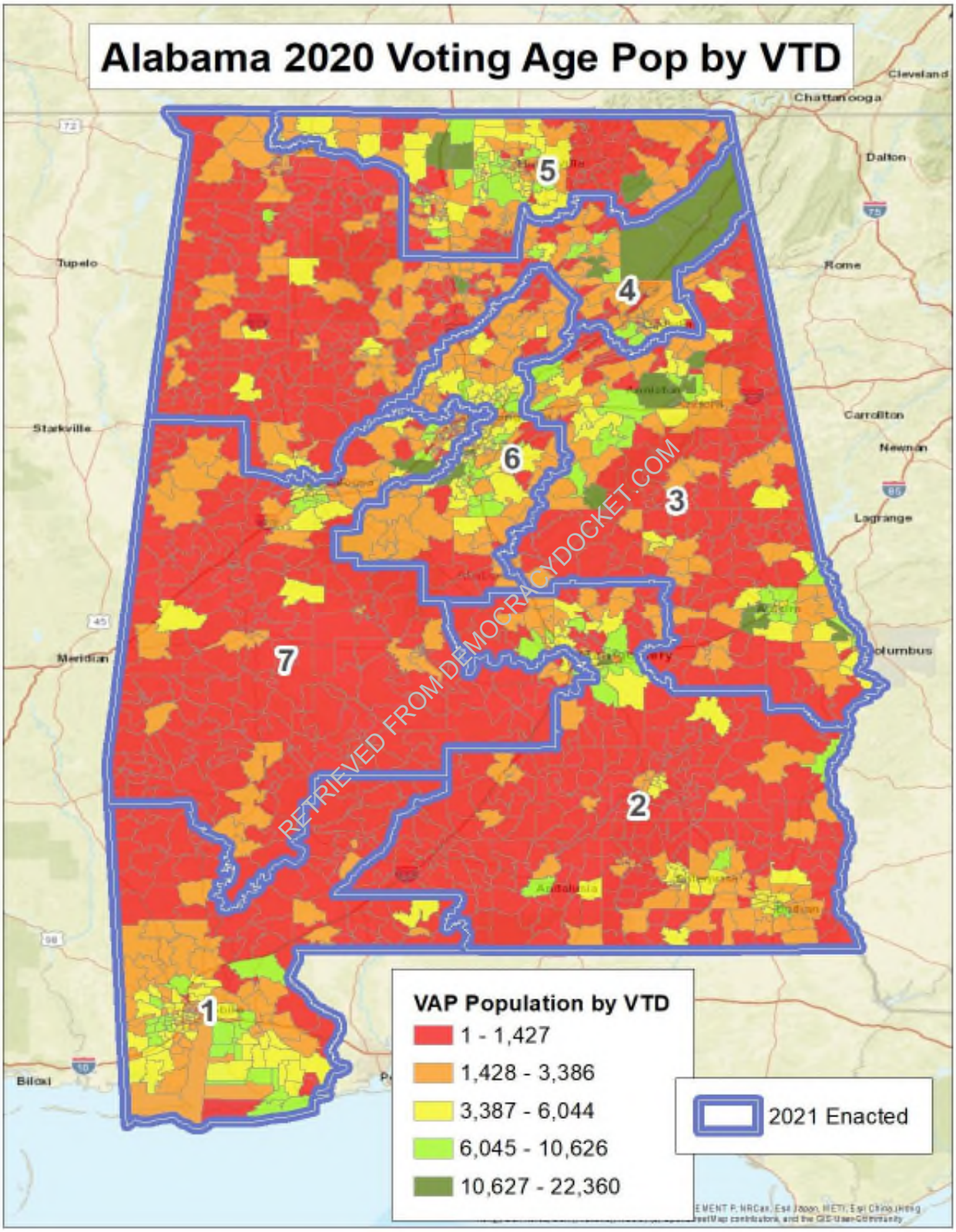


Alabama Enacted Plan
Map Appendices
% Black Alone and VAP
By County and VTD

Map Appendix 3 (State of Alabama Enacted Plan Percent Black Alone VAP by VTD)



Map Appendix 4 (State of Alabama Voting Age Population by VTD)



Duchin Plans
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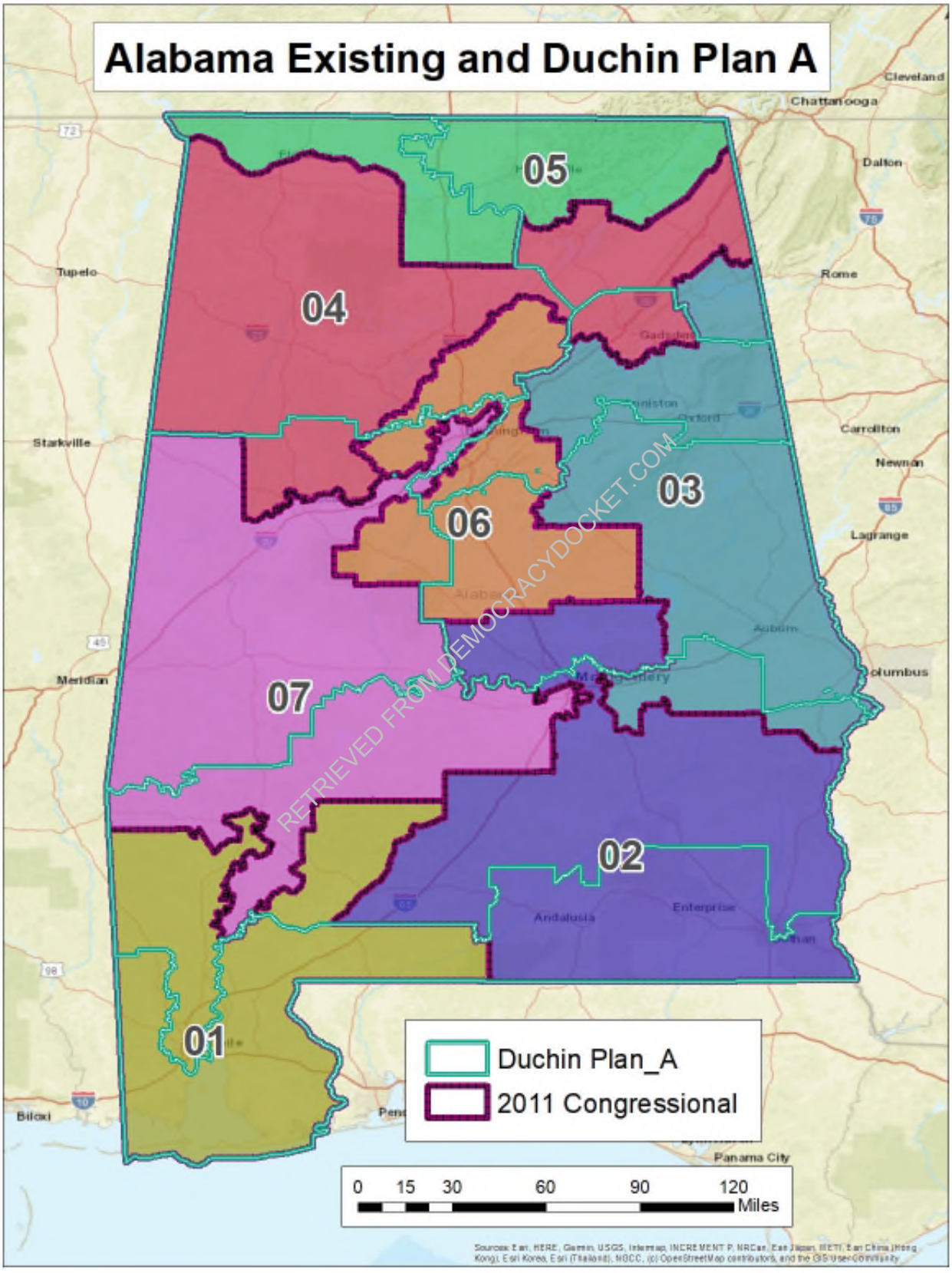
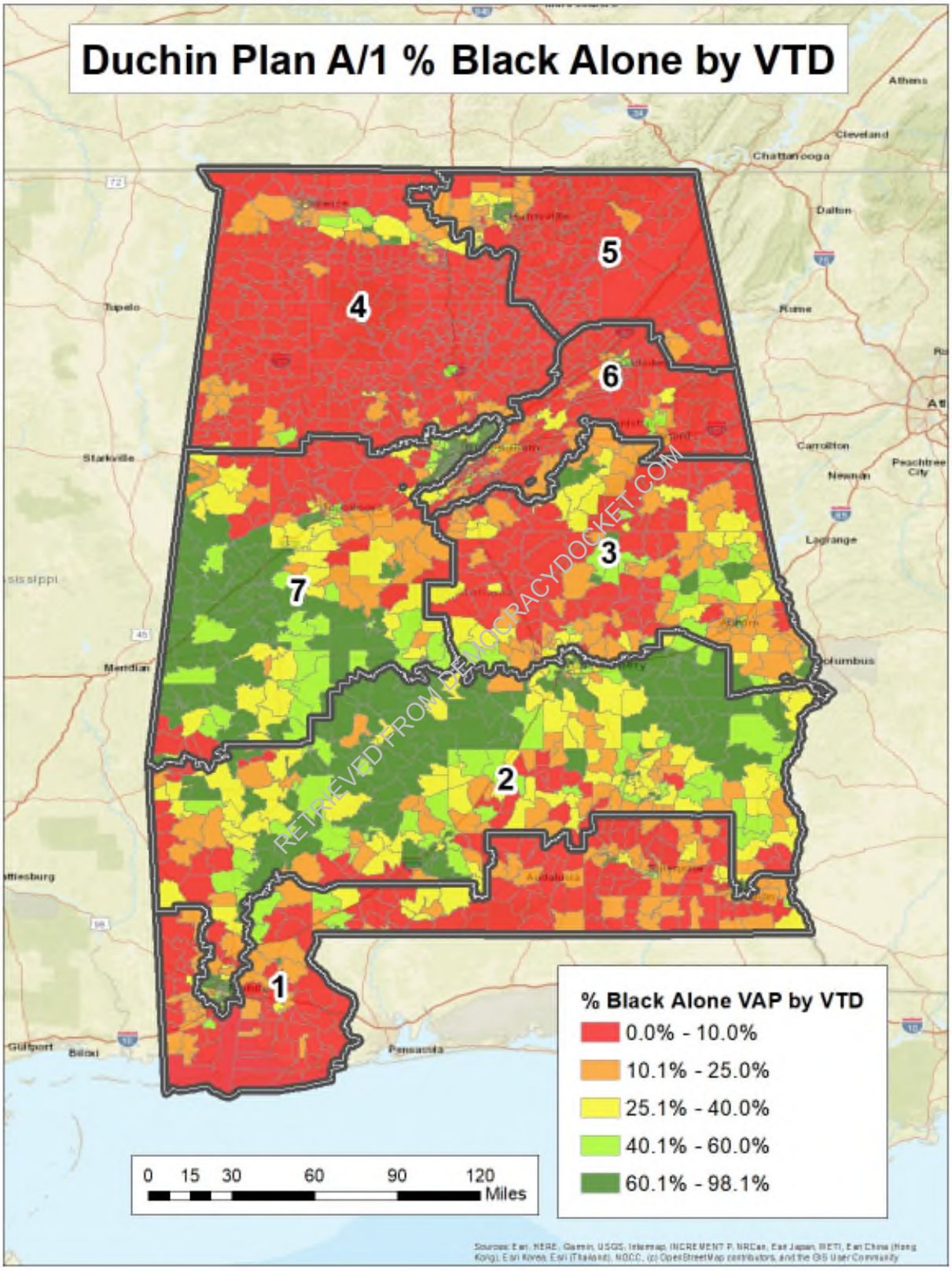
Base Map and
% Black Alone and VAP
By Census VTD

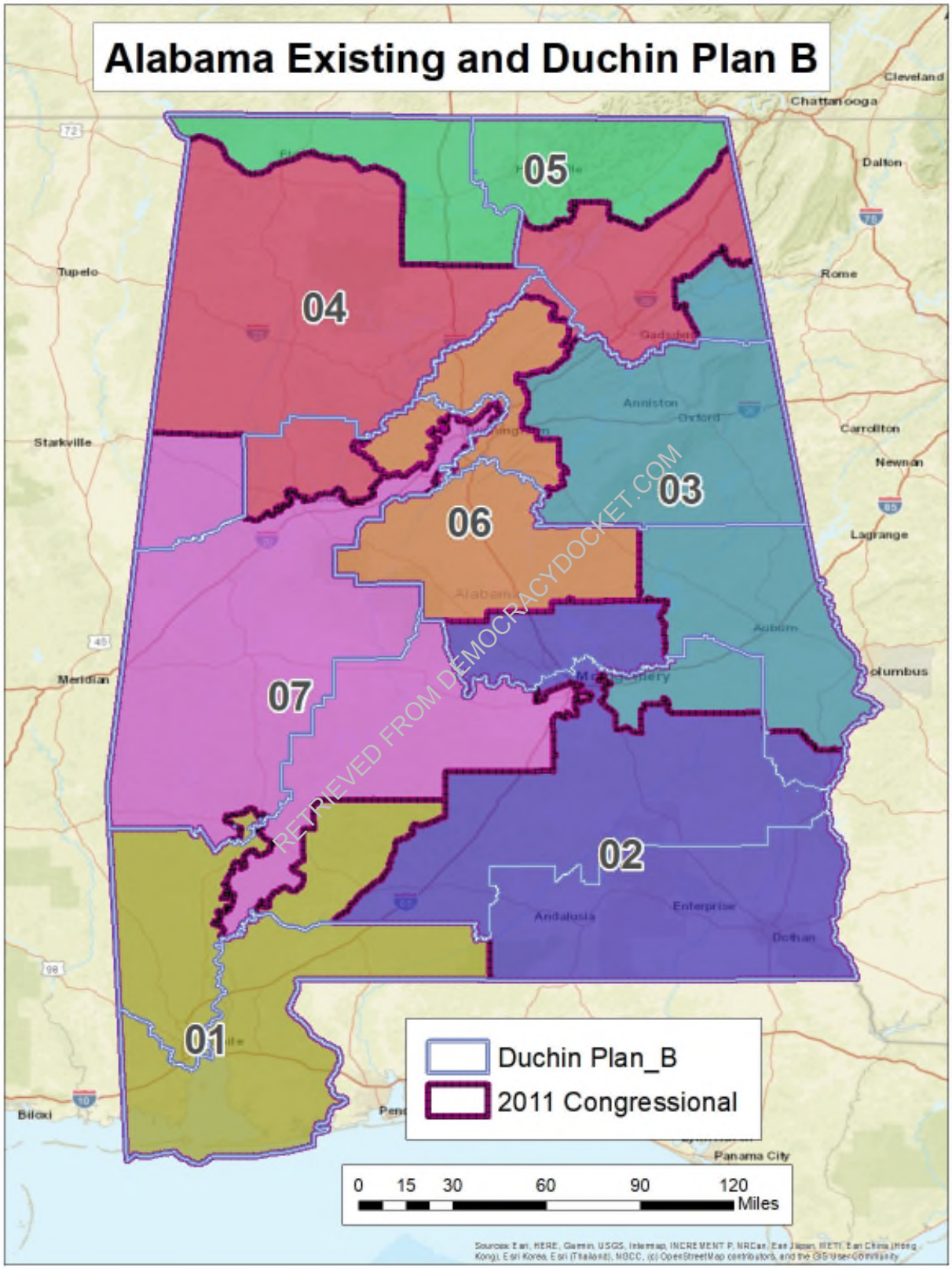
Map Appendix 5 (Duchin Plan A/1 and Alabama Existing Districts)



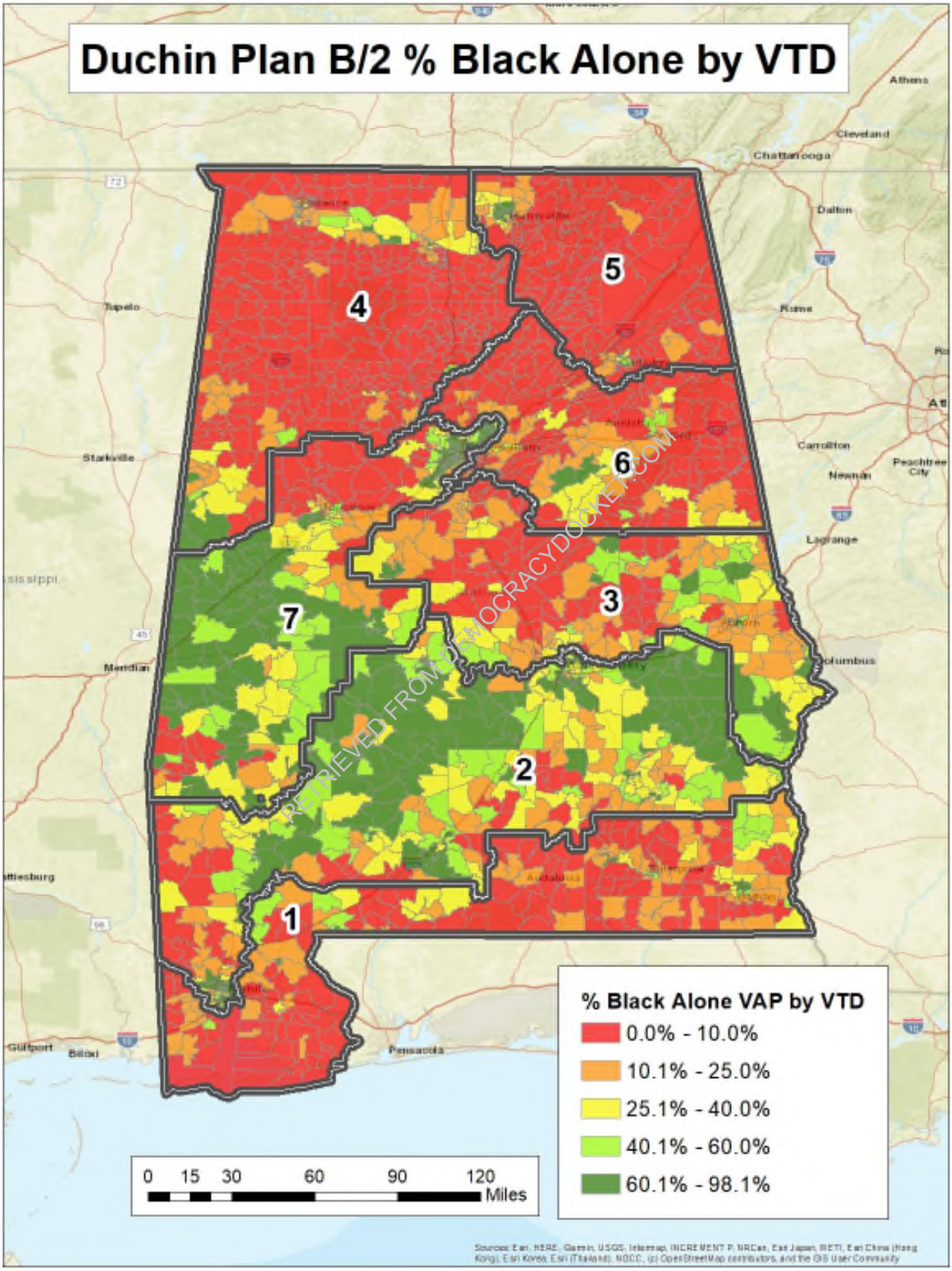
Map Appendix 5A (Duchin Plan A/1 Plan Percent Black Alone VAP by VTD)



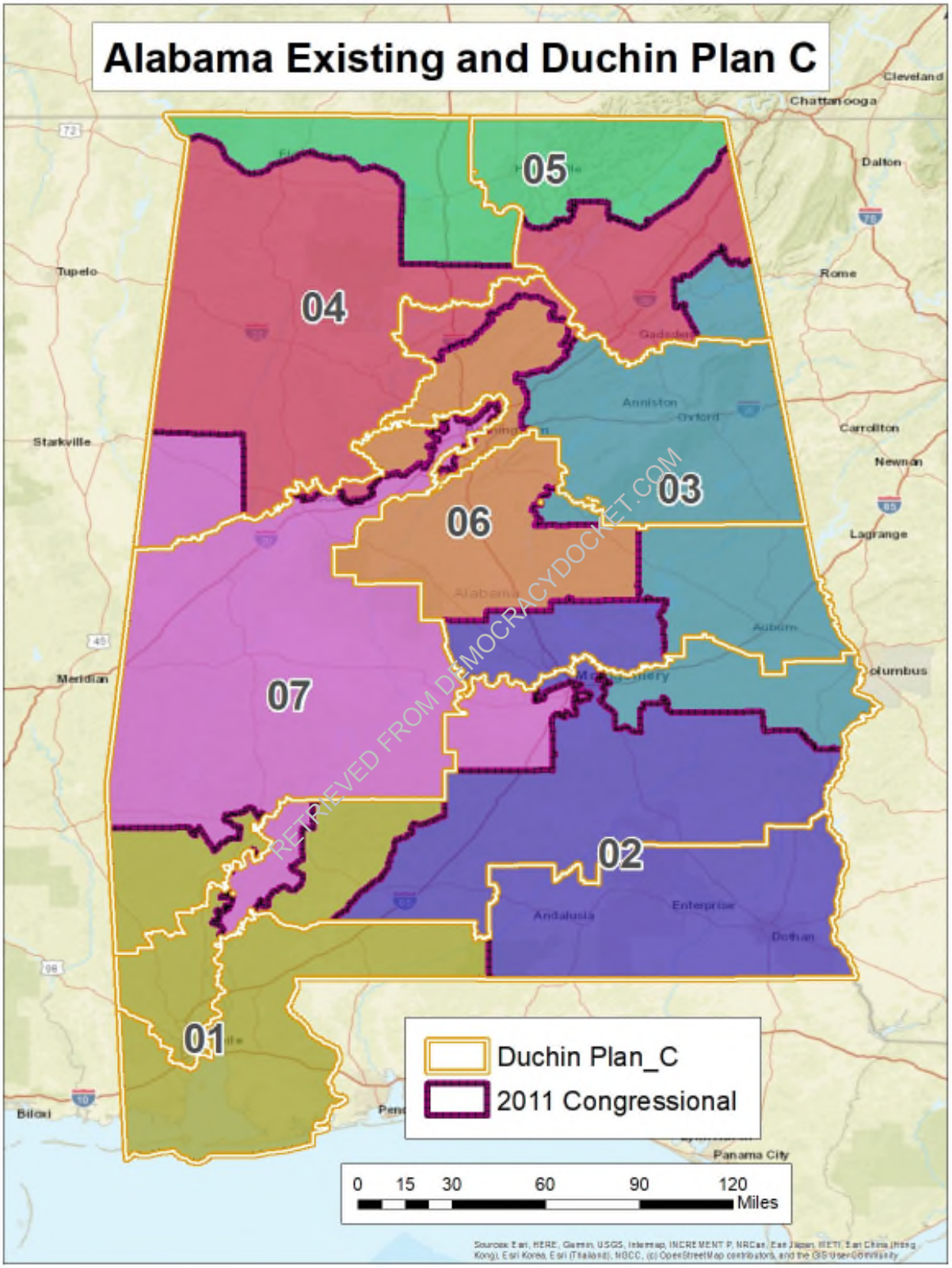
Map Appendix 6 (Duchin Plan B/2 and Alabama Existing Districts)



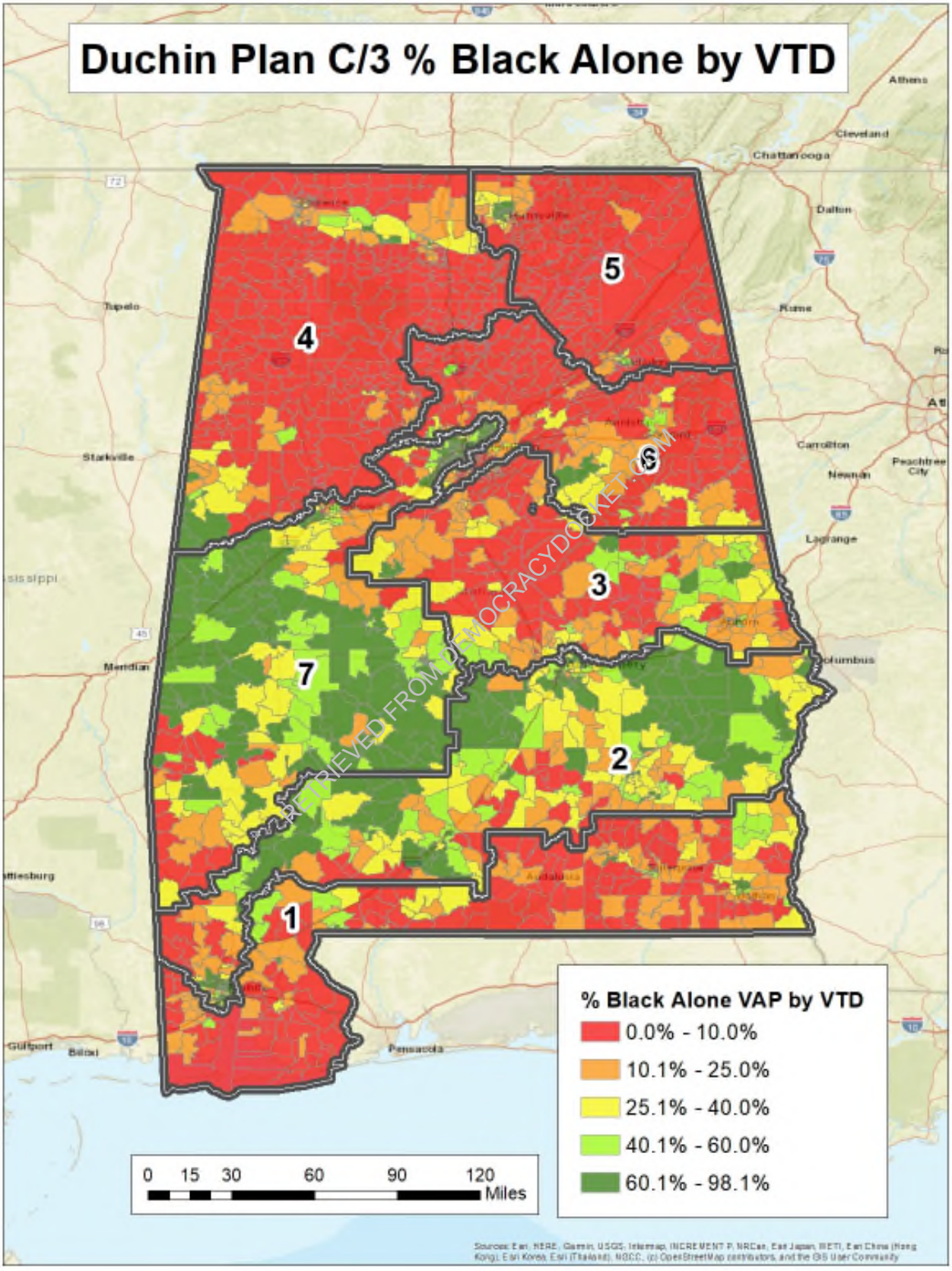
Map Appendix 6A (Duchin Plan B/2 Plan Percent Black Alone VAP by VTD)



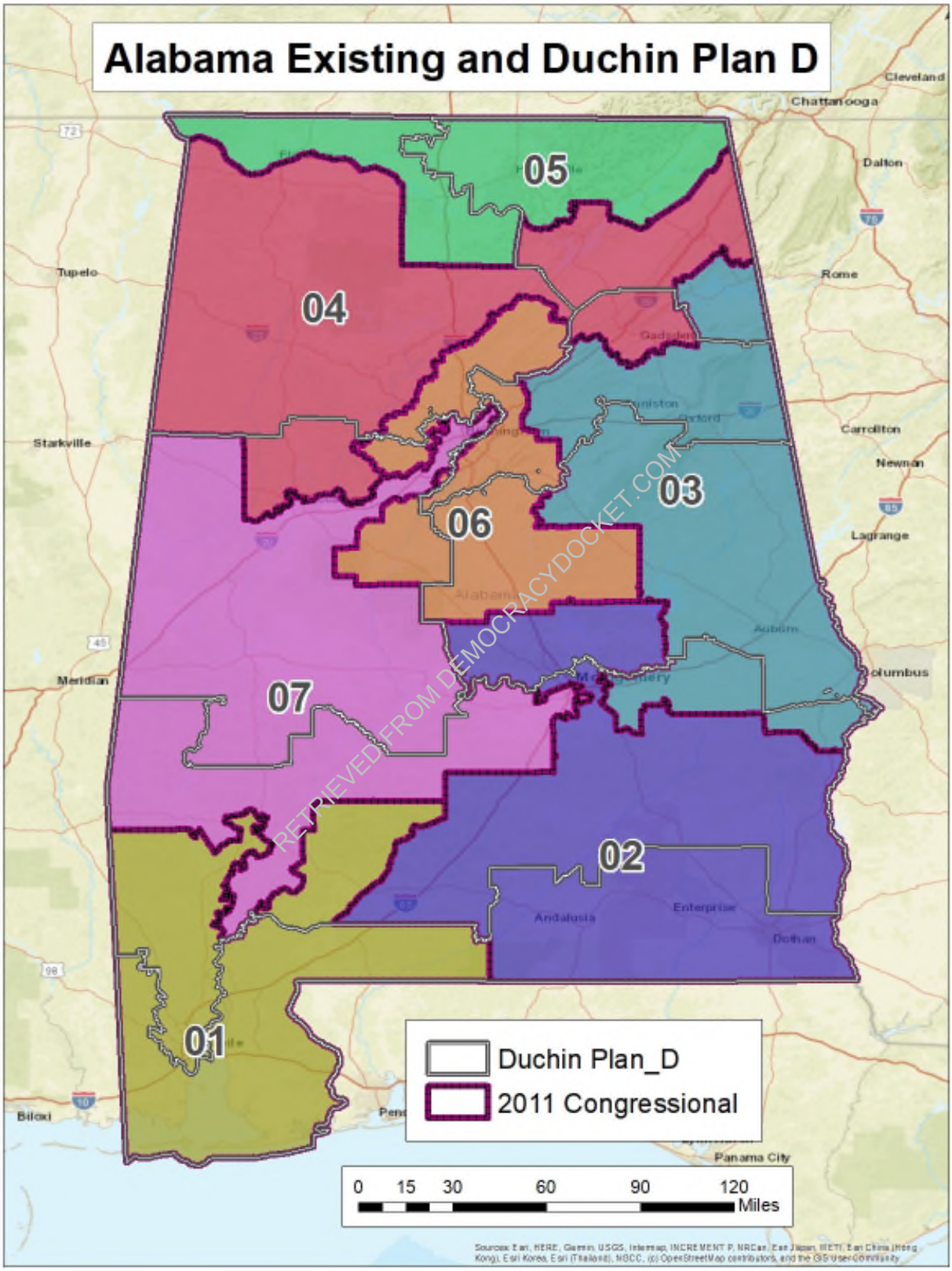
Map Appendix 7 (Duchin Plan C/3 and Alabama Existing Districts)



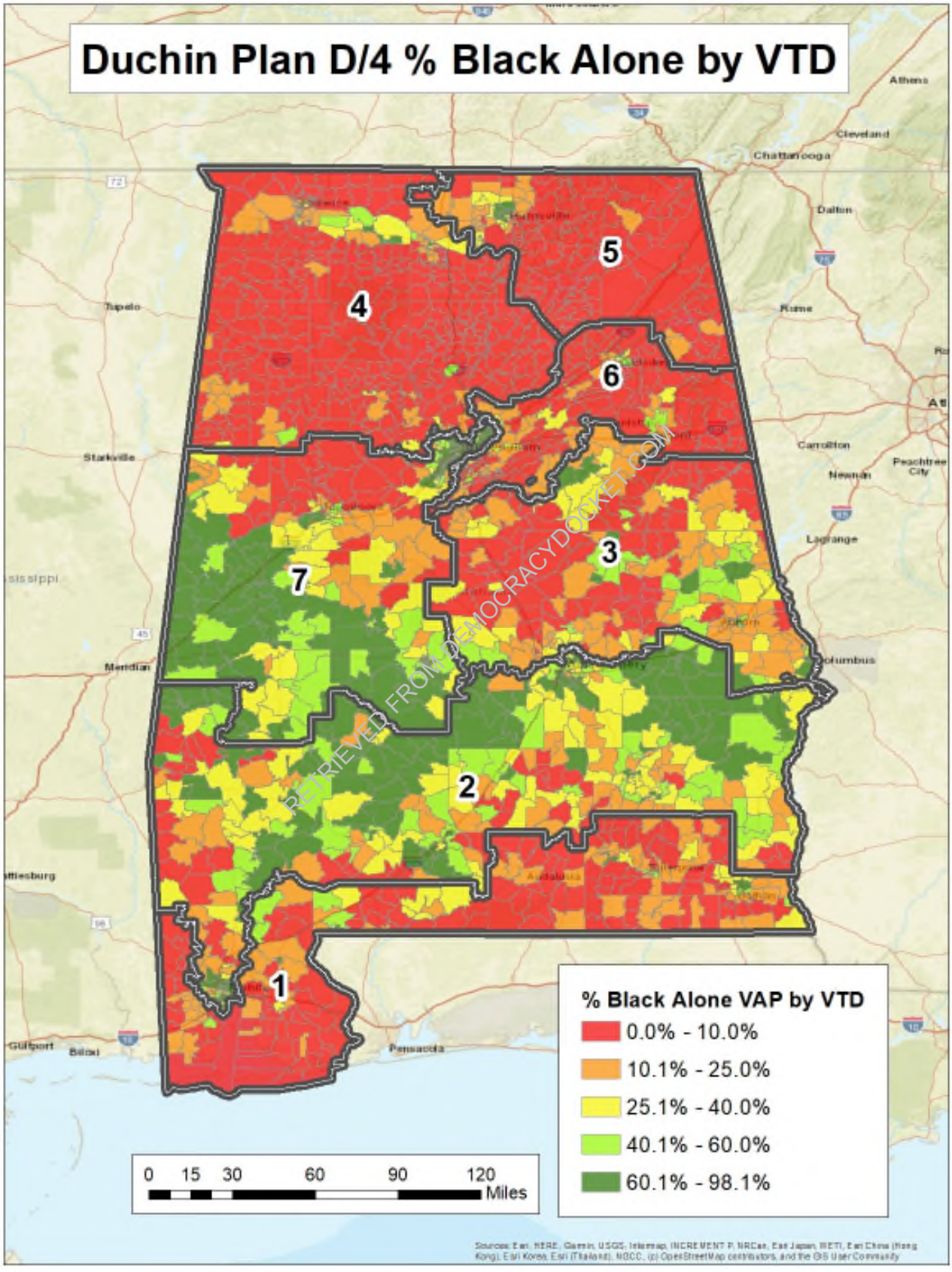
Map Appendix 7A (Duchin Plan C/3 Plan Percent Black Alone VAP by VTD)



Map Appendix 8 (Duchin Plan D/4and Alabama Existing Districts)

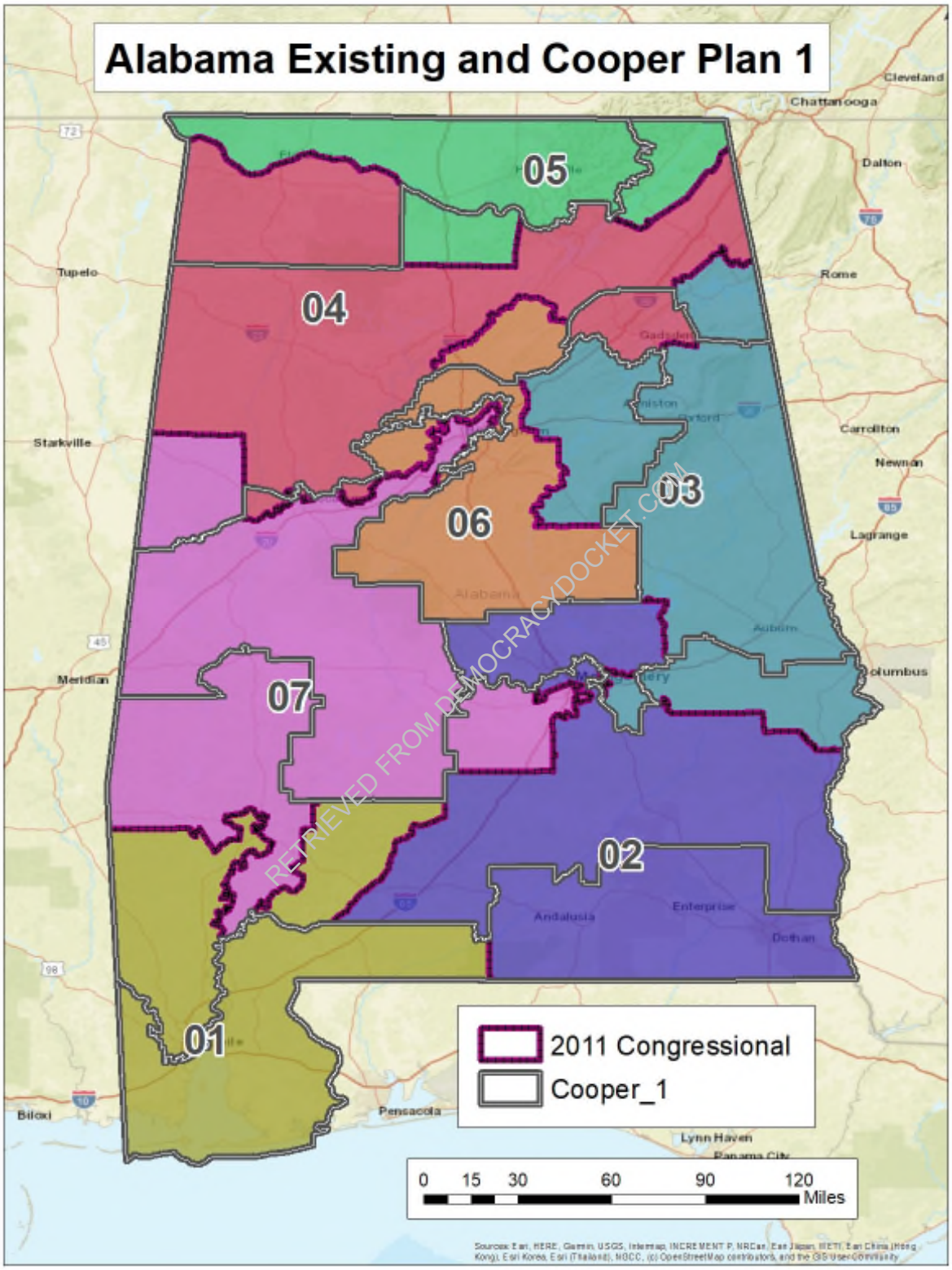


Map Appendix 8A (Duchin Plan D/4 Plan Percent Black Alone VAP by VTD)

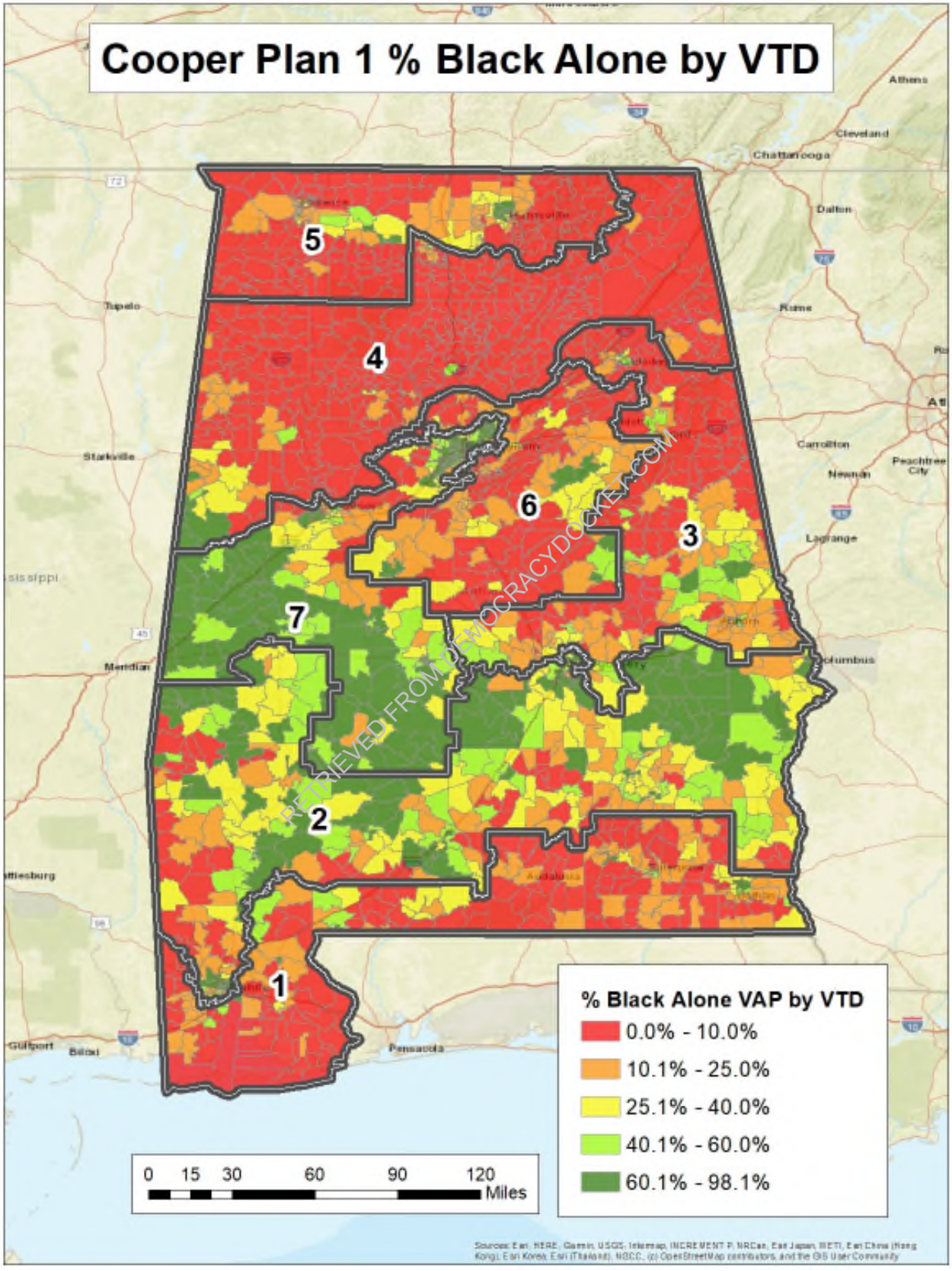


Cooper Plans
Map Appendices
% Black Alone and VAP
By Census VTD

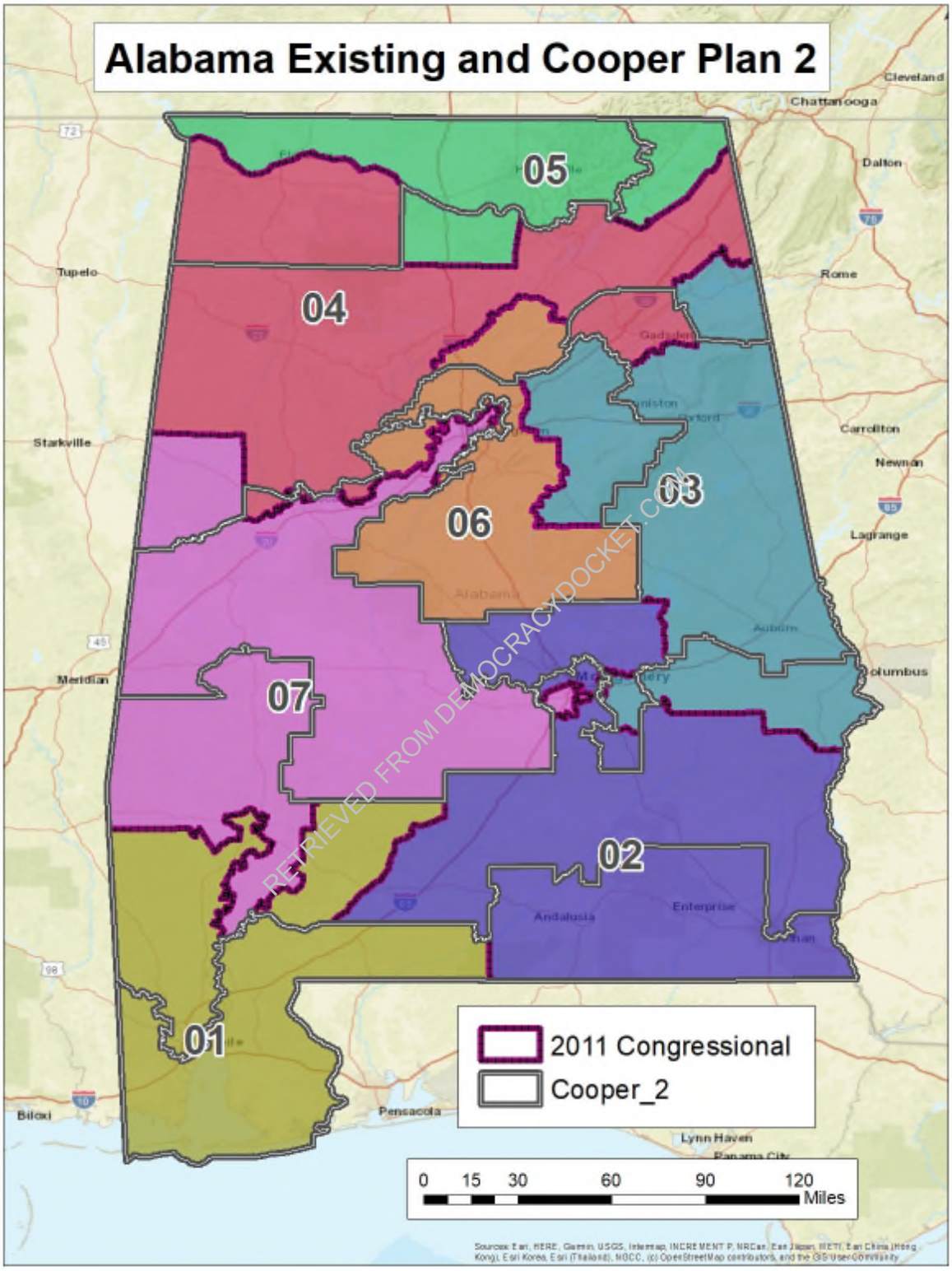
Map Appendix 9 (Cooper Plan 1 and Alabama Existing Districts)



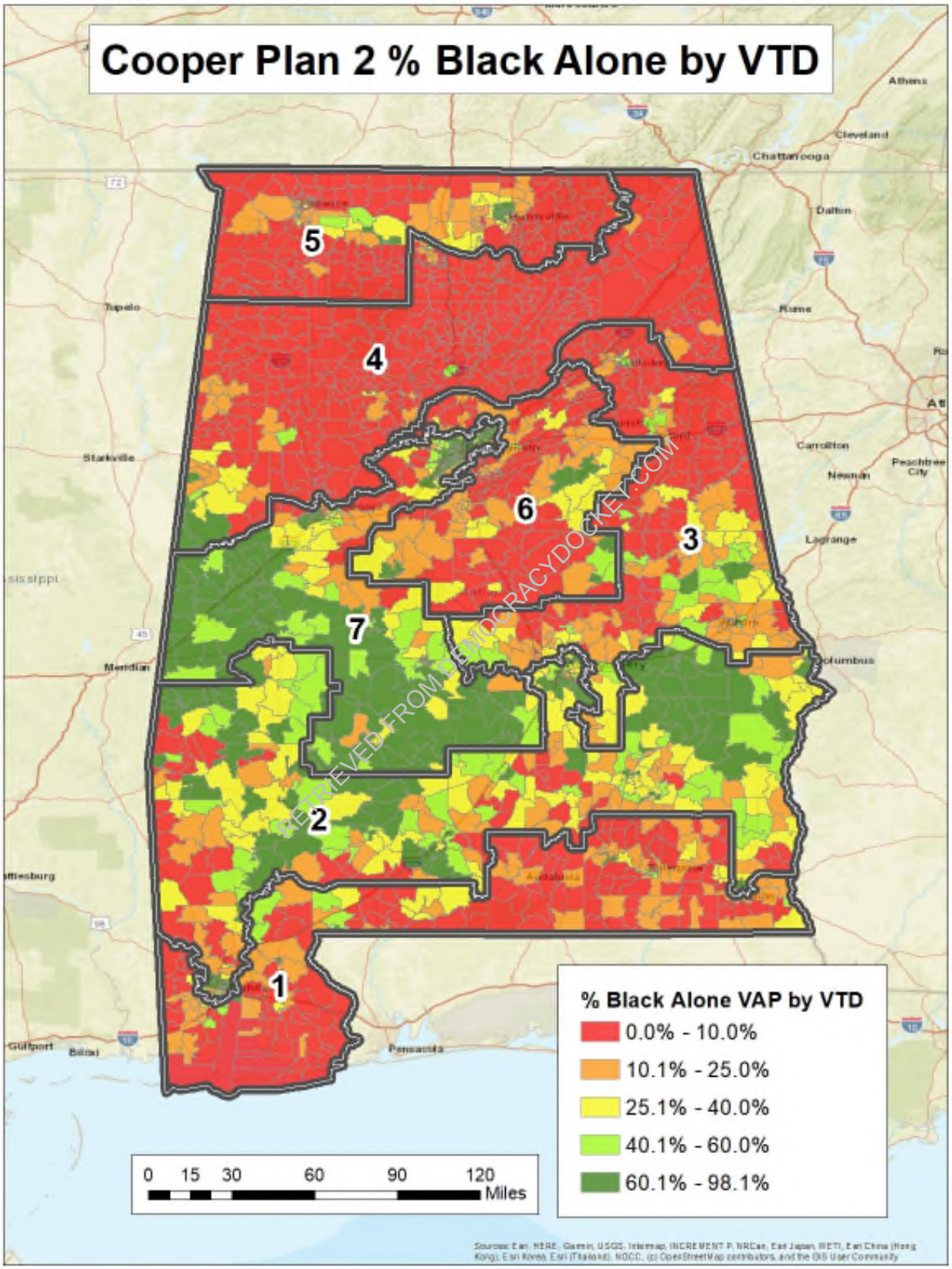
Map Appendix 9A (Cooper Plan 1 Plan Percent Black Alone VAP by VTD)



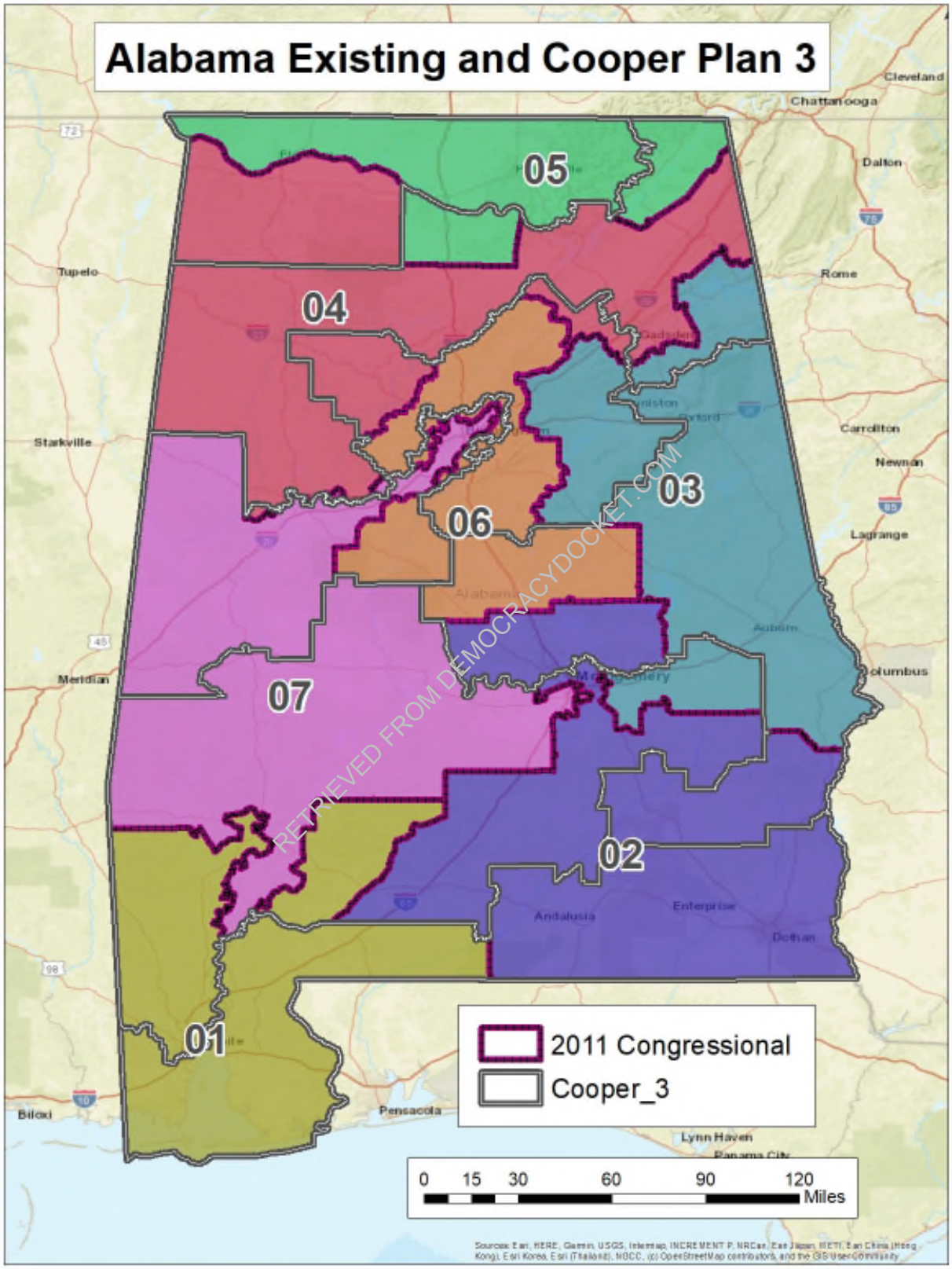
Map Appendix 10 (Cooper Plan 2 and Alabama Existing Districts)



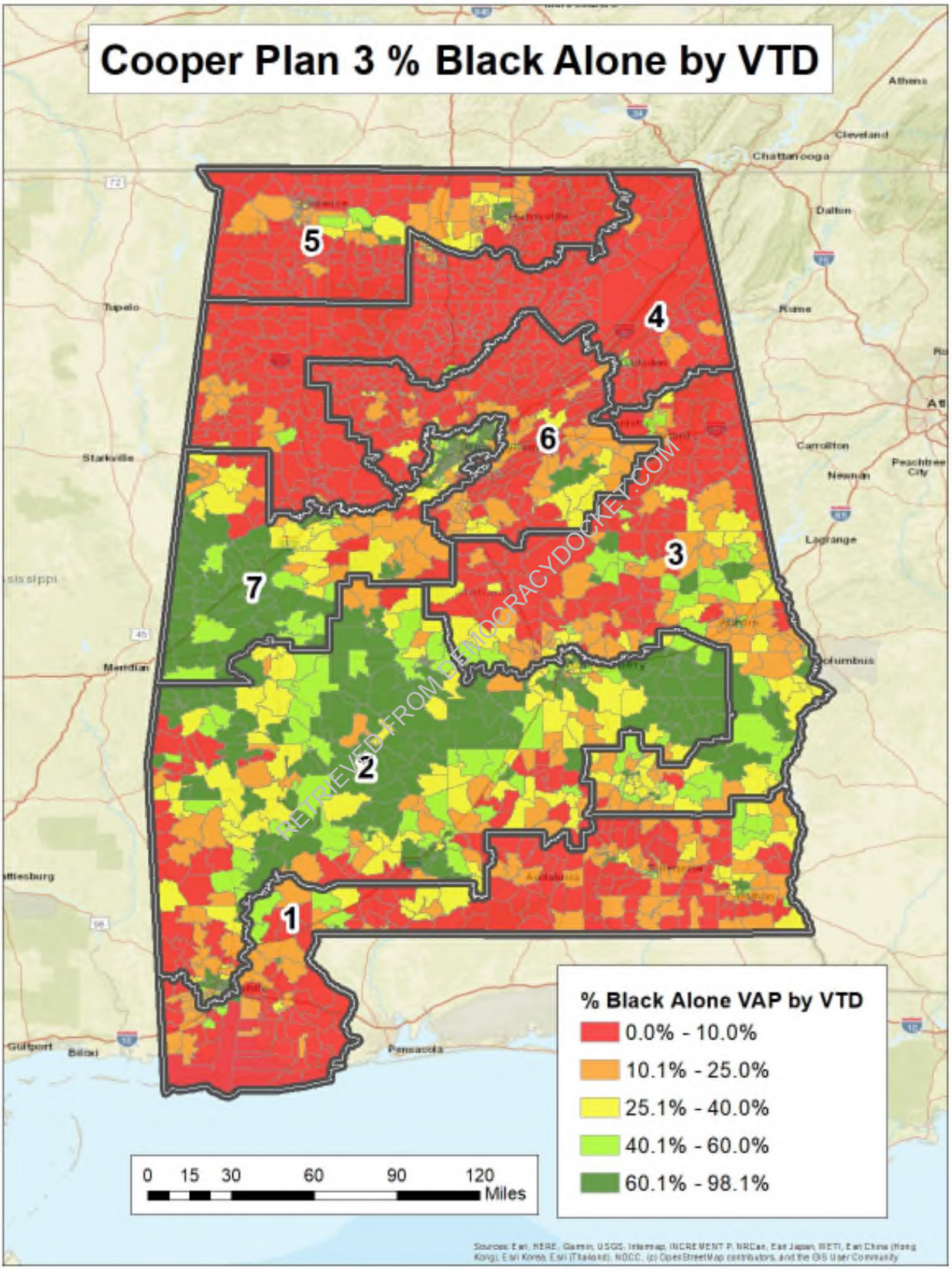
Map Appendix 10A (Cooper Plan 2 Plan Percent Black Alone VAP by VTD)



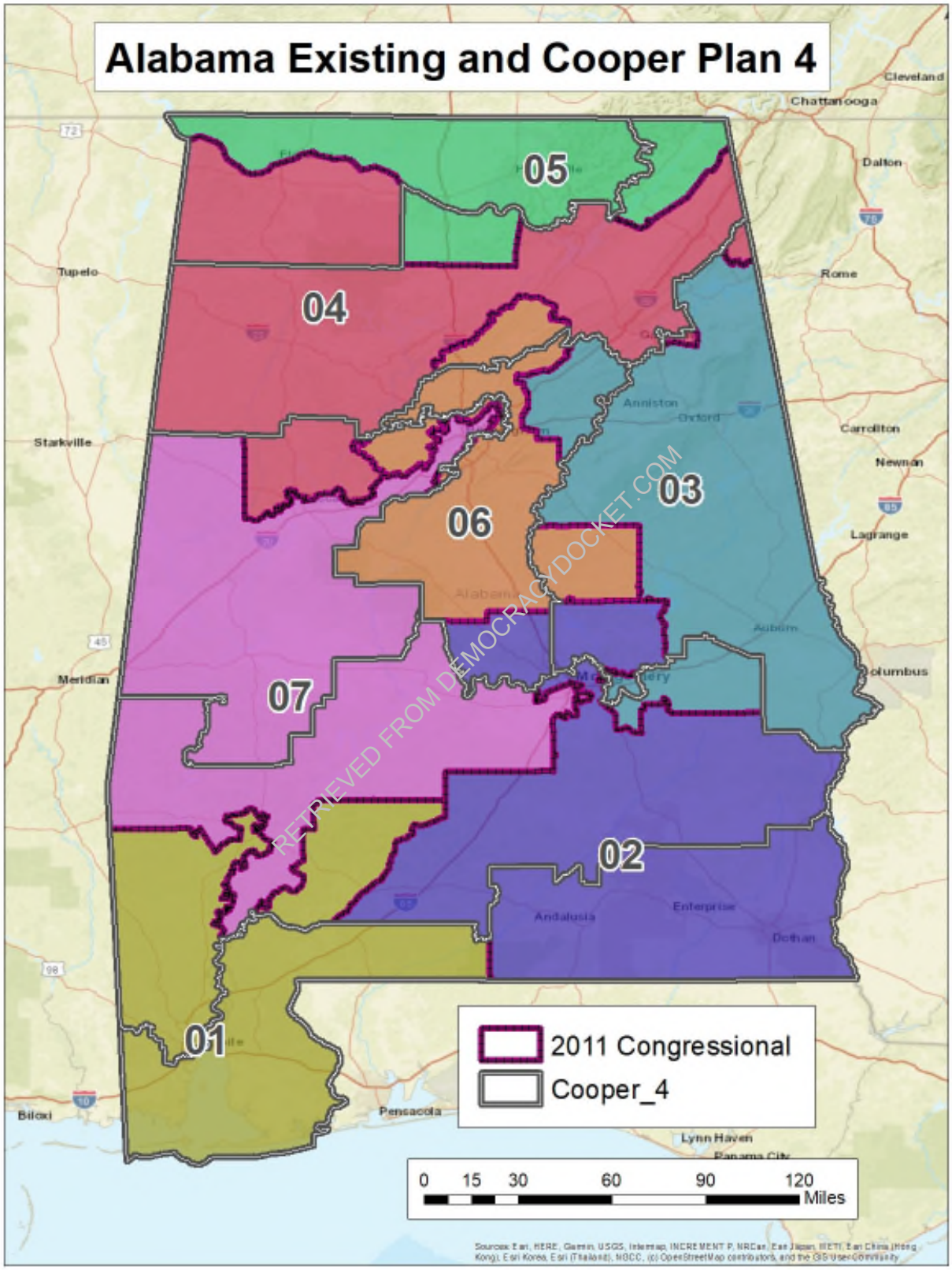
Map Appendix 11 (Cooper Plan 3 and Alabama Existing Districts)



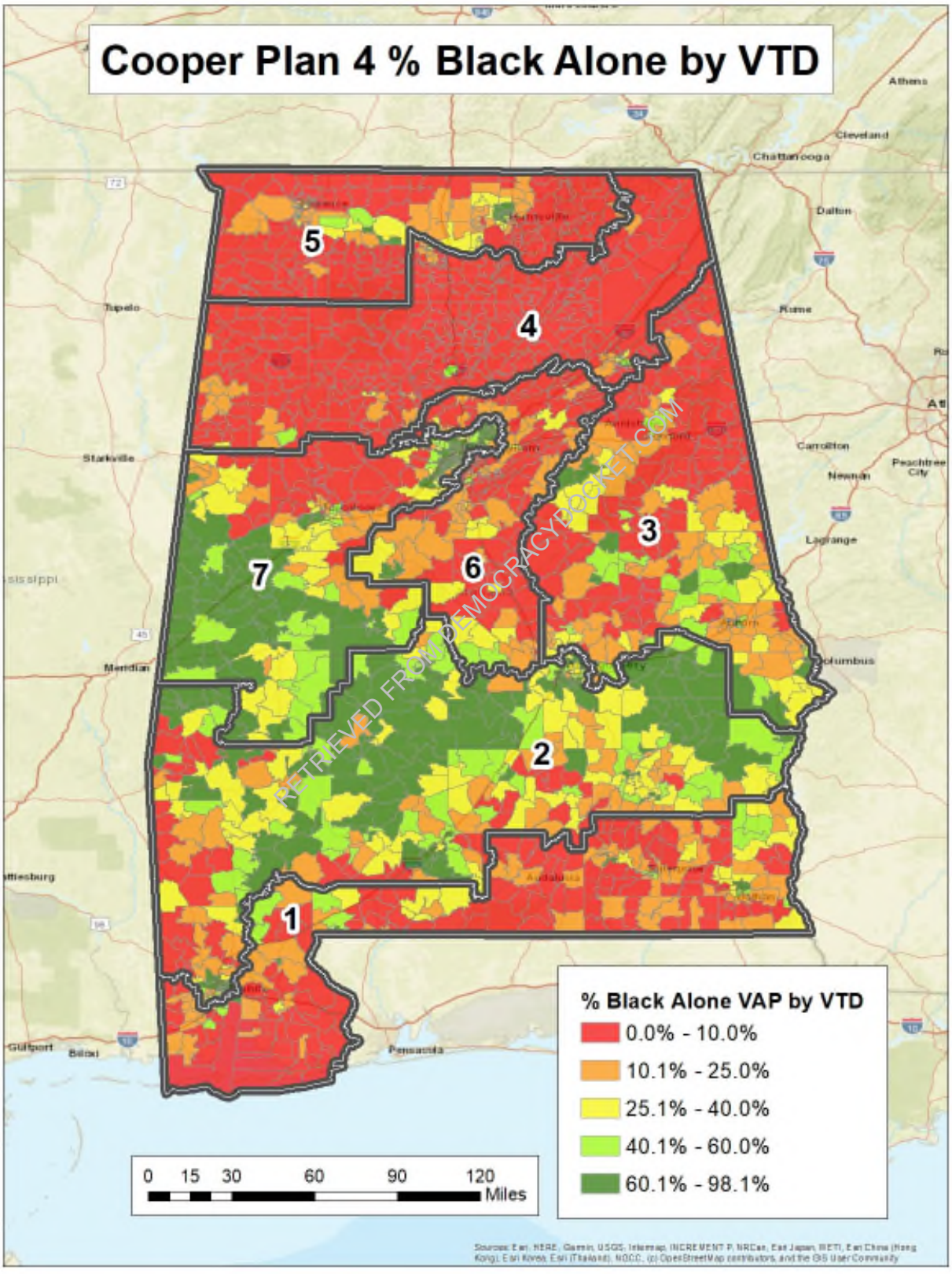
Map Appendix 11A (Cooper Plan 3 Plan Percent Black Alone VAP by VTD)



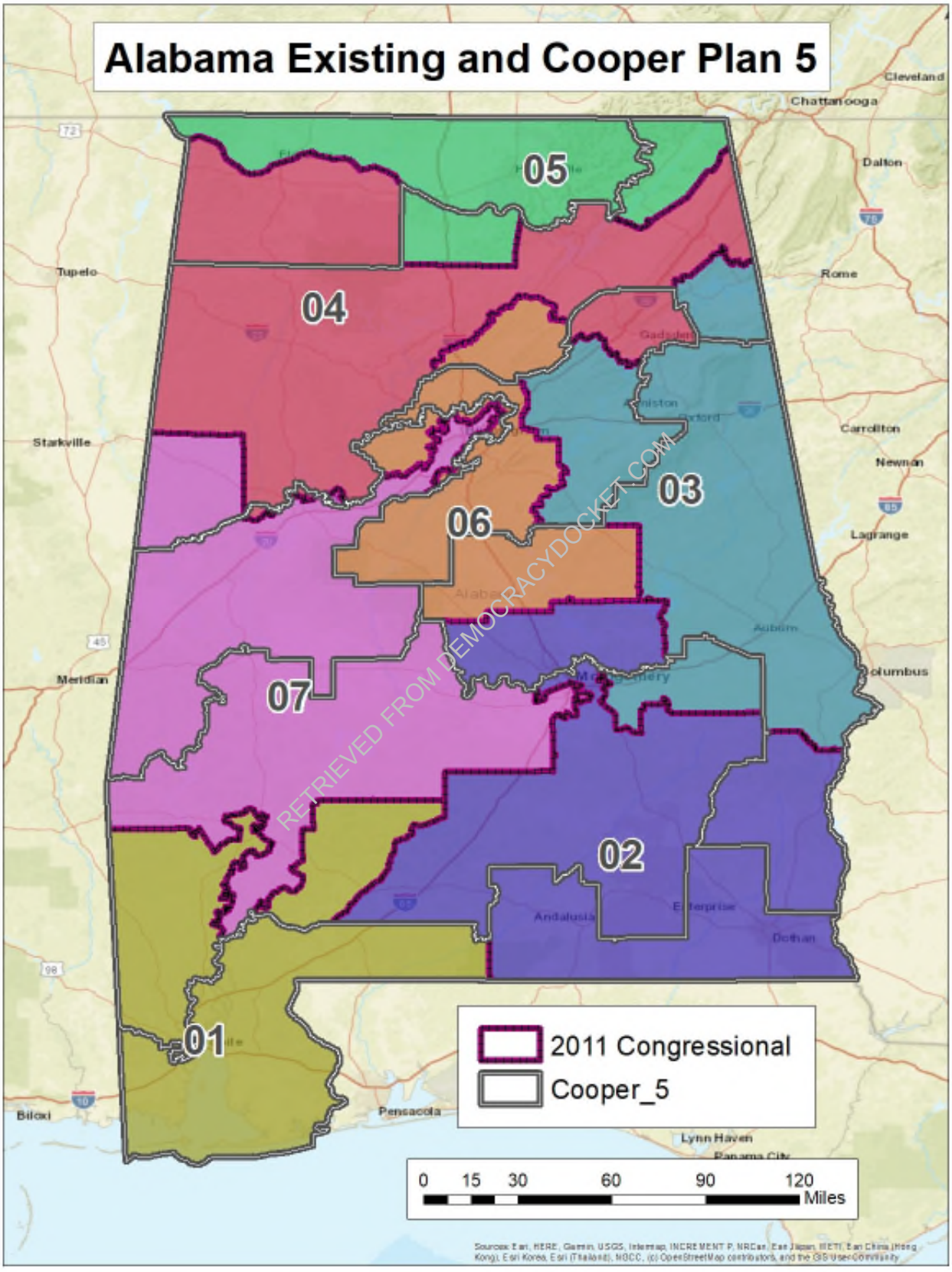
Map Appendix 12 (Cooper Plan 4 and Alabama Existing Districts)



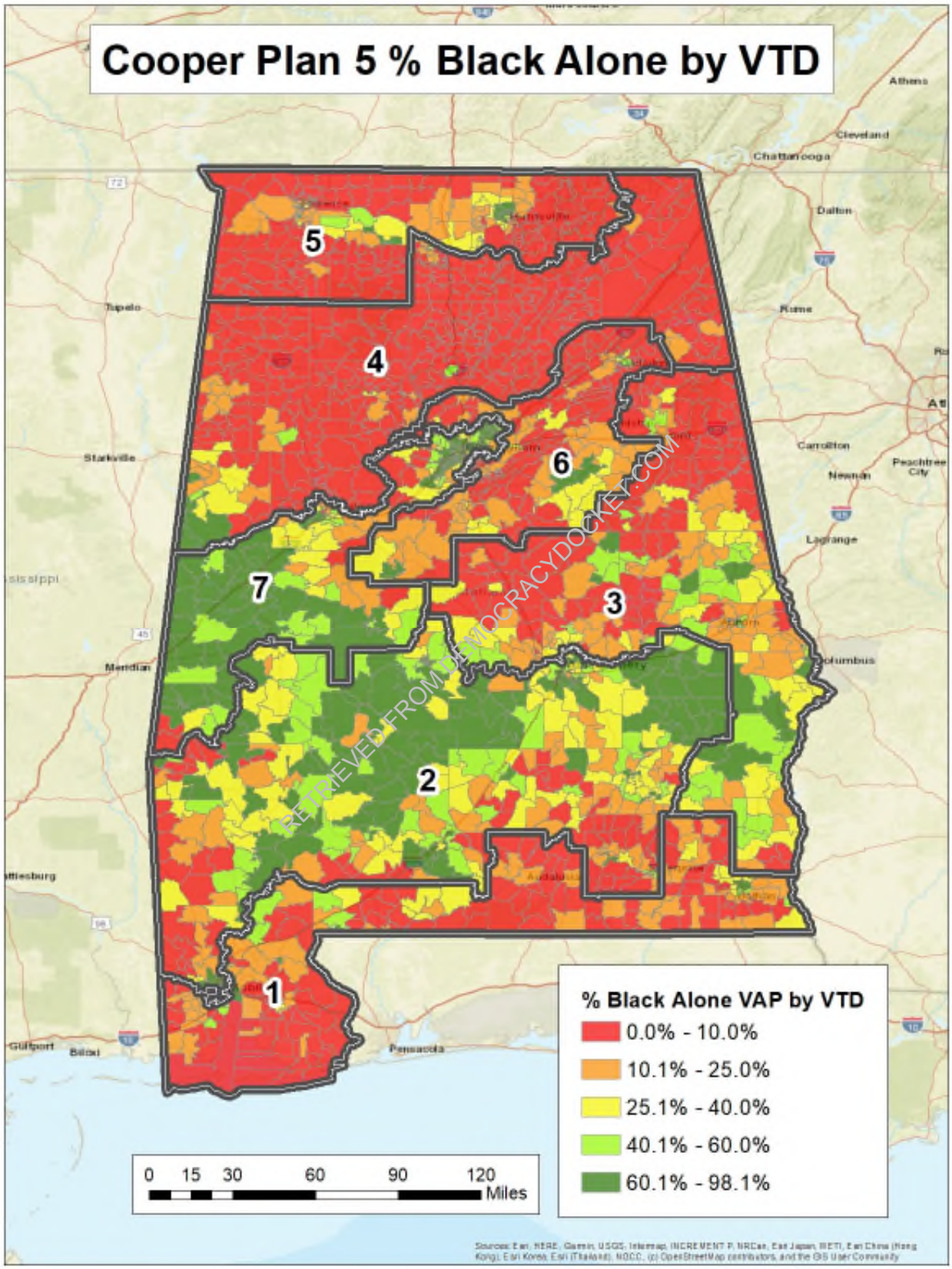
Map Appendix 12A (Cooper Plan 4 Plan Percent Black Alone VAP by VTD)



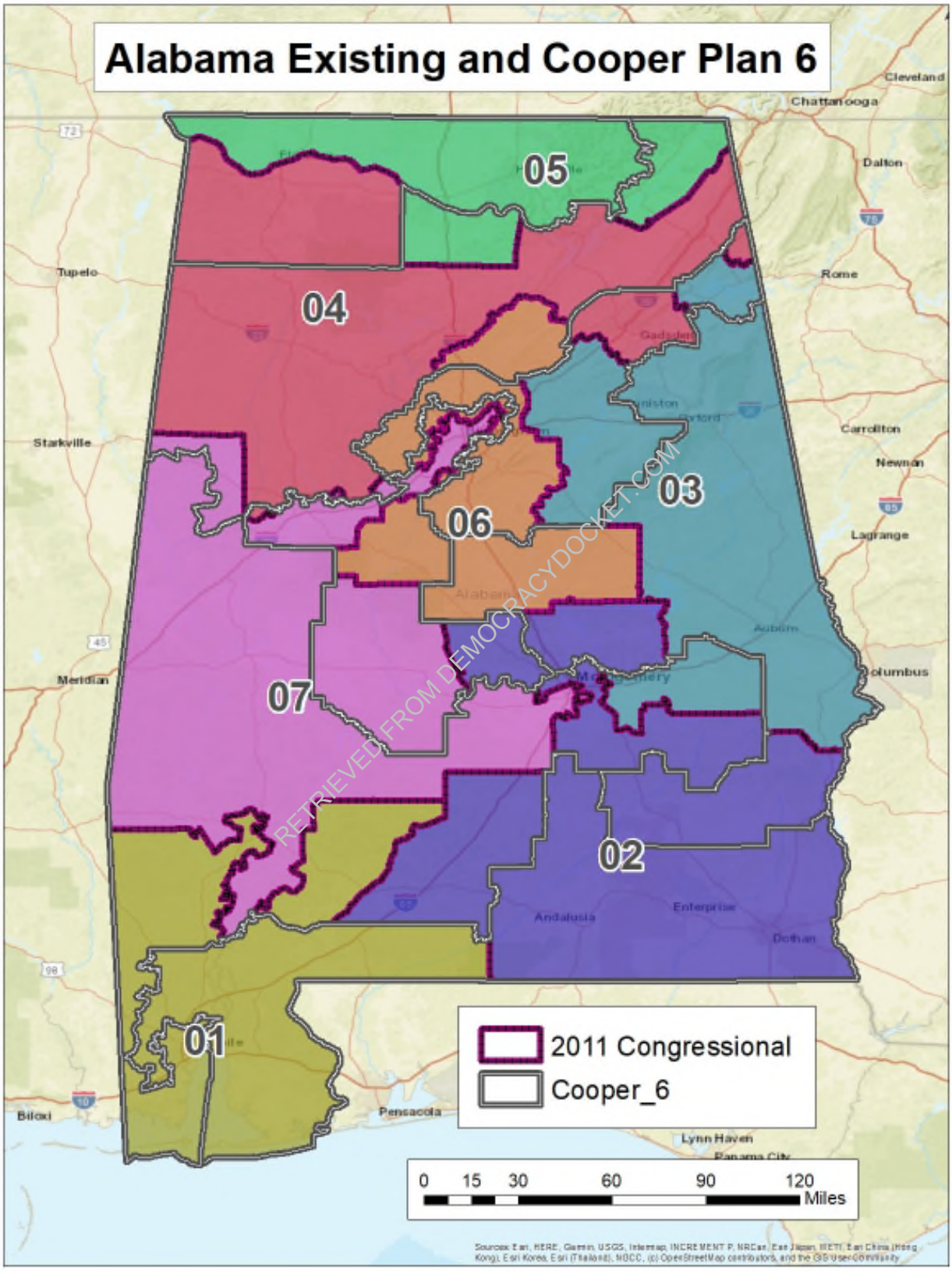
Map Appendix 13 (Cooper Plan 5 and Alabama Existing Districts)



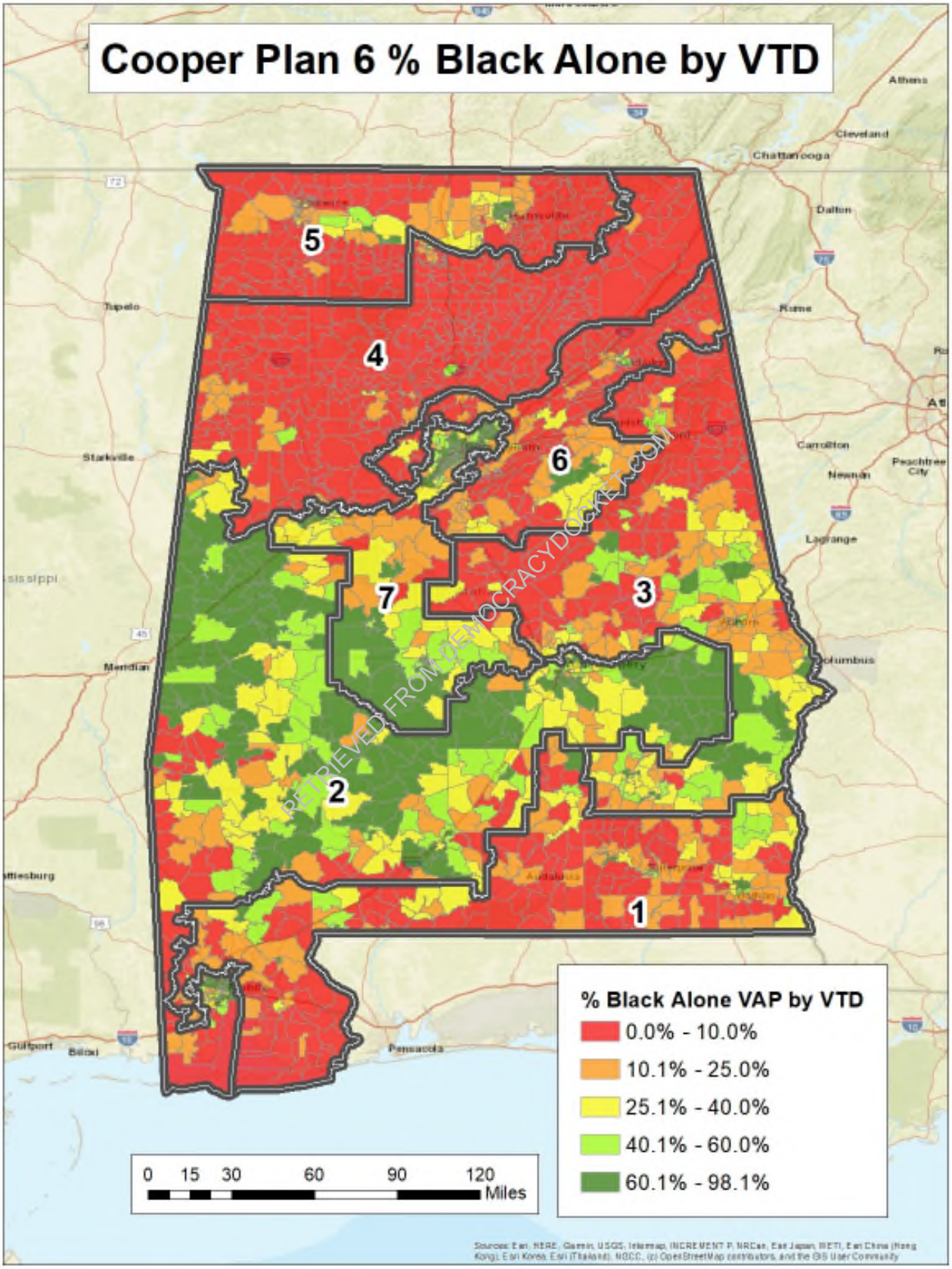
Map Appendix 13A (Cooper Plan 5 Plan Percent Black Alone VAP by VTD)



Map Appendix 14 (Cooper Plan 6 and Alabama Existing Districts)



Map Appendix 14A (Cooper Plan 6 Plan Percent Black Alone VAP by VTD)



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U.S. DISTRICT COURT
N.D. OF ALABAMA

IN THE UNITED STATES DISTRICT COURT
FOR THE NORTERN DISTRICT OF ALABAMA
(SOUTHERN DIVISION)

BOBBY SINGLETON, *et al.*, **Plaintiffs,** **v.** **JOHN MERRILL, in his official capacity as Alabama Secretary of State** **Defendant.**	**Case No. 2:21-cv-01291-AMM** **THREE-JUDGE COURT**
EVAN MILLIGAN, *et al.*, **Plaintiffs,** **v.** **JOHN MERRILL, in his official capacity as Alabama Secretary of State** **Defendant.**	**Case No. 2:21-cv-01530-AMM**
MARCUS CASTER, *et al.*, **Plaintiffs,** **v.** **JOHN MERRILL, in his official capacity as Alabama Secretary of State** **Defendant.**	**Case No.: 2:21-cv-1536-AMM**

SUPPLEMENTAL EXPERT REPORT OF M.V. HOOD III

I, M.V. Hood III, affirm the conclusions I express in this report are provided to a reasonable degree of professional certainty. In addition, I do hereby declare the following:

In this supplemental expert report, I write to raise some questions concerning reports issued by plaintiffs' experts Professor Maxwell Palmer and Professor Baodong Liu. Both Professor Palmer and Professor Liu conducted a series of racially polarized voting analyses.

My concerns are as follows:

1. Professor Palmer relies on Citizen Voting Age Population from the Census. Although these data come from the U.S. Census Bureau, they are based on survey data from the American Community Survey (ACS) and not on the population enumeration data collected every decade (P.L. 94-171).[1] As such, these figures are actually estimates which come with a margin of error. Unlike most states, Alabama records the race of registrants in its voter registration database. Combining this source with voter history files also allows one to calculate turnout by race. In this case, these are not estimates, but actual counts of registration and turnout by race. Additionally, the CVAP data from the ACS are only available down to the block group level. Districting plans that are drawn at the block-level would require one to disaggregate the CVAP data to that level. While this can be done, one is required to make a number of assumptions about the manner in which the CVAP block group data should be disaggregated to the respective blocks in the group.[2] This process may, in turn, also introduce another source of potential error.

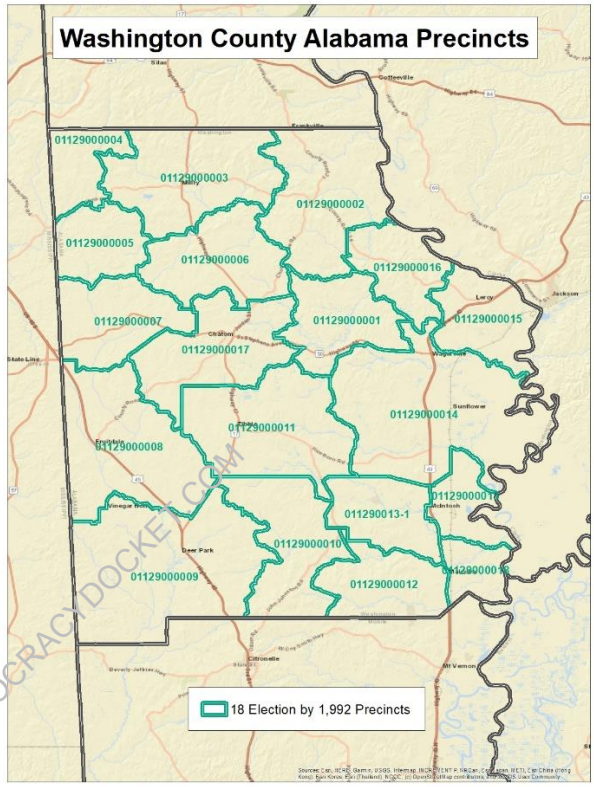
2. Professor Palmer obtained most of the data he used in his analyses from the Redistricting Data Hub website. Under the data for Alabama hosted on this website, a document provides a detailed set of notes on data collection and management. Precinct-level election data merged with precinct geography shapefiles are provided on this site. But, there are a number of potential notes of caution. For example, this organization reports they "were not able to replicate joining election data and precinct boundaries because we did not have precinct boundary data for every county."[3] It is unclear from his report how much time Professor Palmer engaged in to validate the quality of data housed on the Redistricting Data Hub website.

As an example, the VTDs (precincts) on the Redistricting Data Hub's website for Washington County do not comport with the actual precinct boundaries. After examining the VTD shapefiles for Washington County on the Redistricting Data Hub website, I was able to determine they were represented by Figure 1 below (red lines). However, after consultation with Washington County election officials, I was able to determine Washington's voting precincts are actually represented by Figure 2 (green lines).

[1]See Citizen Voting Age Population by Race and Ethnicity (https://www.census.gov/programs-surveys/decennial-census/about/voting-rights/cvap.html).
[2]See Citizen Voting Age Population by Race and Ethnicity (https://www.census.gov/programs-surveys/decennial-census/about/voting-rights/cvap.html).
[3]Found at: https://redistrictingdatahub.org/wp-content/uploads/2021/06/al_vest_20_validation_report.pdf.

Figure 1

Figure 2



3. For 2020, Professor Palmer reports that he uses actual turnout data by race, again obtained from the Redistricting Data Hub website. These data were derived from a commercial vendor L2. Although Alabama does record data on the race of registrants, L2 instead imputes the race of registrants in its database. Using the voter registration and history files from the Alabama Secretary of State, I was able to compare L2's racial turnout data to the state's. By county, the L2 data consistently underestimated the percentage of white voters by an average of 4.3%.[4] On the other hand, the percentage of *other* voters was consistently overestimated by L2 by an average of 4.2% at the county-level.[5] The percentage of black voters was overestimated by L2 in some counties and underestimated in others. While these discrepancies in the L2 turnout data may not appear to be all that sizable, they certainly could make a difference in a district functionality analysis where the racial composition of the district in question is evenly divided.

4. Professor Liu provides a number of district functionality tests in his report that record a column for turnout. I am unsure how exactly this figure is calculated or the manner in which it is used in determining functionality as there are no explanatory notes provided. They appear to be estimates; again this property does not need to be estimated in Alabama. If one assumes these are

[4]Calculated as the mean of (L2 Percent White-SOS Percent White) for Alabama's 67 counties.
[5]The *other* category comprises any voter who is not identified as white or black.

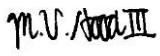
turnout rates by racial group, then in every case reported in Tables 4-7, the black turnout rate exceeds that for whites (twelve out of twelve times) and in some cases by ten percentage points. But, data from the Alabama Secretary of State suggest that white turnout is typically slightly higher than black turnout. For example, in my initial report in this matter for the 2020 presidential election in CD 7 (Adopted) white turnout based on SOS figures was 63.6%, compared to 57.9% for blacks. Professor Liu reports black turnout for the 2018 Lieutenant Governor's race for Adopted CD 7 at 50.3%, compared to 41.5% for whites.

5. Professor Liu also reports using *any-part* Black VAP in the functional (effectiveness) analyses presented for his report (see Footnote 20 of his report). However, this raises a valid question as to whether individuals who are multi-racial (in this case any-part Black) vote cohesively with the population of single-race groups (in this case single-race, non-Hispanic Blacks). I am unable to determine exactly how Professor Palmer operationalized racial categories in his analyses based on his report. To the best of my knowledge, racial classifications in the Alabama voter registration database are based on single-race categories.

DECLARATION

I declare under penalty of perjury under the laws of the United States that the foregoing is true and correct to the best of my knowledge.

Executed on December 20, 2021.



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