

## Response to Expert Report of Stephen W. Hodge

Jowei Chen, University of Michigan  
Jonathan Rodden, Stanford University

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On November 11, 2013, Mr. Stephen W. Hodge submitted a new expert report expressing concern regarding four aspects of the computer districting simulations from our original February 15, 2013 expert report. The four aspects of our simulations discussed by Mr. Hodge were: 1) The compactness and contiguity of the simulated districts; 2) The extent to which incorporated city boundaries are preserved; 3) The number of simulated districts with significant Hispanic populations; and 4) The summing of population across counties and simulated districts.

In this response, we demonstrate that Mr. Hodge's concerns have no substantive effect on our main conclusion that the Legislature's congressional plan (H000C9047) exhibits significantly more Republican bias than could be expected from a non-partisan districting process. After adjusting the simulation algorithm in response to Mr. Hodge's various concerns, we find that, to the extent our results have changed, we now have even stronger statistical confidence in our main conclusion that the Legislature's plan was drawn with the intent to favor Republicans.

As detailed below, we have made several adjustments in the simulation algorithm to respond to each of Mr. Hodge's concerns. After conducting a new set of 1,000 simulations under this revised simulation algorithm, we find that our simulation results are now more precise and allow us to draw more definitive conclusions: Our results show that it is virtually impossible for a non-partisan districting procedure to produce a congressional plan as extreme as the Florida Legislature's enacted plan (H000C9047), in which McCain voters outnumbered Obama voters in 17 of the 27 districts (using November 2008 presidential vote counts). Not a single one of the 1,000 simulated districting plans produces as many as 17 districts that favored McCain. In fact, only 4 of the 1,000 plans (0.4%) produces as many as 16 districts favoring McCain. The majority of our non-partisan simulated districting plans produce only 14 Republican-leaning seats.

Therefore, we conclude with very high statistical certainty that a congressional plan with either 16 or 17 districts favoring McCain over Obama falls outside the range of partisan bias that could be expected from the non-partisan districting process called for in the Florida Constitution. Our analysis thus strengthens our original conclusion that the Florida Legislature's enacted congressional plan was drawn with intent to favor the Republican Party.

Below, we detail the adjustments we made to the simulation algorithm in response to Mr. Hodge's expert report, and we describe how the new set of 1,000 simulations were conducted and analyzed.

## **1. Compactness and Contiguity of Simulated Districts:**

In response to Mr. Hodge's concerns regarding the compactness of the simulated districts, we incorporated a quantifiable measurement of district compactness into the simulation procedure. Specifically, we measure the compactness of districts using the Convex Hull Reock measure of compactness. This measure is defined as the area of a district, divided by the area of the convex hull of the district. (Geometrically, the district's convex hull is defined as the smallest convex polygon that fully contains the district.) Larger values of the Convex Hull Reock indicate that a district is more compactly shaped.

We first calculated the Convex Hull Reock scores of the 27 districts in the Legislature's enacted congressional plan, including the majority-black population districts (5, 20, and 24). We found that the Legislature's plan exhibits a mean Convex Hull Reock score of 0.6608. We then required that our simulation algorithm produce plans with a mean compactness score exceeding the Legislature's score of 0.6608. Whenever a particular run of the simulation algorithm produced a simulated plan with a mean compactness lower than that of the Legislature's plan, we instructed the computer to simply discard the plan and start anew. As a result, this requirement guaranteed that every one of our 1,000 simulated districting plans exceeds the Legislature's plan with respect to the mean compactness of districts.

Figure 1 illustrates the result of this requirement by displaying the mean compactness score of each of our 1,000 new simulated districting plans. The 1,000 simulated districting plans have mean compactness scores ranging from 0.6682 to 0.6987, all of which exceed the 0.6608 compactness score exhibited by the Legislature's enacted plan.

Finally, Mr. Hodge found that 2.04% of our districting simulations (204 out of 10,000 simulations) had inadvertently created non-contiguous districts. We have now addressed this issue by conducting a contiguity test at the end of the simulation process and discarding non-contiguous plans. Not surprisingly, due to the very small number of original simulated plans that were affected by this issue, addressing it has no substantive effect on our main findings discussed below.

## **2. Preservation of City Boundaries:**

In our original expert report, we required that simulated districting plans hold intact the boundaries of the 46 counties that remain intact in the Legislature's plan. We continue to impose this requirement on the simulated districting plans, and Appendix B presents a list of the 46 counties that are kept wholly intact in the districting plans. In his expert report, Mr. Hodge expressed concern regarding the related issue of preserving city boundaries.

In response, our new simulations incorporate a stringent requirement regarding the preservation of cities: We analyzed Florida city boundaries, as depicted by the Census Bureau's 2010 shapefile of consolidated cities, and discovered that the Legislature's congressional plan preserves the boundaries of 384 cities. We now require that our simulated districting plans keep intact the polygon boundaries of these same 384 cities. When a single city contains multiple disjoint fragments, we treat each fragment as a separate city, requiring that each contiguous

polygon comprising the city be kept intact. Appendix B presents a list of the 384 cities that remain intact in the districting plans.

### **3. Districts with Significant Hispanic Population:**

Mr. Hodge's report expressed concern regarding whether our simulated plans produced districts with sufficiently large Hispanic populations. As explained in our original report of February 15, 2013, our simulation algorithm requires the preservation of the three majority-black-population districts created by the Legislature's enacted plan (districts 5, 20, and 24). We continue to incorporate this same feature in our new set of 1,000 simulations.

As noted in our original report, we do not impose a similar requirement for the three Hispanic-majority-population districts in the Legislature's plan (districts 25, 26, and 27) because virtually all of our simulations already produce exactly three districts with over 50% Hispanic population. However, Mr. Hodge's report also expressed interest in the number of simulated districts that have Hispanic super-majorities (such as 60% and 65% Hispanic thresholds).

In response to Mr. Hodge's interest in these higher Hispanic thresholds, we have conducted the following analysis: After conducting a full set of 1,000 simulations using our revised algorithm, we analyze in isolation the subset of simulated plans that created three districts of over 60% Hispanic population, as well as the subset of plans with three districts exceeding 65% Hispanics. Our analysis, as described later in Figures 2 and 3, reveals that our main results do not change when examining simulated plans with three Hispanic super-majority districts. Regardless of the presence of Hispanic super-majority districts, the non-partisan districting simulation procedure never creates a plan with 17 districts contain more McCain than Obama voters; simulated plans with 16 Republican-leaning districts occur well under 2% of the time. The strength of our main conclusion does not change, regardless of whether one imposes a requirement of having three Hispanic-super-majority districts.

### **4. The Populations of Counties and Districts:**

Mr. Hodge's report expressed concern regarding the manner in which our original data files had calculated the population of particular counties and districts. In our new simulations, we have now taken the following three steps to address these concerns.

First, Mr. Hodge correctly noted that our base shapefile had very slightly undercounted population in certain areas. This undercounting occurred in coastal areas such as the Florida Keys, where many census blocks cover non-land areas not represented in our original base shapefile; in such situations, we simply did not allocate the populations of such census blocks to any polygon in our base shapefile. In response to Mr. Hodge's concern, we have now adjusted our base shapefile in order to have every census block assigned to the nearest polygon in the shapefile. This adjustment guarantees that we are now fully accounting for the entirety of Florida's 18,801,310 population as of the 2010 Census. Note, however, that our simulations continue to exclude Districts 5, 20, and 24, the three majority-black districts in the Legislature's enacted plan. Hence, the total population being assigned through our simulations is only

16,712,275, which is the amount of population required to fill Florida's 24 non-majority-black districts.

Second, we have tightened the equal population requirements of our simulation algorithm. The algorithm now requires that each district in a simulation plan must contain from 99% to 101% of the target population of an equally-populated district. The target population of a district, based on the 2010 Census, is 696,345, so each simulated district must now contain from 689,382 to 703,308 individuals.

Finally, to verify that our simulations have strictly followed these equal population requirements, we have produced a separate file ("District.Statistics.pdf") detailing the population count of every simulated district in each of our 1,000 new simulated plans.

### **Analysis of the Districting Plans Under the Adjusted Simulations**

To summarize, we have conducted 1,000 simulations using the adjusted simulation procedure described above, which now incorporates the following features:

- 1) As in our original report, we hold the three majority-black-population districts (5, 20, and 24) from the Legislature's plan geographically fixed, requiring that their boundaries be incorporated into every simulated plan.
- 2) As in our original report, we require that each simulated plan keep intact the boundaries of the same 46 counties that are preserved in the Legislature's enacted plan.
- 3) We now require that each simulated districting plan exceed the compactness of the Legislature's enacted plan, defined as having an average Convex Hull Reock measure higher than 0.6608.
- 4) We have conducted a contiguity check at the end of the simulation process.
- 5) We now require that each simulated plan keep intact the boundaries of the same 384 consolidated cities that are preserved in the Legislature's enacted plan.
- 6) We have adjusted the base shapefile used in the simulations to account fully for 100% of the census blocks' populations.
- 7) We now require that simulated districts must contain from 99% to 101% of the ideal district population.
- 8) Although we do not impose any Hispanic population requirements during the simulations, we analyze separately the simulations that produced three districts with Hispanic super-majorities.

The results of the 1,000 simulations under this adjusted algorithm are summarized in Figures 1 and 2. Figure 1 illustrates not only that all 1,000 simulated plans (colored in gray) are more compact than the Legislature's enacted plan (depicted in red), but also that the Legislature's plan produces more extreme partisan bias than all of the simulated plans. Figure 2 details the breakdown of the partisan bias exhibited by the simulated plans: Most of the simulated plans produced by our non-partisan algorithm contain either 13 or 14 districts favoring McCain, with only 4.1% containing 15 such districts. Only four simulations produce 16 Republican districts, and no simulation ever produces 17 such districts, highlighting the statistically extreme nature of the Legislature's enacted plan. This significant gap between the enacted plan and our simulated

plans strengthens the certainty of our original conclusion that the Legislature's plan was drawn with the intent to favor the Republican Party.

Figures 3 and 4 isolate the simulated plans that produced three districts with Hispanic super-majorities. Of our 1,000 simulations, 648 plans produced 3 districts with 60% or more Hispanic population (Figure 3), and 160 plans produced 3 districts with Hispanics reaching a 65% threshold (Figure 4). These two Figures each illustrate that the presence or absence of Hispanic super-majority districts does not affect our main findings. Regardless of whether we focus on simulations that achieve either of these Hispanic population thresholds, the results consistently reveal that the Legislature's enacted plan is an extreme statistical outlier with respect to its number of districts favoring Republicans.

Figure 1:

### Comparison of Simulated Districting Plans to Legislature's Enacted Plan

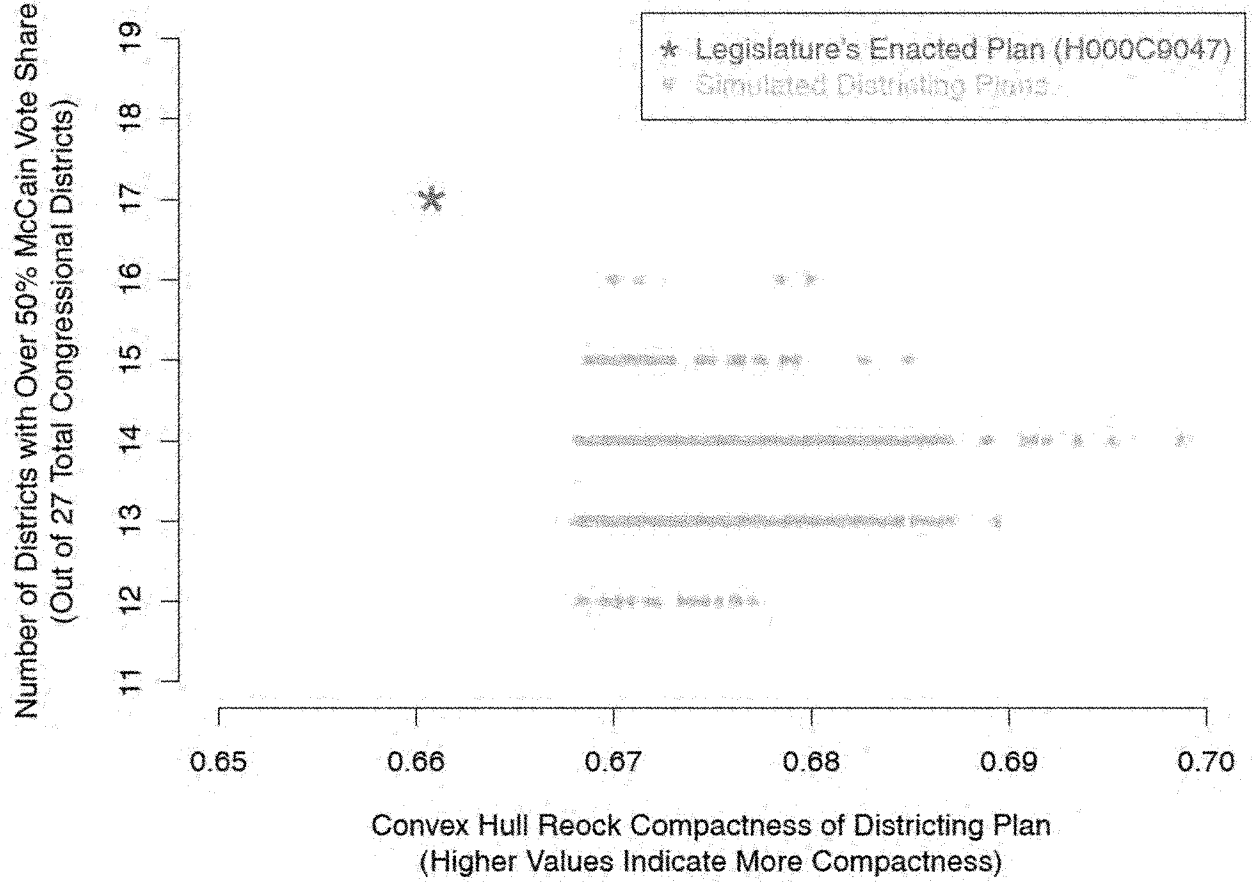
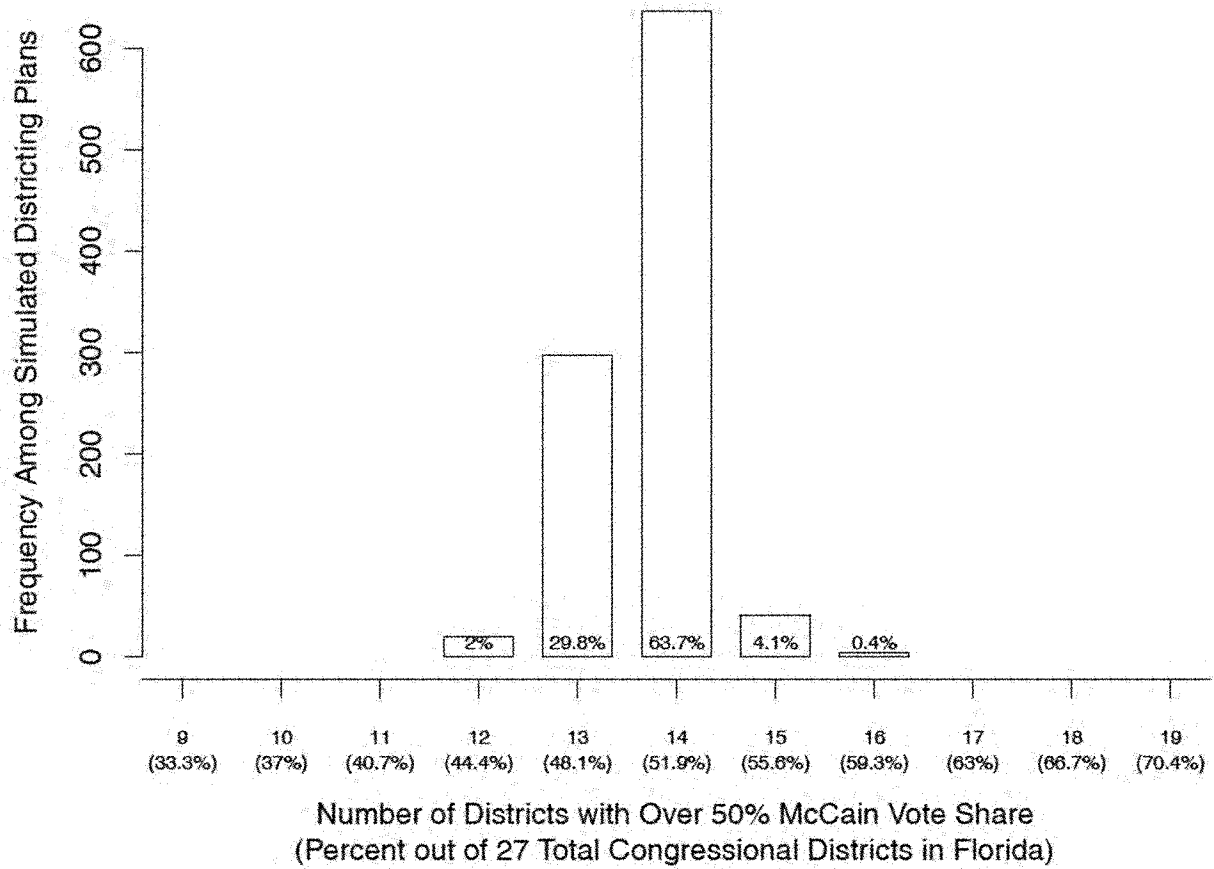
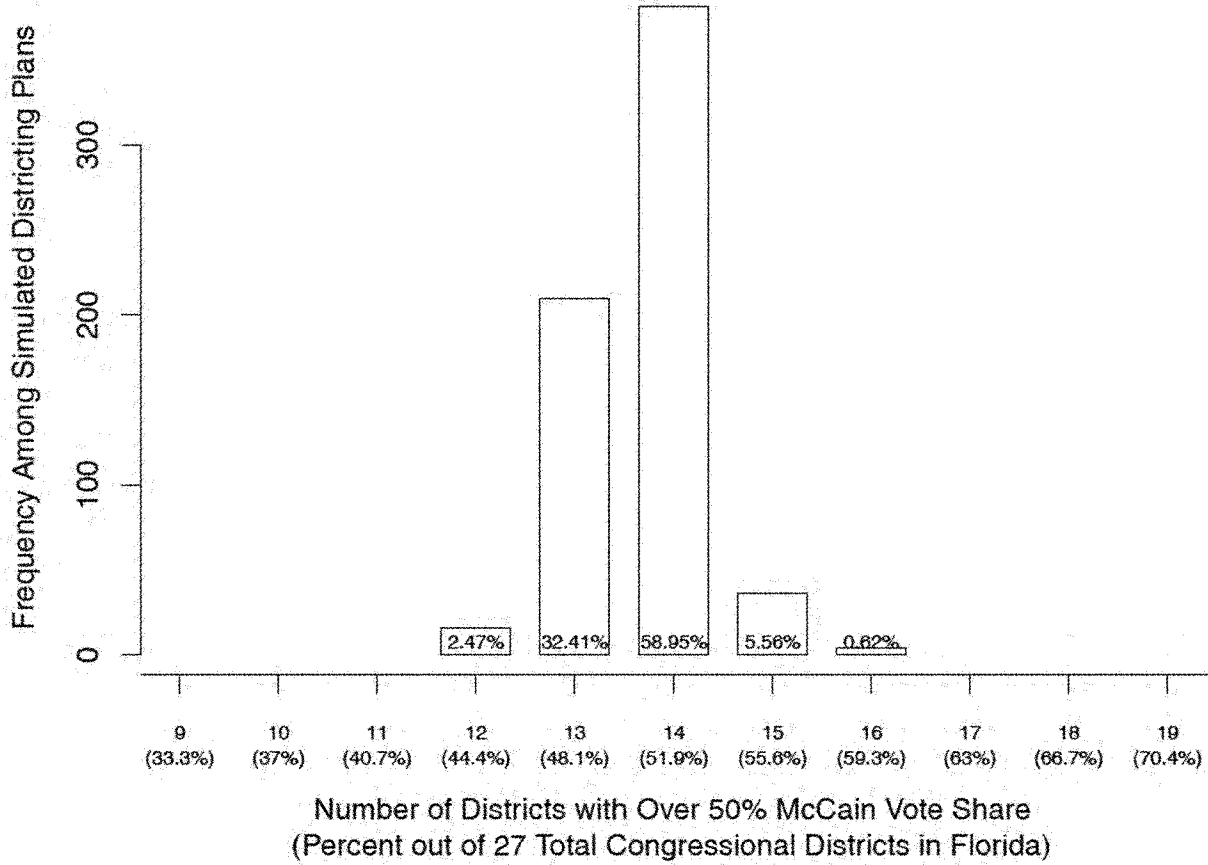


Figure 2:

**Results of 1,000 Simulated Districting Plans  
With 46 Counties and 384 Cities Kept Intact  
And Districts 5, 20, and 24 Held Fixed**

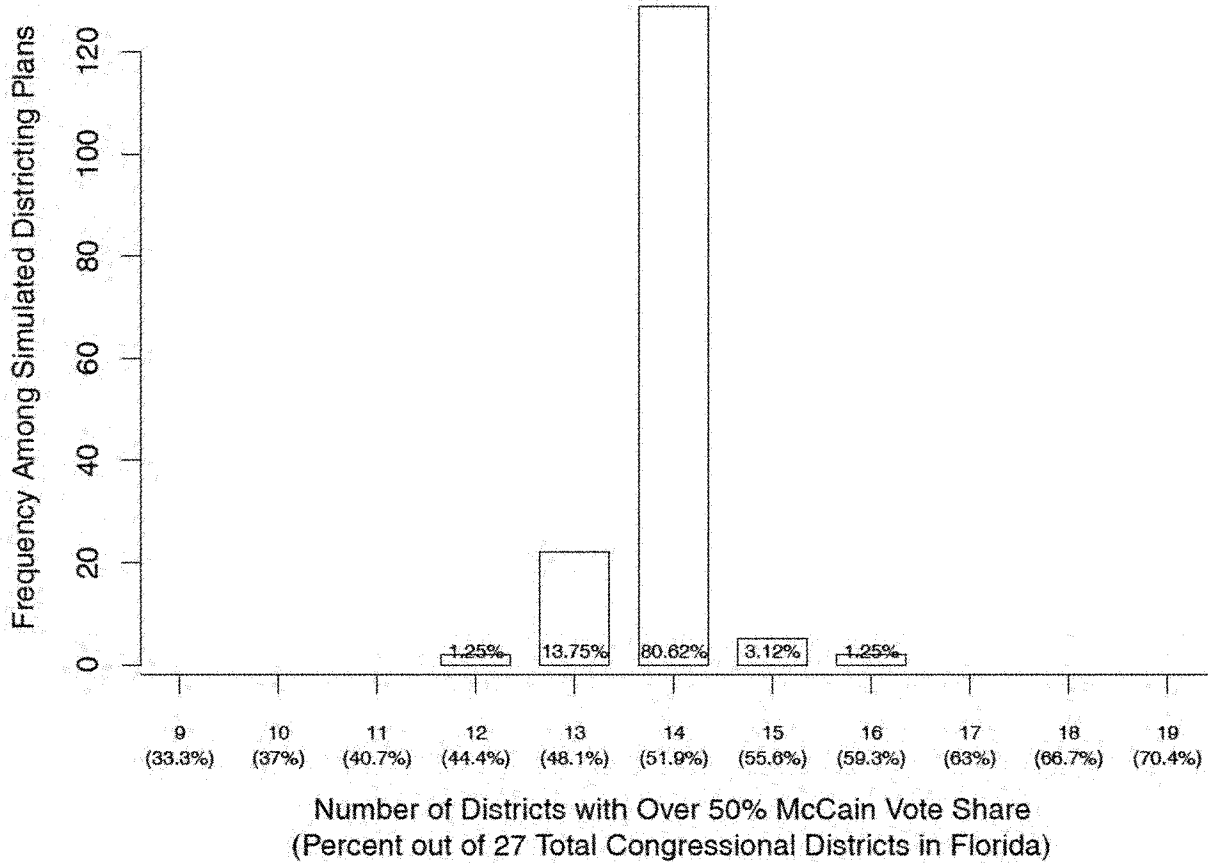


**Results of 648 (Out of 1,000 Total) Simulated Districting Plans  
Containing 3 Districts with Over 60% Hispanic Voting-Age Pop.  
(All Plans Include 46 Counties and 384 Cities Kept Intact  
And Districts 5, 20, and 24 Held Fixed)**





**Results of 160 (Out of 1,000 Total) Simulated Districting Plans  
Containing 3 Districts with Over 65% Hispanic Voting-Age Pop.  
(All Plans Include 46 Counties and 384 Cities Kept Intact  
And Districts 5, 20, and 24 Held Fixed)**



**Table 1:**

<b>Counties Remaining Intact in the Enacted Congressional Districting Plan (46 counties):</b>	<b>Counties Split Into Fragments in the Enacted Congressional Districting Plan (21 counties):</b>
Baker County	Alachua County
Bay County	Broward County
Bradford County	Clay County
Brevard County	Collier County
Calhoun County	Duval County
Charlotte County	Hendry County
Citrus County	Hillsborough County
Columbia County	Holmes County
DeSoto County	Lake County
Dixie County	Lee County
Escambia County	Madison County
Flagler County	Manatee County
Franklin County	Marion County
Gadsden County	Miami-Dade County
Gilchrist County	Orange County
Glades County	Palm Beach County
Gulf County	Pinellas County
Hamilton County	Polk County
Hardee County	Putnam County
Hernando County	Seminole County
Highlands County	Volusia County
Indian River County	
Jackson County	
Jefferson County	
Lafayette County	
Leon County	
Levy County	
Liberty County	
Martin County	
Monroe County	
Nassau County	
Okaloosa County	
Okeechobee County	
Osceola County	
Pasco County	
Sarasota County	
Saint Johns County	
Saint Lucie County	
Santa Rosa County	
Sumter County	
Suwannee County	
Taylor County	
Union County	
Wakulla County	
Walton County	
Washington County	

**Table 2: List of 384 Cities Kept Intact in the Enacted Districting Plan**

Pensacola (1)	Chattahoochee (2)	Williston (3)	Oviedo (7)
Century (1)	Bonifay (2)	Otter Creek (3)	Longwood (7)
Paxton (1)	Greenville (2)	Inglis (3)	Lake Mary (7)
Freeport (1)	Springfield (2)	Chiefland (3)	Casselberry (7)
De Funiak Spring (1)	Parker (2)	Cedar Key (3)	Altamonte Spring (7)
Westville (1)	Panama City Beac (2)	Bronson (3)	Winter Park (7)
Ponce de Leon (1)	Panama City (2)	Fanning Springs (3)	Maitland (7)
Noma (1)	Mexico Beach (2)	Neptune Beach (4)	Orange City (7)
Esto (1)	Lynn Haven (2)	Jacksonville Bea (4)	Deltona (7)
Valparaiso (1)	Callaway (2)	Baldwin (4)	DeBary (7)
Shalimar (1)	Ebro (2)	Atlantic Beach (4)	Grant-Valkaria (8)
Niceville (1)	Chipley (2)	Macclenny (4)	West Melbourne (8)
Mary Esther (1)	Caryville (2)	Glen St. Mary (4)	Titusville (8)
Laurel Hill (1)	Bristol (2)	Hilliard (4)	Satellite Beach (8)
Fort Walton Beac (1)	Wausau (2)	Fernandina Beach (4)	Rockledge (8)
Destin (1)	Vernon (2)	Callahan (4)	Palm Shores (8)
Crestview (1)	White Springs (3)	Reddick (5)	Palm Bay (8)
Cinco Bayou (1)	Jennings (3)	McIntosh (5)	Melbourne Villag (8)
Milton (1)	Jasper (3)	Green Cove Sprin (5)	Melbourne Beach (8)
Jay (1)	Horseshoe Beach (3)	Hawthorne (5)	Melbourne (8)
Gulf Breeze (1)	Cross City (3)	Eatonville (5)	Malabar (8)
Carrabelle (2)	Mayo (3)	Palatka (5)	Indian Harbour B (8)
Apalachicola (2)	Lake City (3)	St. Augustine Be (6)	Indialantic (8)
Campbellton (2)	Fort White (3)	St. Augustine (6)	Cocoa Beach (8)
Bascom (2)	Dunnellon (3)	Marineland (6)	Cocoa (8)
Alford (2)	Live Oak (3)	Hastings (6)	Cape Canaveral (8)
Sneads (2)	Branford (3)	Palm Coast (6)	Vero Beach (8)
Marianna (2)	Starke (3)	Bunnell (6)	Sebastian (8)
Malone (2)	Lawtey (3)	Beverly Beach (6)	Orchid (8)
Jacob City (2)	Hampton (3)	Welaka (6)	Indian River Sho (8)
Greenwood (2)	Brooker (3)	Pomona Park (6)	Fellsmere (8)
Grand Ridge (2)	Penney Farms (3)	Interlachen (6)	Lake Hamilton (9)
Graceville (2)	Keystone Heights (3)	Crescent City (6)	Haines City (9)
Cottdonale (2)	Worthington Spri (3)	South Daytona (6)	Davenport (9)
Monticello (2)	Raiford (3)	Port Orange (6)	St. Cloud (9)
Wewahitchka (2)	Lake Butler (3)	Ponce Inlet (6)	Kissimmee (9)
Port St. Joe (2)	Trenton (3)	Pierson (6)	Umatilla (10)
Sopchoppy (2)	Bell (3)	Ormond Beach (6)	Tavares (10)
St. Marks (2)	Madison (3)	Oak Hill (6)	Mount Dora (10)
Blountstown (2)	Lee (3)	New Smyrna Beach (6)	Montverde (10)
Altha (2)	Waldo (3)	Lake Helen (6)	Minneola (10)
Tallahassee (2)	Newberry (3)	Holly Hill (6)	Mascotte (10)
Perry (2)	Micanopy (3)	Edgewater (6)	Leesburg (10)
Quincy (2)	La Crosse (3)	DeLand (6)	Howey-in-the-Hil (10)
Midway (2)	High Springs (3)	Daytona Beach Sh (6)	Groveland (10)
Havana (2)	Archer (3)	Daytona Beach (6)	Fruitland Park (10)
Gretna (2)	Alachua (3)	Flagler Beach (6)	Eustis (10)
Greensboro (2)	Yankeetown (3)	Winter Springs (7)	Clermont (10)

Astatula (10)	Belleair Shore (13)	Fort Myers Beach (19)	Dania Beach (23)
Polk City (10)	Belleair Bluffs (13)	Fort Myers (19)	Cooper City (23)
Lake Alfred (10)	Belleair Beach (13)	Cape Coral (19)	Weston (23)
Auburndale (10)	Belleair (13)	Bonita Springs (19)	Southwest Ranche (23)
Winter Garden (10)	Temple Terrace (15)	Sanibel (19)	Surfside (23)
Windermere (10)	Plant City (15)	Naples (19)	Sunny Isles Beac (23)
Ocoee (10)	Mulberry (15)	Marco Island (19)	North Bay Villag (23)
Oakland (10)	Lakeland (15)	North Lauderdale (20)	Miami Beach (23)
Lake Buena Vista (10)	Bartow (15)	Lauderhill (20)	Indian Creek (23)
Edgewood (10)	Palmetto (16)	Lauderdale Lakes (20)	Golden Beach (23)
Belle Isle (10)	Longboat Key (16)	Tamarac (20)	Bay Harbor Islan (23)
Bay Lake (10)	Holmes Beach (16)	Clewiston (20)	Bal Harbour (23)
Inverness (11)	Bradenton Beach (16)	Loxahatchee Grov (20)	Aventura (23)
Crystal River (11)	Bradenton (16)	South Bay (20)	Pembroke Park (24)
Lady Lake (11)	Anna Maria (16)	Pahokee (20)	West Park (24)
Ocala (11)	Venice (16)	Mangonia Park (20)	Opa-locka (24)
Belleview (11)	Sarasota (16)	Lake Park (20)	North Miami Beac (24)
Weeki Wachee (11)	North Port (16)	Haverhill (20)	North Miami (24)
Brooksville (11)	Okeechobee (17)	Glen Ridge (20)	Miami Shores (24)
Wildwood (11)	Sebring (17)	Cloud Lake (20)	Miami Gardens (24)
Webster (11)	Lake Placid (17)	Belle Glade (20)	El Portal (24)
Coleman (11)	Avon Park (17)	Parkland (21)	Biscayne Park (24)
Center Hill (11)	Lake Wales (17)	Coral Springs (21)	Miami Lakes (25)
Bushnell (11)	Punta Gorda (17)	Coconut Creek (21)	Doral (25)
Tarpon Springs (12)	Moore Haven (17)	Wellington (21)	Sweetwater (25)
Oldsmar (12)	Hillcrest Height (17)	Greenacres (21)	Medley (25)
Zephyrhills (12)	Highland Park (17)	Lighthouse Point (22)	Hialeah Gardens (25)
San Antonio (12)	Frostproof (17)	Lazy Lake (22)	LaBelle (25)
St. Leo (12)	Fort Meade (17)	Lauderdale-by-th (22)	Everglades (25)
Port Richey (12)	Eagle Lake (17)	Hillsboro Beach (22)	Marathon (26)
New Port Richey (12)	Dundee (17)	Wilton Manors (22)	Layton (26)
Dade City (12)	Arcadia (17)	Sea Ranch Lakes (22)	Key West (26)
Treasure Island (13)	Bowling Green (17)	South Palm Beach (22)	Key Colony Beach (26)
South Pasadena (13)	Zolfo Springs (17)	Palm Springs (22)	Islamorada, Vill (26)
Seminole (13)	Wauchula (17)	Palm Beach (22)	Florida City (26)
St. Pete Beach (13)	Stuart (18)	Ocean Ridge (22)	Palmetto Bay (27)
Safety Harbor (13)	Sewall's Point (18)	Manalapan (22)	Cutler Bay (27)
Redington Shores (13)	Ocean Breeze Par (18)	Lake Clarke Shor (22)	West Miami (27)
Redington Beach (13)	Jupiter Island (18)	Hypoluxo (22)	Virginia Gardens (27)
Pinellas Park (13)	Tequesta (18)	Highland Beach (22)	South Miami (27)
North Redington (13)	Palm Beach Shore (18)	Gulf Stream (22)	Pinecrest (27)
Madeira Beach (13)	Palm Beach Garde (18)	Golf (22)	Miami Springs (27)
Largo (13)	North Palm Beach (18)	Delray Beach (22)	Key Biscayne (27)
Kenneth City (13)	Jupiter Inlet Co (18)	Briny Breezes (22)	Islandia (27)
Indian Shores (13)	Juno Beach (18)	Boca Raton (22)	Coral Gables (27)
Indian Rocks Bea (13)	Jupiter (18)	Atlantis (22)	
Gulfport (13)	St. Lucie Villag (18)	Hollywood (23)	
Dunedin (13)	Port St. Lucie (18)	Hallandale Beach (23)	
Clearwater (13)	Fort Pierce (18)	Davie (23)	