

# Report of Plaintiffs' Expert Regarding Tennessee State Senate Reapportionment

Jonathan Cervas

October 10, 2022

# I. Introduction

I have prepared this report at the request of Plaintiffs' Counsel regarding the Tennessee state senate reapportionment plan enacted by the Tennessee General Assembly in February 2022. Counsel has asked me to determine if it is possible to draw a senate plan that sequentially numbers districts in all counties that have multiple districts.

Given my experience and expertise in redistricting, it is easy to conclude that the Legislature could have numbered all districts within a single county sequentially, while complying with all federal and state constitutional and statutory law.

The Tennessee Constitution requires that “[a]fter each decennial census made by the Bureau of Census of the United States is available the General Assembly shall establish senatorial and representative districts” (Art. 2, Sect. 4).

“The number of senators shall be apportioned by the General Assembly among the several counties or districts substantially according to population, and shall not exceed one-third the number of representatives. Counties having two or more senators shall be divided into separate districts. In a district composed of two or more counties, each county shall adjoin at least one other county of such district; and no county shall be divided in forming such a district” (Art. 2, Sect. 6).

“In a county having more than one senatorial district, the districts shall be numbered consecutively” (Art. 2, Sect. 3).

In Tennessee, for the state senate, even-numbered districts are elected in presidential election years and odd-numbered districts are elected in gubernatorial election years (Art. 2, Sect. 3).

For this report, I created three illustrative plans<sup>1</sup> adhering to the following criteria:

*The following criteria are taken from the “Guidelines for Submission of Senate or Congressional Redistricting Plans to the Senate Ad Hoc Committee on Redistricting”<sup>2</sup> [Accessed August 16, 2022].*

1. Be composed of contiguous districts; contiguity by water is sufficient
2. Be for the state as a whole:
  - Plans for the Senate must contain thirty-three (33) districts
3. Only contain single member districts
4. ...have a population within a ten percent overall range (expressed as a percentage from the smallest to the largest district). (The ideal population of a Senate district is 209,419. The 10% overall range is 219,890 to 198,948.)
5. Comply with the Voting Rights Act, the United States Constitution, and the Tennessee Constitution

A document hyperlinked “ESRI Connectivity Test”<sup>3</sup> [Accessed September 9, 2022] list the following information about geographic contiguity:

---

<sup>1</sup>I have provided the URLs to each of my illustrative plans. These link to Dave’s Redistricting App, a publicly available and free redistricting program. Plans can be downloaded in multiple formats, including shapefiles, geojson files, and block equivalency files.

<sup>2</sup>Guidelines for Submission of Senate or Congressional Redistricting Plans to the Senate Ad Hoc Committee on Redistricting, <https://www.capitol.tn.gov/Archives/senate/112GA/committees/redistricting/Revised%20Senate%20Redistricting%20Criteria.pdf>.

<sup>3</sup>ESRI Connectivity Test, <https://www.capitol.tn.gov/Archives/senate/112GA/committees/redistricting/ESRI%20Connectivity%20Test.pdf>.

6. A document advises that certain blocks are part of non-contiguous counties, but should be considered contiguous: “However be aware that certain counties have ‘island’ geography that may pop up as error but ARE SUFFICIENT.” (emphasis original).

• These are as follows:

- Loudon County has three land “islands” that include the Blocks labeled: 471020607001109 and 471020607001110; 471050607002104 and 471050607002105; and 471050607002102 and 471050607002103.
- White County has one land “island” in Cumberland County are Blocks labeled 471859350001075 and 471859350001076.
- Davidson County has one land “island” in Wilson County which is the Block labeled 470370156351000.
- Dickson County has one land “island” in Cheatham County which is the Block labeled 470430602012051.
- Tipton County has a segment in the Mississippi River that connects on land to Shelby County. Those Blocks include: 471670401001020 through 471670401001032

Although not listed on the Senate committee’s redistricting guidelines, the Tennessee Constitution requires:

7. All Senate district numbers are sequenced such that all districts contained within a single county are ordered and skip no numbers.

Plaintiffs ask that any illustrative plan I create adhere to the requirements of the Tennessee Constitution, while also complying with federal and state constitutional and statutory law.

Plaintiffs asked that all illustrative plans be appended to this expert report as examples of maps that meet the seven enumerated goals stated above.

***I approached this task in the same way I had when I served the federal courts in voting rights cases. Plans I create are narrowly tailored to cure the constitutional violation, making changes to adjacent districts only as necessary to comply with applicable federal and state law.***

My illustrative plans score equal to or better on traditional redistricting criteria such as county-splits, compactness, and have similar levels of population deviation.

## **II. Qualifications and Publications**

My name is Jonathan Cervas and I am a resident of Pittsburgh, Pennsylvania. I am a postdoctoral fellow at Carnegie Mellon University. I teach courses for the Institute of Politics and Strategy, the undergraduate and master’s degree-granting unit of political science for the university; one class is a graduate seminar on American politics and one on representation and voting rights. I will also teach a research and statistical methods course in the Spring 2023 semester. I am also an uncompensated Research Associate of the Electoral Innovation Lab at Princeton University, which is home to the non-partisan Princeton Gerrymandering Project.

I joined the Institute for Politics and Strategy in 2020 after receiving my Ph.D. in Political Science from the University of California, Irvine. I received my undergraduate degree at the University of Nevada Las Vegas, and my graduate degrees at the University of California, Irvine. My 2020 doctoral dissertation is titled *A Quantitative Assessment of the Electoral College, 1790-2020*. As my curriculum vitae, attached as Appendix A,

shows, I have published eleven peer-reviewed scholarly articles on topics related to political institutions, elections, redistricting, and voting rules. My work has been published in journals which specialize in political science, geography, economics, and law. These include the *Proceedings of the National Academy of Arts and Sciences*, *Social Science Quarterly*, *Political Geography*, *Public Choice*, *Election Law Journal*, *Stanford Journal of Civil Rights & Civil Liberties*, *Presidential Studies Quarterly*, and *PS: Political Science and Politics*. I have been invited to give talks to Princeton University, University of Houston, and the National Conference of State Legislatures. As part of my service commitment to the discipline of political science, I have served as referee for *American Journal of Political Science*, *Political Geography*, *Election Law Journal*, *Public Choice*, and *Political Research Quarterly*.

I have assisted three federal courts and one state court in cases relating to redistricting and racial minority voting rights. I served as redistricting consultant to the Pennsylvania Legislative Reapportionment Commission in 2021. I served the New York State Supreme Court as Special Master in May of 2022, redrawing the State Senate and Congressional districts that are to be used for the 2022 through 2030 elections.

***Navajo Nation v. San Juan County (2018)***: The first case in which I was involved was *Navajo Nation v. San Juan County*, UT, D.C. No. 2:12-CV-00039-RJS (2018). The federal district court in Utah ruled that the election districts for school board and county commission violated the Fourteenth Amendment to the United States Constitution. Specifically, the Navajo Native American tribe had been, for decades, denied the opportunity to elect candidates of their choice. After the court rejected the county's remedial map, the court retained Prof. Bernard Grofman as Special Master. I was employed as the assistant to the Special Master and helped to prepare remedial maps. The court selected the illustrative maps I helped prepare for immediate use in the next election. These maps were upheld by the Tenth Circuit Court of Appeals *Navajo Nation v. San Juan County*, No.18-4005 (10th Cir. 2019). These maps resulted in the first time the Navajo tribe was able to elect a majority to the school board and county commission. The story of the Navajo in San Juan County can be read in David Daley's book "Unrigged" (<https://wwnorton.com/books/9781631495755>).

***Bethune-Hill v. Virginia State Board of Elections (2019)***: The second case in which I was involved centered on Black representation in Virginia's House of Delegates. In *Bethune-Hill v. Virginia State Bd. of Elections*, 141 F. Supp. 3d 505 (ED Va. 2015) the federal court ruled that twelve of Virginia's 100 House of Delegates districts were unconstitutional gerrymanders under the precedent set in *Shaw v. Reno*, 509 US 630 (1993). Districts had been drafted with a floor of 55% Black, meaning that each district created to adhere to the federal Voting Rights Act had Black proportions far in excess of what was needed to elect a candidate of that community's choice. This case eventually reached the United States Supreme Court (SCOTUS) twice. SCOTUS remanded *Bethune-Hill v. Virginia State Board of Elections*, 580 U.S. \_\_\_\_ (2017) when it first reached the court. The district court then ruled eleven of the twelve districts were unconstitutional racial gerrymanders and ordered them redrawn *Bethune-Hill v. Virginia State Bd. of Elections*, 326 F. Supp. 3d 128 (2018). The district court retained Prof. Grofman as Special Master. I worked with Prof. Grofman as the assistant to the Special Master. Together we created ten map modules; three in Norfolk, two in the peninsula area, three in Petersburg, and two in Richmond. The court selected module combinations that adjusted the boundaries of twenty-five districts. The case was heard for a second time on appeal to SCOTUS, who ruled the intervenors did not have standing in the case. *Virginia House of Delegates v. Bethune-Hill*, 587 U.S. \_\_\_\_ (2019). These districts were used in the 2019 election, and because of census delays, again used in 2021.

***Wright v. Sumter County, GA (2020)***: Sumter County's voting districts diluted the voting power of Blacks in violation of section 2 of the Voting Rights Act. The Georgia Legislature reduced the size of the school board from nine members to seven. In the nine-member board, each member was elected from a district. In the seven-member board, five were elected in districts and two at-large. Evidence on the Court record showed that all three Gingles criteria were satisfied *Wright v. Sumter County Board of Elections and Registration*, (1:14-CV-42 (WLS) U.S. District Court, Middle District of Georgia (2020)). The district court

struck down the plan and ordered it to be replaced. The court retained Prof. Grofman in his capacity as Special Master. I again served as assistant to the Special Master. Working with Prof. Grofman, I assisted him in crafting four seven-district illustrative plans and one five-district illustrative plan. The court chose one of the plans I helped to prepare. Defendants appealed to the Eleventh Circuit, which reviewed the entire record and found the district court did not err in finding a Section 2 violation and that the Special Master “expressly found an easily achievable remedy available”. *Wright v. Sumter County Board of Elections and Registration*, No. 15-13628 at 45 (11th Cir. 2020). You can read more about the background of the case in the New York Times’s article A Voting Rights Battle in a School Board Coup (Casey, Nicholas, October 25, 2020. <https://www.nytimes.com/2020/10/25/us/politics/voting-rights-georgia.html>).

***Pennsylvania Legislative Reapportionment Commission:*** In July of 2021, I entered into a contract with the 2021 Pennsylvania Legislative Reapportionment Commission to provide consulting work relating to the creation of the PA state House of Representatives and PA Senate districts to be used during elections held between 2022 and 2030. This work involved numerous aspects of the reapportionment process, not limited to map drawing. The commission, led by Chancellor Emeritus Mark Nordenberg of the University of Pittsburgh, was composed of the Senate Majority and Minority leaders, and the House of Representatives Majority and Minority leaders. That necessarily meant that it was a political commission with the leaders of the two major parties. As a commission, we sought to expand opportunities for minority representation throughout the commonwealth. We did this by more faithfully adhering to political subdivision boundaries than previous plans. In situations in which we had discretion, we opted for districts that would create opportunities to enhance representation for historically disadvantaged communities. After the May 2022 primary, it seems likely that the next House of Representatives in PA will have the largest share of minorities ever, with additional opportunities for the future. The maps drafted by the commission were passed with a bipartisan vote on February 4, 2022. The Pennsylvania Supreme Court unanimously affirmed the final reapportionment plan in March 2022. My work with the commission is ongoing.

***Harkenrider v. Hochel (2022):*** On April 18, 2022, Justice Patrick McAllister of the New York Supreme Court retained me as “special master to prepare and draw a new neutral, non-partisan Congressional map”. After the Redistricting Commission failed to create a Congressional plan for the 2022-2030 apportionment, the State Legislature passed its own plan. This plan was ruled by Justice McAllister as a substantive gerrymander, violating the state constitution’s mandate that “Districts shall not be drawn to discourage competition” (Section 3(c)(5)). The court initially allowed the Legislature the opportunity to remedy the violation. I was instructed to create a contingency plan in case the Legislature failed to create its own. On April 27, 2022, the New York Court of Appeals (the highest court in NY) agreed with Justice McAllister’s opinion but further decided that the plan was a procedural violation since the Legislature had no right to draw its own plans under the 2014 Constitutional amendment which established the process of redistricting. In the Court of Appeals opinion, the court ordered me to draw both the Congressional plan and the state Senate plan, since that plan too was passed through an unconstitutional procedure. The failure of the Commission to agree on lawful maps and the time consumed by subsequent litigation meant that, even after an initial postponement of the date for the primaries, the Court was operating under extremely severe time constraints. The Court provided a timetable for my work which included deadlines for submission of comments and expert witness reports to me and the Court, a deadline for the dissemination of a preliminary proposal and report, deadlines for submission of comments and expert witness reports pertaining to this preliminary proposal, and a deadline for the preparation and dissemination of a final map adopted by the Court. I did not begin my map-drawing process *de novo*. There was a considerable volume of information and public comment that had been compiled by the Redistricting Commission that I was able to draw upon. In preparing my preliminary proposed maps for the Court, I (with the help of my research assistants) pored over thousands of pages of court records and testimony that was presented to the Redistricting Commission. In addition, I reviewed the several hundred submissions of testimony via email or through the court docket

that came after or just before my appointment, along with several dozen complete or near-complete plans directly submitted to me. On May 6, 2022, Justice McAllister and I held a hearing in Bath, NY to listen to testimony from citizens. Around 30 citizens testified. I delivered preliminary proposed plans on May 16, 2022. After the dissemination of a map on May 16, 2022, I was pleased to receive additional extensive input from the public and concerned groups, most of which were specifically directed to the proposed maps. This feedback included over 800 e-mails and messages directed at me through social media. Additionally, I estimate that over 3,000 comments were submitted to the Court directly, pursuant to the Court's stipulation of time periods to receive suggestions for map revisions and briefs or expert witness reports. At this stage of the map-making process, my attention was focused on suggestions for changes in the proposed maps that involved the treatment of particular communities of interest. I evaluated suggestions based on the merits of the proposal, not on who (or which political party) was suggesting the change. In particular, if a change was advocated to unify neighborhoods or for community of interest reasons and had few or no partisan consequences and it was feasible to implement, I examined it very carefully and sometimes proposed it to the Court for adoption in the final map. I delivered my final map to the Court on May 20, 2022. The Court swiftly approved my proposal, and the maps will be used for the entirety of the decade, 2022-2030.

My opinions in this report are based on the knowledge I have accumulated through my education, training, and experience. This training has included a detailed review of the relevant academic literature. My opinions follow additionally from statistical analysis of the following data:

### **III. Data**

In order to evaluate the State Senate plan, I examined:

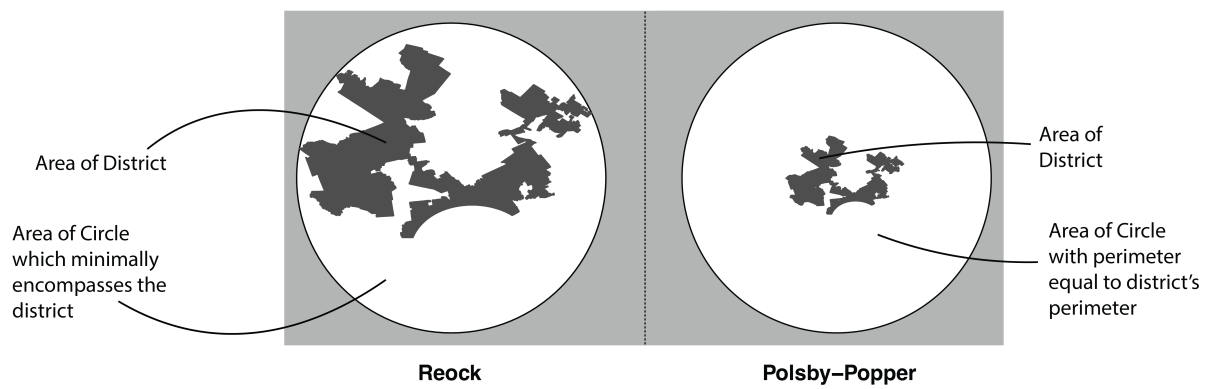
- 1) Data delivered by the United States Census on August 12, 2021. This data is referred to as 2020 Census State Redistricting Data (Public Law 94-171), sometimes PL.94-171 and colloquially referred to as "PL data". It can be found at [https://www2.census.gov/programs-surveys/decennial/2020/data/01-Redistricting\\_File-PL\\_94-171/](https://www2.census.gov/programs-surveys/decennial/2020/data/01-Redistricting_File-PL_94-171/).
  - This data provides the total population base used to create districts of approximately equal people, along with several demographic population totals.
  - Data in the PL file is dis-aggregated as low as the census block level, and can be aggregated into totals for block-groups, tracts, precincts, counties, and for the entire state.
- 2) GIS (Geographic Information Systems) Files
  - Official census GIS product from the "Tigerline" program. These files contain the polygons of the nested hierarchical political and geographic subdivisions. I downloaded the 2020 vintage from <https://www.census.gov/geographies/mapping-files/time-series/geo/tiger-line-file.html>. I post-processed these files to merge with PL population data.
  - Tennessee State Senate district lines, obtained on August 16, 2022 from <https://www.capitol.tn.gov/house/committees/Redistricting.aspx>. I compared these shapefiles to those found on Dave's Redistricting App (DRA) and find them to match.
  - An alternative map proposed by the Democratic caucus, which can be found <https://davesredistricting.org/join/9cd1b377-8c90-48cb-ac9c-1a0e29c26e21>
  - I requested the addresses of the incumbent legislators so that the illustrative plans do not place an incumbent who has two years left on their term in a district where they would need to run for

re-election early. This data has not been made available to me. I have made efforts to avoid such circumstances, though there is no mandate in the Tennessee constitution to do so.

- I examine the compactness of district plans using two measures traditionally found in the academic literature, which are often used by courts. Compactness refers to the geographic appearance of a district. Two common measures of compactness are called the *Reock* and *Polsby-Popper* measures. They are typically measured at the district level, and then averaged to find a plan-wide compactness score. *Reock* compactness is the geometric area of the district divided by the area of a circle that minimally bounds the district. *Polsby-Popper* compactness is the geometric area of a district divided by the area of a circle which has a perimeter equal to the district's perimeter. Both of these measures compare the shape of districts relative to a circle, which is generally considered to be the most compact shape. On both measures, the closer the district compactness score is to 1, the more like a circle it is, which implies that it is more compact. Districts with meandering boundaries score low, particularly on *Polsby-Popper*, and district with irregular shapes score low, particularly on *Reock*. *Figure 1* shows an example of both *Reock* and *Polsby-Popper* compactness. For more information on compactness and other traditional redistricting criteria, see *The Terminology of Districting*.<sup>4</sup>

---

**Figure 1 - Compactness Measures**



<sup>4</sup>Grofman, Bernard, and Cervas, Jonathan. 2020. "The Terminology of Districting." <https://dx.doi.org/10.2139/ssrn.3540444>.

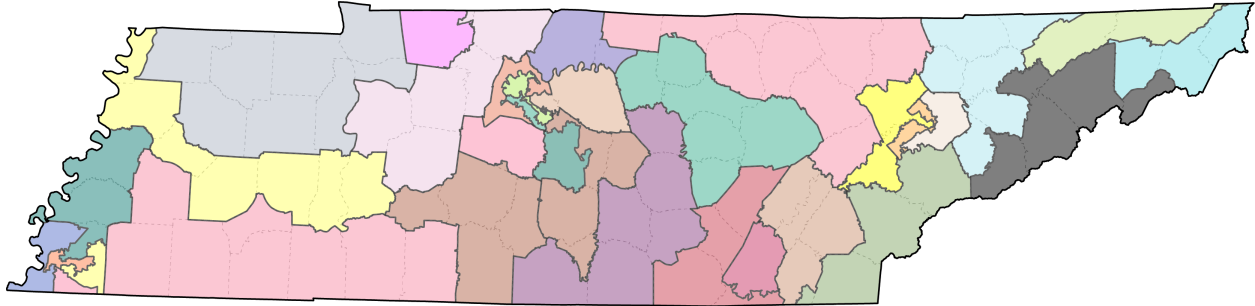
## IV. Background

### Enacted State Senate Plan - Overview

I begin this report by reflecting on the State Senate plan passed by the State Legislature slated to be used in current and future elections beginning in November 2022. This plan is shown in *Figure 2* and the area of detail that reflects the Davidson County senate districts can be seen in *Figure 3*.

---

**Figure 2 - 2022 Enacted Plan**

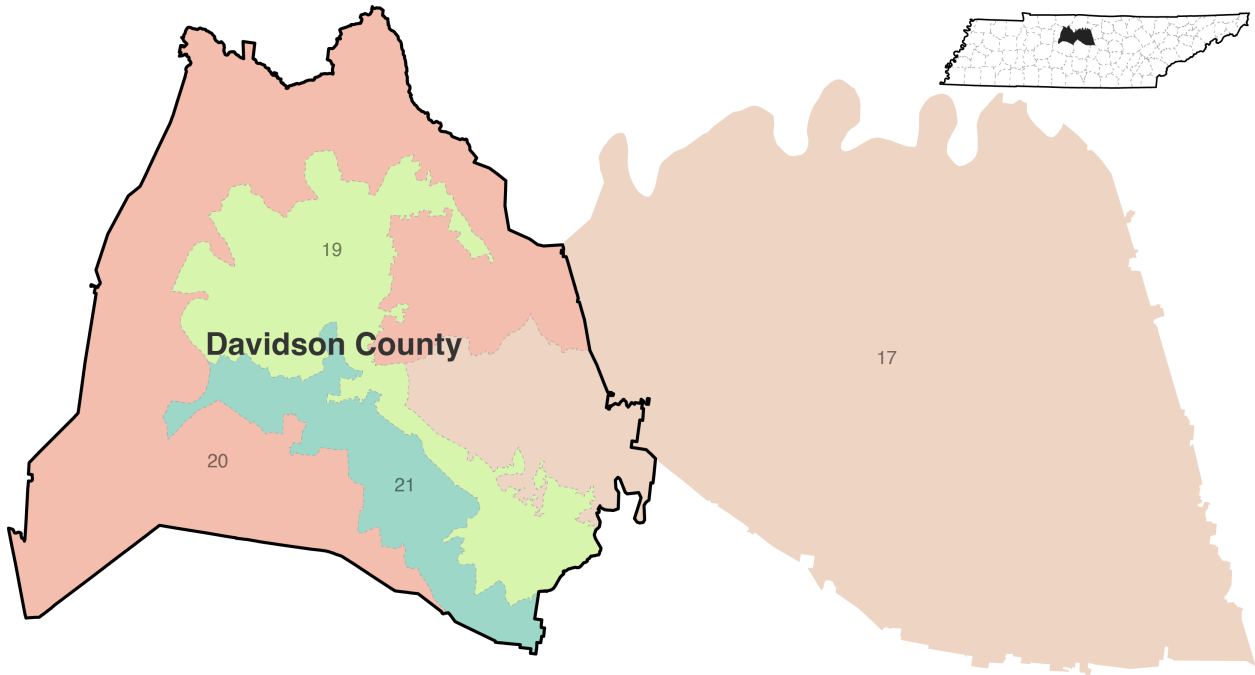


---

The plan consists of 33 districts. The districts each contain 2020 census populations between 203,169 and 216,092. The overall range of population deviations is 6.2%, and the average absolute deviation of the districts is 2.3%. The plan creates four Black-majority voting-age districts (SD-19, SD-29, SD-30, and SD-33). No other district contains a majority of non-White residents either alone or in combination. The enacted Senate plan has an average Reock compactness score of 0.3399 and an average Polsby-Popper compactness score of 0.2251. Nine counties are split at least once, and counties are split a total of 15 times. Seven counties have populations that exceed the population threshold for a district and must be split.



**Figure 3 - Non-Sequentially Numbered Districts in the 2022 Enacted Plan - Detailed Map**



**Enacted State Senate Plan - Non-Sequential Numbering**

In the plan that was enacted by the State Legislature, Davidson County contains four districts (see *Figure 3*). Three of these districts are wholly contained within the county boundaries, with one district extending beyond the Davidson border to get the remaining population from adjacent Wilson County. The Tennessee Constitution requires that all districts within a county must be numbered sequentially. However, in the enacted plan, Davidson County contains districts with numbers 17, 19, 20, and 21. Sumner and Trousdale counties are combined to form District 18. Davidson County therefore contains three odd numbered districts, and only one even numbered district.

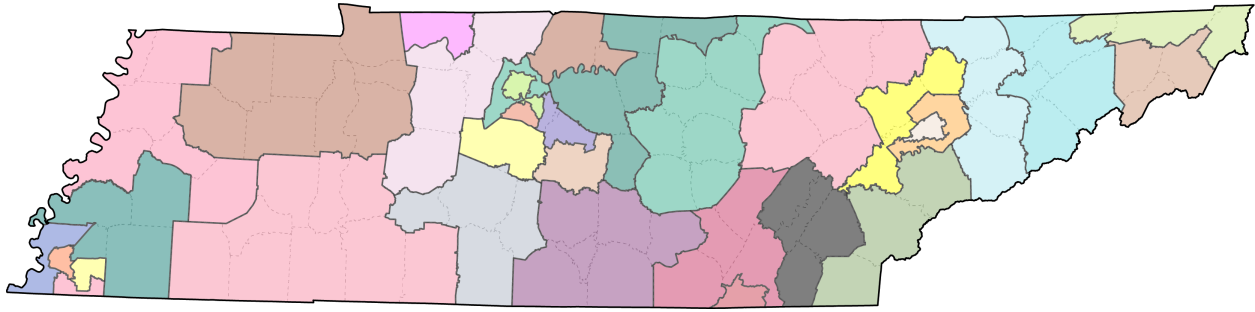
**Senate Constitutional Numbering Map**

I was sent, by counsel, a map that was proposed that sequentially numbers districts in all counties as required by the Tennessee Constitution.<sup>5</sup> This plan is shown in *Figure 4* and the area of detail that reflects Davidson County senate districts can be seen in *Figure 5*.

---

<sup>5</sup>I had to make slight adjustments to the map sent to me so that all precincts were assigned. These adjustments had no material impact on the plan or my analysis.

**Figure 4 - Senate Constitutional Numbering Map**

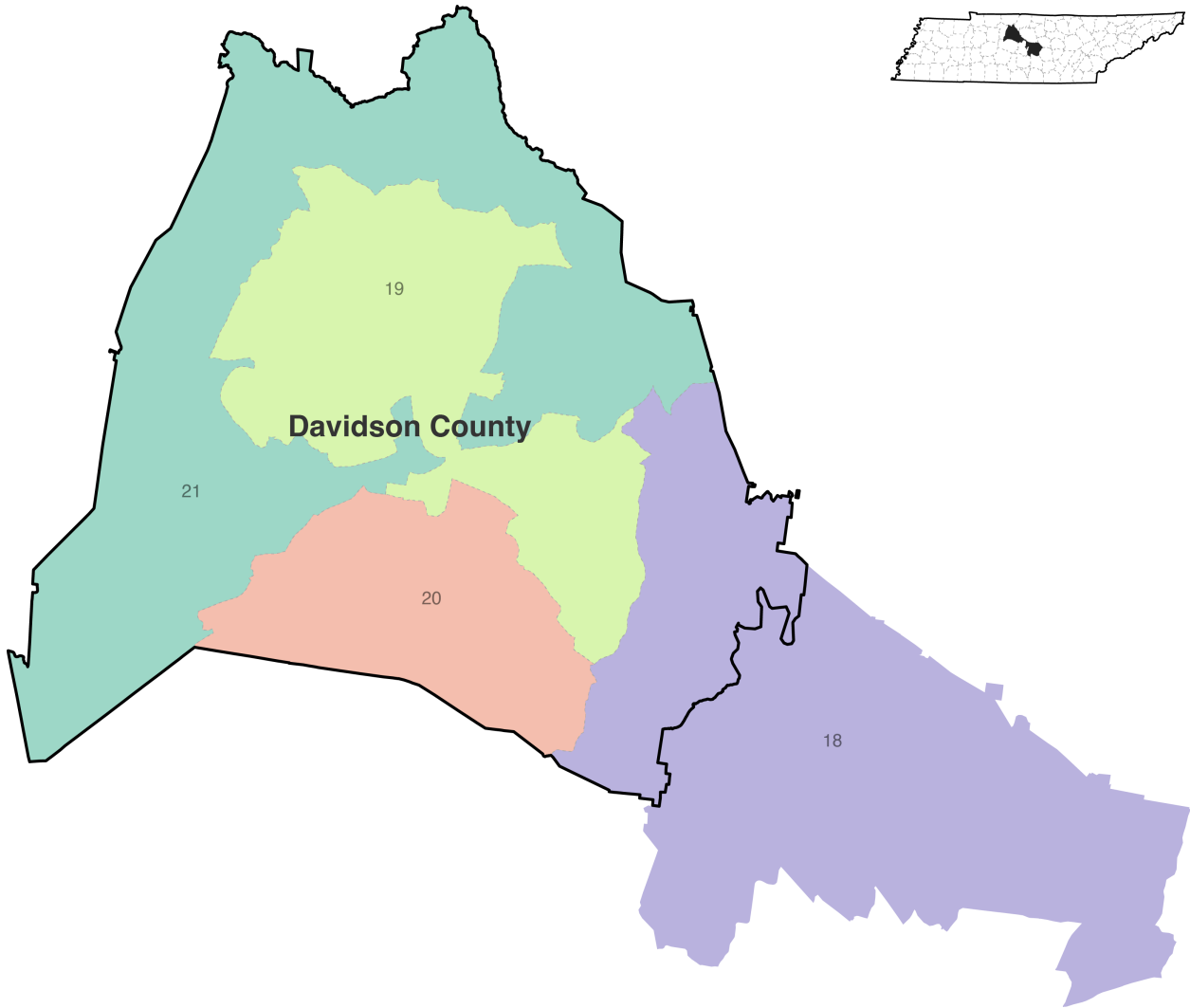


---

This proposal contains 33 districts. It has populations that range between 199,074 and 215,195 people. It has an overall deviation of 7.7%. The average absolute deviation is 1.4%. The plan creates three districts that have Black-majority voting age populations, and two districts where there are sizable Black populations, that constitute a majority non-White. The Reock compactness score for this proposal is 0.3781 and the Polsby-Popper average is 0.2786. Eight counties are split in this proposal, a total of 15 times. For each of the counties which have two or more districts inside their boundaries, each of the districts are sequentially numbered. For instance, Davidson County has four districts, SD-18, SD-19, SD-20, and SD-21; two even, and two odd.

---

**Figure 5 - Sequentially Numbered Districts in the Senate Constitutional Numbering Map - Detailed Map**



---

## **V. Cervas Senate Illustrative Plans**

### **Three Illustrative Plans**

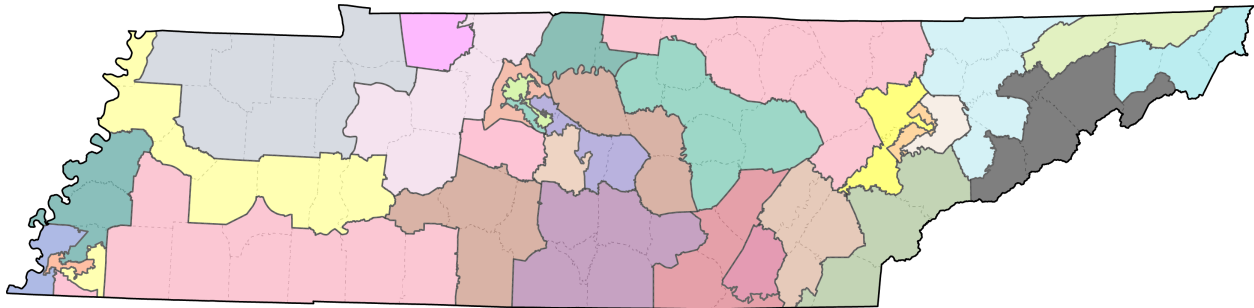
In the following section, I will demonstrate that with minor changes to the enacted map, a plan can comply with all of the criteria outlined in the introduction. Moreover, the Legislature has ample discretion to enact a plan of its choosing that complies with that criteria, and I demonstrate several alternatives to the Court. I create the first illustrative map by starting from the enacted map, making only changes to districts required by the state constitution to ensure that all districts are sequentially numbered. From this illustrative map (*Figure 6*), I created two additional variations, which shows that alternative choices can be made regarding the various trade-offs of traditional redistricting criteria. Details of Davidson and Rutherford counties for all three illustrative plans can be found in *Figure 7*.

## Cervas Senate 1 Plan<sup>6</sup>

In the enacted senate plan, Davidson County has four senatorial districts. Three districts are wholly within Davidson County (SD-19, SD-20, SD-21), and one district pairs a portion of Davidson County with all of Wilson County (SD-17). To consecutively number Davidson County's senate districts, the portion of Davidson County currently numbered SD-17 needs to be numbered SD-18. And, to avoid changing an odd-numbered district to an even-numbered district (which could arguably cause a sitting senator's 4-year term to be cut in half), the portion of Davidson County currently included in SD-17 needed to be paired with an adjacent county other than Wilson County. The only county that shares a border with this district besides Wilson is Rutherford County. Without making changes to the other three Davidson County districts, the only viable option is to pair the portion of Davidson County in enacted district 17 with the portion of Rutherford County in enacted district 14. Then, to ensure sequential numbering of the districts in Davidson County, the district numbers of four districts need to be switched. In my Concept 1 map, I switched district numbers in the least disruptive way. The new Davidson/Rutherford district must be SD-18 to ensure sequential numbering. Then, because Rutherford's two districts would then be SD-18 and SD-13, Rutherford County's second district must become SD-17. To make these two changes, I swapped the numbers of districts 14 and 18, and swapped the numbers of districts 13 and 17. This switch replaces one odd-numbered district for a different odd-numbered district, and one even-numbered district for a different even-numbered district. In both cases, odd-numbered districts remain odd-numbered districts, and even-numbered districts remain even-numbered districts, ensuring that no senator elected to a four-year term has to run again after just two years as a result of the redistricting process.

---

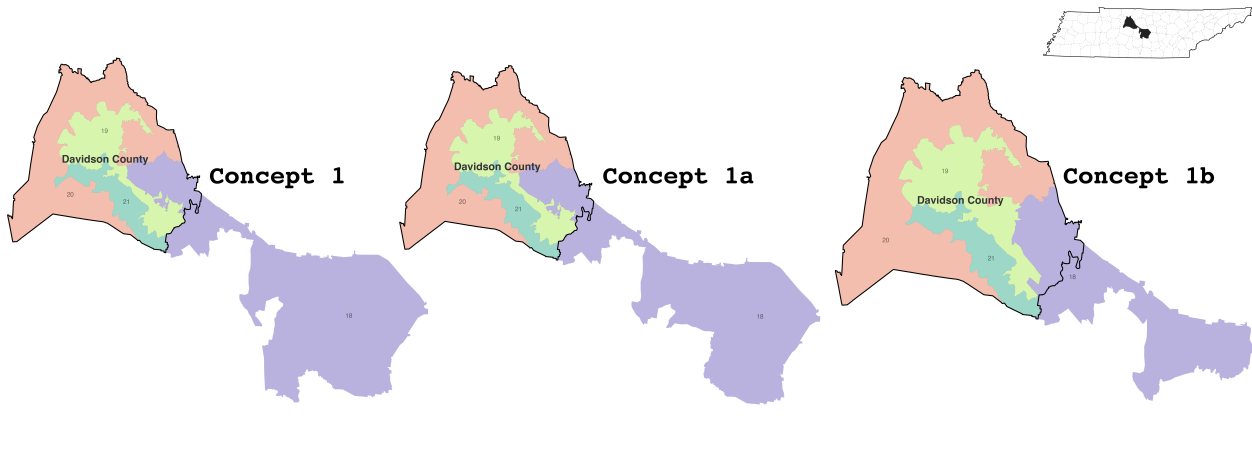
**Figure 6 - Cervas Senate 1 Plan**



---

<sup>6</sup><https://davesredistricting.org/maps#viewmap::82b1145e-0bd7-480c-8896-0ab5226f2c44>

**Figure 7 - Sequentially Numbered Districts in Cervas Senate 1, 1a, 1b plans - Detailed Map**



Turning to an analysis of the population breakdown between my illustrative Cervas Senate 1 Map and the enacted map, without making changes to the other three Davidson County districts, (which I note all have populations that exceed the ideal, resulting in the county being underrepresented compared to the rest of the state; SD-19: +5,960, SD-20: +6,657, SD-21: +6,665), the remaining part of Davidson has 68,345 people. Since each district has an ideal population of 209,419, the district needs at least 141,074 more persons.

Enacted SD-14 includes a portion of Rutherford County, as well as all of Cannon, Bedford, and Moore counties. Adding all of enacted SD-14 to the portion of Davidson County in enacted SD-17 would create too large of a district (this hypothetical district would exceed the ideal district population by +68,311). However, adding the residual Davidson County population to the Rutherford County population in enacted SD-14 (138,181) and the whole population of Cannon County (14,506) creates a district that is just 11,613 from ideal. This population deviation, while larger than preferred, complies with the 10% overall deviation threshold for 'one person, one vote'. However, enacted 13 (which becomes SD-17 in Cervas Senate 1), has a deviation of -6,114. This means that these two adjacent districts can swap census blocks until they are approximately equal in size. Cervas Senate 1a and 1b are alternative proposals that do just that, or make other alterations showcasing the various trade-offs involved with district drawing. All of these are acceptable remedies that result in a plan that meets all of the constitutional standards.

Changes to enacted districts 14 and 16 become necessary for contiguity. Recall that enacted district 14 contains a portion of Rutherford, as well as all of Cannon, Bedford, and Moore counties. In Cervas Senate 1, Bedford and Moore counties become part of SD-16, and DeKalb and Warren counties join Wilson County to form SD-13. This three county district has a population deviation of just -649.

This illustrative map has district populations that range between 203,169 and 221,032 persons. This is an overall population deviation range of 8.5%. It has an average absolute deviation of 2.4%. Although this map has an overall deviation under 10%, SD-18's population of 221,032 is beyond 5%, a pole that has been recognized as the highest (or lowest) allowable deviation. Changes can be made to adjacent districts which reduce it to far below this value. I do so in Cervas Senate 1a and Cervas Senate 1b.<sup>7</sup>

This plan maintains the four majority-Black districts completely untouched (SD-19, SD-29, SD-30, and SD-33).

This plan is narrowly tailored to cure the violation of district numbering while attempting to respect the

<sup>7</sup>In Cervas Senate 1, the population deviation of SD-17 is -6,114 and SD-18 is +11,613. If I were presenting this as a plan for enactment, I would balance these two adjacent districts.

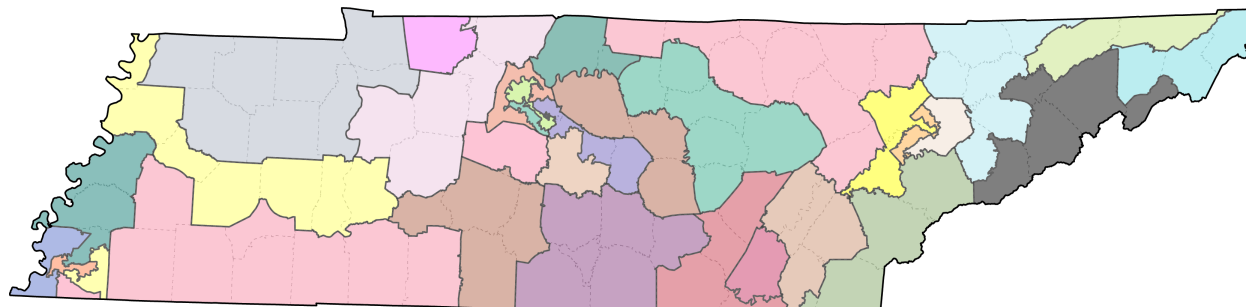
discretion of the Legislature in their enacted plan. The next two iterations show how trade-offs might be managed while fixing the district numbers.

### **Cervas Senate 1a Plan<sup>8</sup>**

I have also created an illustrative Cervas Senate 1a plan that makes several changes to Cervas Senate 1 (Figure 8). There are some trade-offs that are made to achieve these improvements. Redistricting often involves trade-offs between the numerous required criteria and other desired outcomes, such as preserving communities of interests. For instance, reducing the population deviations of districts requires that more political subdivisions are divided. Given the low number of counties that are divided in the enacted Senate plan, it seems as though the Legislature put high value on that criteria. In the spirit of limited changes, Cervas Senate 1a builds upon Cervas Senate 1 by reducing the population deviation of SD-18. To do so, I had to make adjustments to SD-17. I do so in order to make clear to the Court that there are a number of ways to correct the constitutional violation of district numbering, but that other changes are necessary.

---

**Figure 8 - Cervas Senate 1a Plan**



---

To reduce the deviation in SD-18, I make precinct and census block trades between SD-17 and SD-18, in Rutherford County. Specifically, because SD-17 is over 6,000 persons short of ideal, and SD-18 is over 11,000 above ideal, I add population to SD-17 from SD-18. I add just two precincts to SD-17, “6-1 Whitworth-Buchanan Middle School” and the remaining part of “21-2 BlackFox elementary School” (the other part was already in SD-17). Now, both districts have deviations well below 2%.

Cervas Senate 1a plan has a smallest district that is 203,170 persons and a largest district that is 216,092. The overall population deviation is 6.17%. The average absolute deviation is 2.2%. The Reock and Polsby-Popper averages in Cervas Senate 1 are nearly identical to the enacted plan, with a Reock average score of 0.3312 and an average Polsby-Popper score of 0.2297 (the enacted map has scores of 0.3399 and 0.2251, respectively). Like the enacted plan, Cervas Senate 1a splits nine counties a total of 15 times.

Cervas Senate 1a affects just four districts from the enacted senate map. It scores equal on the number of county splits, scores slightly higher on Polsby-Popper compactness and slightly lower on Reock compactness, and has population deviations that are slightly closer to ideal both on average and on the largest and smallest districts (overall deviation). Four majority-Black districts are maintained as the Legislature drew them. All districts in counties that are divided are numbered sequentially.

---

<sup>8</sup><https://davesredistricting.org/maps#viewmap::8d85eb6d-511a-408b-867e-feb965f88c89>

## Cervas Senate 1b Plan<sup>9</sup>

Rutherford County and Davidson County, which are adjacent to each other, have a combined population of 1,057,370 persons. Since Tennessee state senate districts have a 2020 ideal population size of 209,419, to evenly distribute the population among their five total districts, each would have 211,474 persons. This would mean each district would have an average deviation of just +2,055. In the enacted plan, the four districts within Davidson County average +6,486 persons. So, by connecting Rutherford County with Davidson, it is possible to reduce the average deviation for the senate plan. Two of the three highest population districts (and three of the top six districts) in the enacted plan are found in Davidson County.

Cervas Senate 1b (*Figure 9*) attempts to do just that, reduce the population deviations of this entire area, and thus in the plan more generally. This requires changes to the two non-Davidson/Rutherford based districts as in Cervas Senate 1, and changes also to SD-17, SD-19, SD-20, and SD-21. I also had to make changes to SD-13 and SD-15. None of these changes resulted in any additional county divisions.

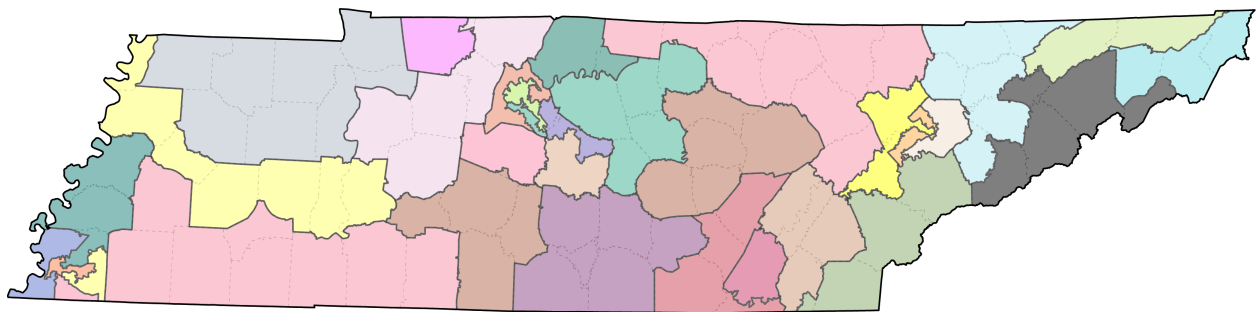
The smallest district in Cervas Senate 1b contains 203,169 persons, while the largest district has 216,092. The overall deviation is 6.2% and the average absolute deviation is just 2.1%. As mentioned above, this map has the same number of county divisions as the enacted plan. It contains three majority-Black districts, and one district (SD-19) that has a 47.8% Black-alone voting age population, and is 64.1% minority. It is my opinion that this district would give Black voters the opportunity to elect their candidate of choice. Note that in drawing this and all conceptual maps, I used no racial data. Plaintiffs' counsel have informed me that Defendants have not produced any Voting Rights analysis showing that any specific majority-minority district must be retained or created under current Voting Rights Act jurisprudence. Given my evaluation of this plan, it appears to be in full compliance with all state and federal law. Had I drawn this region *de novo*, I likely would have made different choices than the Legislature had in the creation of these districts, opting for more compact districts that complied with all state and federal law.

To illustrate some of the trade-offs in forming particular districts, enacted district 19, which has a 51.23% Black voting age population and has a Polsby-Popper compactness of 0.067. Contrast that to Cervas Senate 1b district 19, with a 47.8% Black voting age population, but has a Polsby-Popper compactness score of 0.085. And, Senate 1b's district 19 could be far more compact if more extensive changes were made to the enacted map, and the BVAP might not decrease any further, or may actually increase.

The choices of the map-maker might dictate the specific trade-offs that make the most sense in the context of the law and acceptable choices. My conceptual maps attempt to illustrate these trade-offs while adhering to the constitutional requirements.

---

**Figure 9 - Cervas Senate 1b Plan**



<sup>9</sup><https://davesredistricting.org/maps#viewmap::d7918197-91bd-4ead-9ab3-aad3a107adcf>

---

**Table 1 - Plan Comparisons**

PLAN	County Splits (Total Splits)	Overall Dev.	Mean Dev.	Reock	Polsby Popper
2022 Enacted	9 (15)	6.2%	2.3%	0.34	0.23
2012 Enacted	8 (14)	9.2%	2.5%	0.38	0.24
Dem. Concept	8 (15)	7.7%	1.4%	0.38	0.28
Cervas 1	9 (15)	8.5%	2.4%	0.33	0.23
Cervas 1a	9 (15)	6.2%	2.2%	0.33	0.23
Cervas 1b	9 (15)	6.2%	2.1%	0.34	0.23

*Note: “County Splits” is the total number of counties that have at least two districts in them. “Total Splits” is the total number of pieces in counties.*

---

## **VI. Conclusion**

Given my experience and expertise in redistricting, it is easy to conclude that the Legislature could have numbered all districts within a single county sequentially.

My illustrative plans are intended to demonstrate that it is possible to sequentially number senate districts consistent with the Tennessee constitution while managing the various redistricting criteria found in state and federal law, tradition, and caselaw. These plans are not intended to be a complete and total accounting of options before the Court, nor are they meant to be exhaustive. I have shown that it is possible to sequentially number the districts in Davidson County while making only minor changes to the surrounding districts. I have also shown that by making more extensive changes to surrounding districts, it is possible to improve various traditional criteria while fully satisfying the legal requirements.

---

### **Links to Plans**

- Cervas 1: <https://davesredistricting.org/maps#viewmap::82b1145e-0bd7-480c-8896-0ab5226f2c44>
- Cervas 1a: <https://davesredistricting.org/maps#viewmap::8d85eb6d-511a-408b-867e-feb965f88c89>
- Cervas 1b: <https://davesredistricting.org/maps#viewmap::d7918197-91bd-4ead-9ab3-aad3a107adcf>



# Appendix A

# JONATHAN ROBERT CERVAS

---

Carnegie Mellon University  
Institute for Politics and Strategy  
Posner Hall 387D, 5000 Forbes Avenue  
Pittsburgh, PA 15213

Email: cervas@cmu.edu  
Website: jonathancervas.com  
Twitter: @cervasj  
Github: jcervas  
Google Scholar: Jonathan R. Cervas  
*Revised October 2022*

## EMPLOYMENT

- 2020-Present     **Carnegie Mellon University**  
*Post-Doctoral Fellow, Institute for Politics and Strategy – cervas@cmu.edu*
- 2021-Present     **Pennsylvania Reapportionment Committee**  
*Map Consultant to the commission – jonathan.cervas@redistricting.state.pa.us*

## EDUCATION

### University of California, Irvine

#### **Ph.D., Political Science, August 2020**

- \* Dissertation Committee: Bernard Grofman (Chair), Michael Tesler, Carole Uhlaner
- \* Dissertation: “A Quantitative Assessment of the U.S. Electoral College, 1790-2020”
- \* Fields: American Politics, Political Methodology, Comparative Politics

#### **M.A., Political Science, December 2018**

### University of Nevada, Las Vegas

#### **B.A., Political Science, 2007**

#### *ADDITIONAL TRAINING*

- Workshop on Research Design for Causal Inference, **Northwestern University**, 2017
- Inter-university Consortium for Political and Social Research (ICPSR), **University of Michigan**, 2016

## PUBLICATIONS

- 2022     **11** - Using Folded Seats-Votes Curves to Compare Partisan Bias in the 2020 Presidential Election with Partisan Bias in the Five Other Presidential Elections in the 21st Century. **Jonathan Cervas** and Bernard Grofman. 2022. *Presidential Studies Quarterly*, June. [\[READ ONLINE\]](#)
- 10** - Turning Communities of Interest Into a Rigorous Standard for Fair Districting. Samuel S.-H Wang, Sandra J. Chen, Richard F. Ober, Jr., Bernard Grofman, Kyle T. Barnes, and **Jonathan Cervas**. 2022. *Stanford Journal of Civil Rights & Civil Liberties*, 18, 101. [\[READ ONLINE\]](#)
- 9** - Why Donald Trump Should be a Fervent Advocate of Using Rank-Choice Voting in 2024. **Jonathan Cervas** and Bernard Grofman. 2022. *PS: Political Science & Politics*, 55(1), 1-6. [\[READ ONLINE\]](#)
- 2021     **8** - A Systems Framework for Remediating Distortions in U.S. Democracy. Sam Wang, **Jonathan Cervas**, Bernard Grofman, and Keena Lipsitz. 2021. *Proceedings of the National Academy of Science*, 118(50), e2102154118. [\[READ ONLINE\]](#)
- 7** - The Unanticipated Effect of Covid-19 on House Apportionments. **Jonathan Cervas** and Bernard Grofman. 2021. *Social Science Quarterly*, 102(5) 2432-2434. [\[READ ONLINE\]](#)
- 2020     **6** - ZIP Codes as Geographic Bases of Representation. Bernard Grofman and **Jonathan Cervas**. 2020. *Election Law Journal*. [\[READ ONLINE\]](#)

- 5 - Legal, political science and economics approaches to measuring malapportionment. **Jonathan Cervas** and Bernard Grofman. 2020. *Social Science Quarterly*, 101(6): 2238-2256. [\[READ ONLINE\]](#)
- 4 - Tools for identifying partisan gerrymandering with an application to congressional districting in Pennsylvania. **Jonathan Cervas** and Bernard Grofman. 2020. *Political Geography*, 76: 102069. [\[READ ONLINE\]](#)
- 2019 3 - Are Presidential Inversions Inevitable? Comparing Eight Counterfactual Rules for Electing the U.S. President\*. **Jonathan Cervas** and Bernard Grofman. 2019. *Social Science Quarterly*, 100(4): 1322-1342. [\[READ ONLINE\]](#)
- 2018 2 - Can State Courts Cure Partisan Gerrymandering: Lessons from League of Women Voters v. Commonwealth of Pennsylvania (2018). Bernard Grofman and **Jonathan Cervas**. 2018. *Election Law Journal*, 17(4): 264–285. [\[READ ONLINE\]](#)
- 2017 1 - Why noncompetitive states are so important for understanding the outcomes of competitive elections: The Electoral College 1868–2016. **Jonathan Cervas** and Bernard Grofman. 2017. *Public Choice*, 173(3–4): 251-265. [\[READ ONLINE\]](#)

#### OTHER PUBLICATIONS

- 2022 Report of the Special Master (Harkinrider v. Hochel). **Jonathan Cervas** [\[READ ONLINE\]](#)
- 2021 Fracking: A Contiguity-Related Redistricting Metric. **Jonathan Cervas** and Bernard Grofman. *Election Law Blog* [\[READ ONLINE\]](#)
- Trump the wrestler and the 2024 grudge match. Bernard Grofman and **Jonathan Cervas**. [\[READ ONLINE\]](#)
- The GOP scared Latinos from the census. Now that may cost the party red seats. Sam Wang and **Jonathan Cervas**. *Washington Post* [\[READ ONLINE\]](#)
- Great Lobster and a More Equitable Voting System Exists in Maine. Anjali Akula, **Jonathan Cervas**, and Elsie Goren. *Medium.com* “3Streams” [\[READ ONLINE\]](#)
- 2020 Amicus Curiae with Princeton Electoral Innovation Lab [\[READ ONLINE\]](#)
- How Likely is Trump to Lose the Popular Vote but Win the Electoral College? **Jonathan Cervas** and Bernard Grofman. *Medium.com* “3Streams” [\[READ ONLINE\]](#)
- These Are the Political Consequences of Excluding Undocumented Immigrants from Apportionment. Angela Ocampo and **Jonathan Cervas**. 2020. *Medium.com* “3Streams” [\[READ ONLINE\]](#)
- 2018 Pennsylvania has to draw new congressional districts but getting rid of gerrymandering will be harder than you think. Bernard Grofman and **Jonathan Cervas**. 2018. *The Washington Post*. [\[READ ONLINE\]](#)

#### IN PROGRESS

- \* “Can State Courts Constrain Partisan Gerrymandering in Congressional Elections?” (accepted, *New Hampshire Law Review*) [\[READ ONLINE\]](#)
- \* “Recent Approaches to the Definition and Measurement of Compactness” (under review, *Political Geography*) [\[READ DRAFT ONLINE\]](#)
- \* “Fracking: A Contiguity-Related Redistricting Metric” [\[READ DRAFT ONLINE\]](#)
- \* “Fallacies in Statistically-Based Claims about Massive Election Fraud in 2020” (encouraged to revise and resubmit, *Statistics and Public Policy*) [\[READ DRAFT ONLINE\]](#)
- \* “The Terminology of Districting.” (with Bernard Grofman) [\[READ DRAFT ONLINE\]](#)
- \* “The Paradox of Malapportionment.”
- \* “Is the Electoral College Biased in Favor of Republicans? YES and NO.” (with Bernard Grofman)

- \* “An Experiment on Optimal Campaigning Using a Simplified Seven-State Electoral College.” (with Bernard Grofman and Scott Feld)
- \* “Location, Isolation, and Influence.”
- \* “Population-Dependence of Cabinet Sizes.” (with Rein Taagepera and Brian Kaiser) [\[READ DRAFT ONLINE\]](#)
- \* “Representation of Non-Eligible Resident Populations in Legislative Bodies.” (with Angela X. Ocampo)
- \* “Apportionment without non-citizens.”
- \* “Distinguishing Between the Legacy of Slavery, Racial Threat, and Density in the American South.” (with Bernard Grofman)
- \* “Nationalized Campaigns and Midterm Dropoff.”
- \* “Habitual Voting Under Conditions of Gerrymandering.”

## WORK EXPERIENCE

### *SPECIAL MASTER*

*Harkenrider v. Hochul* (2022), New York Congressional and State Senate Districts  
[\[court opinion\]](#) [\[SPECIAL MASTER REPORT\]](#)

### *CONSULTANT*

Pennsylvania Reapportionment Commission

### *ASSISTANT TO THE SPECIAL MASTER*

- 2019-2020 *Wright v. Sumter County Board of Elections and Registration*. U.S. District Court, Middle District of Georgia (2020) [\[court opinion\]](#)
- 2018-2019 *Bethune-Hill v. Virginia State Board of Elections*. U.S. District Court for the Eastern District of Virginia (2019) [\[court opinion\]](#)
- 2017 *Navajo Nation v. San Juan County, UT*. United States District Court for the District of Utah (2018) [\[court opinion\]](#)

### *EXPERT WITNESS*

Moore v. Lee, Case No. 22-0287-IV (2022). Chancery Court of Tennessee

## INVITED TALKS

- 2021 “Voting Rights and Election Law”, Hofstra Law School., Hosted by Judge Phil So September 12, 2022
- “Measuring Compactness”, Pennsylvania Redistricting with Geographers: Communities of Interest Criteria and Beyond, American Association of Geographers [\[Slides\]](#)
- 2021 “Voting Rights and Elections”, University of Texas at Austin, Hosted by Beto O’Rourke. Spring 2021
- “Tools for Identifying a Partisan Gerrymander”, Princeton University Wintersession.
- 2019 “2019 NCSL Capitol Forum (Legislative Options for Redistricting Post-conference)”, National Conference of State Legislatures.
- “Redrawing the Virginia legislative map: the Bethune-Hill racial gerrymandering case”, Princeton University.
- 2018 “Triple Play: Election 2018, Census 2020 and Redistricting 2021”, University of Houston, Hobby School.
- 2016 “Representation of Non-Eligible Resident Populations in Legislative Bodies”, Center for the Study of Democracy Graduate Student Conference, UC Irvine.

2015 “Asymmetry in State Grant Distribution: Why Proximity to the State Capital Matters”,  
Western Political Science Association, San Diego, California.

### **SERVICE TO THE DISCIPLINE**

Referee: American Journal of Political Science, Political Geography, Election Law Journal,  
Public Choice, Political Research Quarterly

### **REFERENCES**

**Bernard Grofman**, University of California Irvine  
Distinguished Professor of Political Science  
Fellow - American Academy of Arts and Sciences  
[bgrofman@uci.edu](mailto:bgrofman@uci.edu)

**Mark Nordenberg**, University of Pittsburgh  
Chancellor Emeritus, University of Pittsburgh  
Dean emeritus, University of Pittsburgh Law School  
[norden@pitt.edu](mailto:norden@pitt.edu)

**Carole Jean Uhlaner**, University of California Irvine  
Professor of Political Science  
[cuhlaner@uci.edu](mailto:cuhlaner@uci.edu)

**Richard L. Hasen**, University of California Los Angeles Law School  
Chancellor's Professor of Law and Political Science  
[rhasen.uci.edu](mailto:rhasen.uci.edu)