IN THE SUPREME COURT OF WISCONSIN
APPEAL NO. 2021AP1450-OA

BILLIE JOHNSON, et al.,

Petitioners,

BLACK LEADERS ORGANIZING FOR COMMUNITIES, et al.,

Intervenors-Petitioners,

v.

WISCONSIN ELECTIONS COMMISSION, et al.,

Respondents,

THE WISCONSIN LEGISLATURE, GOVERNOR TONY EVERS, in his official capacity, and JANET BEWLEY SENATE DEMOCRATIC MINORITY LEADER, on behalf of the Senate Democratic Caucus,

Intervenors-Respondents.

EXPERT REPORT OF BRIAN AMOS, Ph.D.

EXECUTIVE SUMMARY

In this report, I describe the features of a redistricting plan for the Wisconsin Assembly and Senate districts, proposed by Janet Bewley, Senate Democratic Minority Leader on behalf of the Senate Democratic Caucus. That plan is referred to herein as the "Bewley Maps" (or individually as the "Bewley Assembly map" and the "Bewley Senate map") and a visual depiction of those maps is attached hereto as **Exhibit 1**. I have analyzed the Bewley Maps

according to the criteria set forth in the Wisconsin Supreme Court's November 30, 2021 Order, namely, recognizing the Court's goal to remedy the malapportionment of the maps adopted by statute in 2011 and modified by subsequent court order (the "benchmark" maps or plans), in light of the August 2021 United States Census Bureau data (from the 2020 Census), while also ensuring the maps satisfy all other State and Federal Constitutional and statutory requirements.

The Bewley Maps take a strong "least change" approach: 83.8% of voters retain their district in the Bewley Assembly map, and 90.5% retain their district in the Bewley Senate map. Only 2.3% of voters are moved from an odd-numbered Senate district to an even-numbered one. Total incumbent pairings are also low: the Bewley Maps have only eight Assembly districts and three Senate districts that contain two incumbents' homes.

The Bewley Maps also comply with all constitutional and statutory requirements, as demonstrated by their performing as well or better than the benchmark maps that previously passed federal court muster. As further detailed below:

- the population equality deviation in the Bewley Assembly map is 1.86% from ideal. In the Bewley Senate map, population equality deviation from ideal is 1.61%. These measures are well below the "constitutionally suspect" deviation of 10%.
- The Bewley Maps maintain the same number of districts with majority Black and Hispanic voting age populations as in the benchmark maps: six majority Black districts and two majority

Hispanic districts in the Assembly, and two majority Black districts and one plurality Hispanic district in the Senate.

- The Bewley Maps have a similar number of county and municipal splits as the benchmark maps, with 55 county and 79 municipal splits in the Assembly, and 48 county and 52 municipal splits in the Senate. There are zero ward splits.
- The Bewley Maps have districts that are made up of contiguous wards; any non-contiguity in district geography is caused by the wards themselves not being contiguous.
- The Bewley Maps have compactness scores that are on par with the average compactness of the benchmark maps: in the Bewley Senate map, the Reock scores range from 0.137 to 0.564 with an average of 0.401, while the Polsby-Popper scores range from 0.078 to 0.451 with an average of 0.212. In the Bewley Assembly map, the Reock scores range from 0.148 to 0.624 with an average of 0.405, while the Polsby-Popper scores range from 0.065 to 0.524 with an average of 0.254.

DETAILED REPORT

I. OPINIONS, INCLUDING UNDERLYING FACTS AND DATA RELIED UPON.

The analysis and opinions described herein are based on the technical and specialized knowledge that I have gained from my education, training, and experience, and are consistent with widely accepted and reliable methodologies and practices in the areas of redistricting and political science. The opinions I express in this report are made to a reasonable degree of professional certainty, and

are based on my review and analysis of the information and data referenced and described herein.

I analyzed the Bewley Maps for (1) Equal population (measuring population deviation); (2) Voting Rights Act of 1965 requirements (measuring minority voting age population percentages in each district); (3) Respect for county, precinct, town, and ward lines (measuring the number of municipal and county splits); (4) Contiguousness of Assembly districts; (5) compactness of Assembly districts (using the Reock Degree of Compactness score and the Polsby-Popper test), avoiding multi-member Assembly districts and the division of Assembly districts in forming Senate districts. I reviewed these considerations within a "least change" approach, i.e., with an aim to preserve the core of the districts created by the benchmark maps. In other words, in the context of aiming to make the "least changes" to the benchmark maps, to address population changes, I also evaluated the Bewley Maps for constitutional and statutory compliance. I did not analyze these maps for partisan makeup beyond what was necessary for Voting Rights Act compliance, as the Court has identified that as legally irrelevant.

The Bewley Maps were produced using WISE-District software, a custom software extension to ESRI's ArcGIS Desktop software, created by the Wisconsin Legislative Technology Services Bureau ("LTSB") for Wisconsin's 2021 Legislative and Congressional Redistricting, using only publicly available data and information in the LTSB 2021 Redistricting Database, as follows:

- U.S. Census Bureau TIGER 2020 Geography, available at: https://www2.census.gov/geo/tiger/TIGER2020PL/STATE/55_WISCONSIN/;
- U.S. Census Bureau 2020 Decennial Census Public Law 94-171 demographic data, summarized per the U.S. Department of Justice and available at: https://www2.census.gov/programs-surveys/decennial/2020/data/01-Redistricting_File--PL_94-171/Wisconsin/ and https://legis.wisconsin.gov/ltsb/gis/data/;
- Statewide partisan election result data (geographic estimates) from 1990-2020, available at: https://legis.wisconsin.gov/ltsb/gis/data/;
- Relevant geographic reference data containing the benchmark districts as well as current wards, municipalities, counties, and school districts, available at: https://data-ltsb.opendata.arcgis.com/search?q=Districts, https://legis.wisconsin.gov/ltsb/gis/wise-decade, https://data-ltsb.opendata.arcgis.com/datasets/2012-2020-election-data-with-2020-wards/explore?location=44.645531%2C-89.815220%2C7.00, and https://data-wi-dpi.opendata.arcgis.com/;
- The local redistricting results as of December 10, 2021, available at: https://data-ltsb.opendata.arcgis.com/

I then used ESRI's ArcGIS Desktop software to analyze the data files for the Bewley Maps. I also performed some additional analysis in Python and Microsoft Excel.

Other information and data I used in conducting my analysis and forming my opinions includes:

- LTSB Shapefiles for the benchmark maps, circulated to the parties;
- The November 4, 2021 Stipulation of Facts and Law filed in this case;
- The October 21, 2021 Memorandum from the Wisconsin Legislative Reference Bureau, subject "2011 Act 43 State Legislative Data," attached hereto as **Exhibit 2**;
- The Voting and Election Science Team's "Wisconsin Democratic Primary Results, 2014-2020" and "2018 Precinct-Level Election Results" datasets, available at: https://dataverse.harvard.edu/dataverse/electionscience.

The following sections describe the features of the Bewley Maps:

Measures of Least Change

The Court has directed a "least change" approach in this case. That approach can be identified by a high degree of "core retention," and, to a lesser extent, minimizing Senate voting disenfranchisement and minimizing total incumbent pairings. Each of these measurements are well-demonstrated in the Bewley Maps.

To prevent the confusion of voters in the redistricting process, it is often considered beneficial to keep as many residents as possible within their previous districts when redistricting. This is referred to

as "core retention." Because of variation in population growth across the state and equal population requirements, it is not possible for every resident to keep their district number, but minimizing the change is a goal to strive for. I have included **Exhibits 3 and 4**, which work through the list of new district numbers proposed in the Bewley Maps and give the number of voters that came from different district numbers in the 2011 benchmark plan; if all voters in the new district come from the old district, it is not included in the list. In total, 83.8% of voters retain their district in the Bewley Assembly map, and 90.5% retain their district in the Bewley Senate map. Thus, the Bewley Maps perform better on this "core retention" measurement than the benchmark maps, in which only 58.8% of voters retained their Assembly district as compared to the preceding maps, and only 78.8% of voters retained their Senate district as compared to the preceding maps.[1]

A special case of this question occurs when a resident is moved from an odd-numbered Senate district to an even-numbered Senate district. Because the new odd-numbered districts will be up for election in 2022 but the old even-numbered districts will be in place until 2024, those who get moved will technically not have an elected representative in the Senate for two years. As shown in **Exhibit 5**, the Bewley Senate map only has 2.3% of the state population fall into this category.[2]

---

[1] *See* **Exhibit 2**, p. 2.

[2] This represents 135,560 voters, less than half the number of voters who were disenfranchised in the same way by the benchmark maps. *See id.*

Retaining a district number does not necessarily mean that a voter retains their incumbent: in the changes made to balance populations, an incumbent's home may be moved to a new district number, potentially forcing them to run against another incumbent to retain a seat in the legislature. The 2011 benchmark map had eleven Assembly districts and one Senate district that contained two incumbents' homes. The Bewley Maps have eight Assembly districts and three Senate districts that contain two incumbents' homes. Thus, the Bewley Maps have fewer total incumbent pairings than the benchmark plan from last decade.

Population Equality

The 2020 U.S. Census found that the population of Wisconsin was 5,893,718. Divided equally, this means that each of the 99 Assembly districts ideally should have 59,533 people and each of the 33 Senate districts should have 178,598 people. **Exhibits 6 and 7** list the population for each district in the Bewley Maps. In the Bewley Assembly map, the largest district is 56, with a population of 60,080, or 0.92% over ideal. The smallest are districts 77 and 83 at 58,976 people, or 0.94% under ideal, making a total deviation of 1.86%. In the Bewley Senate map, the largest district is 12, with a population of 179,879, or 0.72% over ideal. The smallest district is 26, with a population of 177,010, or 0.89% under ideal, making a total deviation of 1.61%.

The U.S. Supreme Court has ruled in *Brown v. Thomson*, 462 U.S. 835, 842-843 (1983), that a maximum deviation from the smallest to the largest district over 10% is constitutionally suspect. The

Bewley Maps both fall well below this threshold, having maximum deviations under 2%.

Voting Rights Act

Using 2020 Census data, the benchmark Assembly map has six districts with a majority of the voting age population ("VAP") that reported their race to be Black or Black in any combination of other races or ethnicities (10, 11, 12, 16, 17, and 18) and two that have a VAP that is majority Hispanic (8 and 9). The Bewley Map matches these counts using the same districts.

The benchmark Senate map has two districts with a voting age population that is majority Black (4 and 6), and one that has a VAP that is plurality Hispanic (3). The Bewley Map matches these counts using the same districts.

District	Bewley Black VAP %	2011 Black VAP %
AD10	53.9%	59.4%
AD11	63.3%	65.5%
AD12	50.7%	60.6%
AD16	54.6%	55.6%
AD17	66.4%	68.4%
AD18	50.5%	60.7%
SD4	55.9%	61.8%
SD6	57.1%	61.5%

District	Bewley Hispanic VAP %	2011 Hispanic VAP %
AD8	66.6%	67.2%
AD9	52.8%	56.2%
SD3	44.9%	46.9%

The racial composition of these districts shows that the first prong of the *Gingles* test[3] continues to be met with the number of districts used in the benchmark map. Next, I will demonstrate that there is racially polarized voting in the state, satisfying the second and third prongs of the *Gingles* test. Finally, I will show the minority communities in these majority/plurality districts are able to elect their preferred candidates, demonstrating the success of the Bewley Maps in fulfilling the requirements for *Gingles* districts under the Voting Rights Act.

Majority Black Districts

There are several common methods to estimate the voting preferences of racial communities within a state. The first is a homogeneous precinct analysis, where the voting preferences of wards in the state with a voting age population that is 90% or more a single race are examined. The second is an ecological regression, where the percent of each ward that is a particular race is used to find the best-fitting model to predict the vote for a particular

[3] *Thornburg v. Gingles*, 478 U.S. 30 (1986).

candidate. Finally, an ecological inference analysis uses maximum likelihood estimation on bounds of possible racial voting patterns to make a best prediction for each of the racial categories included in the analysis.

To gauge Black voting trends in a potentially racially polarized context, I use the 2018 gubernatorial election; though the Democratic governor candidate, Tony Evers, is white, his lieutenant governor running mate in the race, Mandela Barnes, is Black. Each of the following analyses was done using ward-level data released by the Wisconsin State Legislature's Legislative Technology Services Bureau ("LTSB"),[4] with wards excluded if they either had no voting age population or votes cast recorded. All three analyses show that Black voters overwhelmingly supported the Evers/Barnes ticket, while white voters had support in the range of 43% to 47%.

Homogeneous Precincts

According to the LTSB, thirty-nine precincts in the state had a voting age population whose residents were 90% or more Black. 19,660 of the 20,368 votes cast for governor in these precincts (96.5%) were for the Evers/Barnes ticket. 5204 precincts were 90% or more white by VAP, which cast 801,660 of 1,860,121 votes (43.1%) for the Evers/Barnes ticket.

[4] https://data-ltsb.opendata.arcgis.com/datasets/2012-2020-election-data-with-2020-wards

Ecological Regression

Using a method first suggested by Goodman[5] that is standard in racial voting reports, we can also use regression analysis to predict the vote for the Evers/Barnes ticket using the share of the electorate by ward that is Black. This analysis returns a figure of 113.5% support for Evers/Barnes among Black voters and 43.5% for those who are not Black. The former figure is obviously impossible, which is common issue with Goodman's regression when support among a racial group is especially high,[6] and a reason to use King's Ecological Inference method instead, as I do below. Still, the takeaway of the analysis matches that of the homogeneous precincts analysis, that Black voting preferences differ from the rest of the voters of the state.

Ecological Inference

Ecological inference techniques solve some of the problems of Goodman's regression by using election data more fully in the analysis; impossible outcomes for each ward are taken into account and minimized as much as possible in predictions. I used the eiPack R module[7] to conduct the analysis, where I separated the voting age population into those who voted for Evers/Barnes, those who voted for the Republican Walker/Kleefisch ticket, and those who voted third party or didn't vote. I also separated the voting age population

---

[5] Goodman, Leo A. 1959. "Alternatives to Ecological Correlation." *American Journal of Sociology* 64(6): 610-625.

[6] See Gary King's *A Solution to the Ecological Inference Problem* (1997, Princeton University Press) for an in-depth discussion of the issue.

[7] Lau, Olivia, Ryan T. Moore, and Michael Kellermann. 2007. "eiPack: Ecological Inference and Higher-Dimension Data Management," *R News* 7(2): 43-47.

by race, into white, Black, Hispanic, and other. Wards with more votes reported than voting age population were by necessity excluded. The results predicted that 46.6% of white voters chose Evers/Barnes, compared to 95.4% of Black voters, 76.2% of Hispanic voters, and 88.9% of voters who fell into other racial categories.

Candidate Performance in Black-Majority Districts

Given that Black voters have different preferences on average than other voters in the state, it is necessary to show that these preferences have won in the districts that are majority Black. In the benchmark map, the six majority-Black Assembly districts and two majority-Black Senate districts saw easy victories for the Evers/Barnes ticket, with the vote for the Democrats ranging from 79% to 89%. Using data from the Voting and Election Science Team ("VEST")[8] that has been disaggregated down to the block level[9] and reaggregated up to the Bewley map, I find similar overwhelming margins for Evers/Barnes.

District	Evers/Barnes %
AD10	86.8%
AD11	79.7%
AD12	71.0%
AD16	88.8%
AD17	84.0%
AD18	80.2%

[8] https://dataverse.harvard.edu/dataverse/electionscience
[9] For a discussion of this method, see Amos, Brian, Michael P. McDonald, and Russell Watkins's 2017 paper "When Boundaries Collide" in *Public Opinion Quarterly* 81(S1).

SD4	79.6%
SD6	84.1%

Even if Democrats win in the general election, the question remains whether Black-preferred candidates can win the Democratic primary in these districts; turnout by race in a primary election could differ enough to make it difficult for the community to elect a candidate of their choosing. Mandela Barnes received more than twice the votes of his closest competitor in the lieutenant governor primary, so it is perhaps no surprise he won every district in the state except those centered on Sheboygan, the hometown of his opponent. However, the runner-up in the gubernatorial primary with 16% of the vote was Mahlon Mitchell, another Black candidate. In a race where seven different candidates won at least 5% of the vote, Mitchell won a plurality in all the majority-Black districts.

District	Barnes %	Mitchell %
AD10	88.5%	47.4%[10]
AD11	87.6%	63.1%
AD12	81.9%	58.6%
AD16	88.2%	58.6%
AD17	86.4%	65.4%
AD18	86.4%	55.3%
SD4	86.3%	55.1%
SD6	86.9%	60.2%

[10] Though this is not a majority, it is a safe plurality: Tony Evers took second place in the district with 25.1% of the vote.

In summary, the Bewley Maps retain six majority-Black districts from the 2011 benchmark Assembly plan and two from the Senate plan that allow the Black community to elect candidates of their choosing.

Majority/Plurality Hispanic Districts

Analyzing the opportunities for the Hispanic districts is more difficult, since I could not identify a Hispanic candidate that ran for statewide partisan office in a recent election year. I can, however, run the same analyses as above on the 2018 gubernatorial race to estimate the party preferences of Hispanic voters. There are no wards where 90% or more of the voting age population is Hispanic, but there are 22 where at least two-thirds of the VAP is Hispanic; 5660 of 6795 votes cast (83.3%) were for Evers/Barnes. Running an ecological regression produces an estimate of 118% support for Evers/Barnes, which requires the same disclaimer as for the Black vote prediction. As stated before, the ecological inference model predicted that 76.2% of Hispanic voters chose Evers/Barnes in the gubernatorial race.

The results are a bit noisier, but it seems clear that Hispanic voters preferred the Democratic candidate in this race. This preference is expressed when looking at the district results: Assembly Districts 8 and 9 voted for Evers/Barnes with 80.7% and 71.3% of the vote, respectively, while Senate District 3 went for Evers/Barnes with 64.9% of the vote.

Split Jurisdictions

It is considered good redistricting practice to keep wards, municipalities, and counties whole within a single district where possible. Due to equal population requirements, though, there are many cases where it is not possible, but an effort can be made to minimize the splits. **Exhibits 8 and 9** list the split counties and municipalities for both the Bewley Assembly and Senate maps.

The Bewley Maps were drawn using wards as the building block, so none is split across districts. The 2011 benchmark Assembly map split 58 counties and 78 municipalities.[11] The Bewley Assembly map splits 55 counties and 79 municipalities. The 2011 benchmark Senate map split 46 counties and 48 municipalities.[12] The Bewley Senate Map split 48 counties and 52 municipalities. In summary, the Bewley Maps have a similar number of splits as the 2011 benchmark maps.

Contiguity

Contiguity is the principle that someone should be able to move from one point in a district to any other point in a district without having to pass through another district – in other words, districts are one, continuous piece of geography. In practice, this has been made complicated in Wisconsin due to municipalities themselves not being contiguous; in the benchmark 2011 Assembly plan around Madison, for instance, there is considerable non-contiguity. However, a slightly different definition of contiguity

[11] *See* **Exhibit 2**, p. 3.
[12] *Id.*

holds, in that every ward in a district is touching another ward in the district.

Like the benchmark plans, the Bewley plans have areas where districts are not contiguous, but they are a product of the wards not being contiguous, and the same rule of being connected at the ward level holds. Thus, the Bewley plans meet contiguity requirements as well as the benchmark plans.

Compactness

Compactness is a measure of the geometric shape of a district, often where a score of 1.0 represents a perfect circle, and the score declines as the district shape spreads out or the border becomes more complicated. Two standard measures of compactness are Reock and Polsby-Popper. Reock is the ratio of a district's area to the area of the smallest circle which completely encloses the district, and Polsby-Popper is the ratio of the area of a district to a circle with the same perimeter as the district.

In Exhibits 10 and 11, I compare the compactness scores for the Bewley Maps with the 2011 benchmark maps. The calculations were made using the Wisconsin Transverse Mercator coordinate system, which is a statewide projected coordinate system developed by the Wisconsin Department of Natural Resources, and major bodies of water were excluded from the calculations.

In the 2011 benchmark Assembly map, the Reock scores range from 0.147 to 0.662 with an average of 0.390, while the Polsby-Popper scores range from 0.048 to 0.562 with an average of 0.260. In the Bewley Assembly map, the Reock scores range from 0.148 to

0.624 with an average of 0.405, while the Polsby-Popper scores range from 0.065 to 0.524 with an average of 0.254. Under both measures, the Bewley Assembly map improves the minimum compactness and is on par with the average compactness of the benchmark plan.

In the 2011 benchmark Senate map, the Reock scores range from 0.127 to 0.667 with an average of 0.402, while the Polsby-Popper scores range from 0.053 to 0.464 with an average of 0.230. In the Bewley Senate map, the Reock scores range from 0.137 to 0.564 with an average of 0.401, while the Polsby-Popper scores range from 0.078 to 0.451 with an average of 0.212. Like with the Bewley Assembly map, the Bewley Senate map improves the minimum compactness under both measures and is on par with the average compactness of the benchmark plan.

Other District Concerns

The Wisconsin Constitution requires that each Assembly district elects a single member and that Assembly districts cannot be divided across two or more Senate districts. Both requirements are met in the Bewley Maps.

II. QUALIFICATIONS AND PRIOR TESTIMONY.

I received my Doctorate in Political Science from the University of Florida and am currently an Assistant Professor at Wichita State University. My research explores the intersection of geography and politics, with an emphasis on redistricting. I have collaborated with University of Florida Professors Michael P.

McDonald and Daniel A. Smith on numerous occasions, including in redistricting litigation and as a co-author on peer reviewed articles on the topic of redistricting. I have served as a consulting expert in other redistricting litigation. I have not previously given testimony, either in trial or by deposition. My education, employment history, relevant experience, publications and other relevant qualifications are detailed on my *curriculum vitae*, attached hereto as **Exhibit 12**.

III. COMPENSATION.

I am charging $150 per hour for my work in this case.

Respectfully Submitted,

Dated: 12-15-21

Brian Amos, Ph.D.

Bewley Assembly Map - Full State

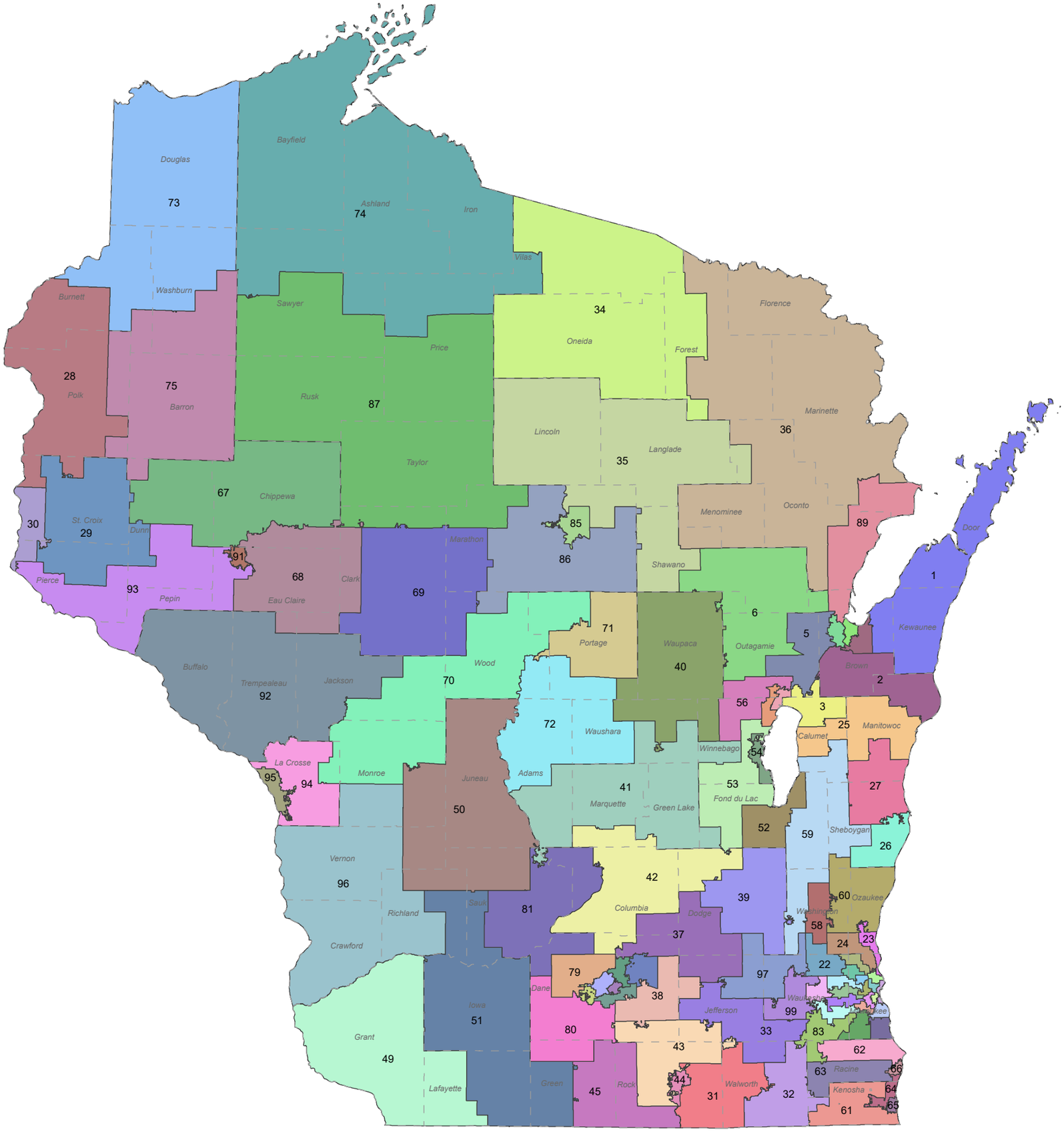

EXHIBIT 1

Bewley Assembly Map - Milwaukee Area

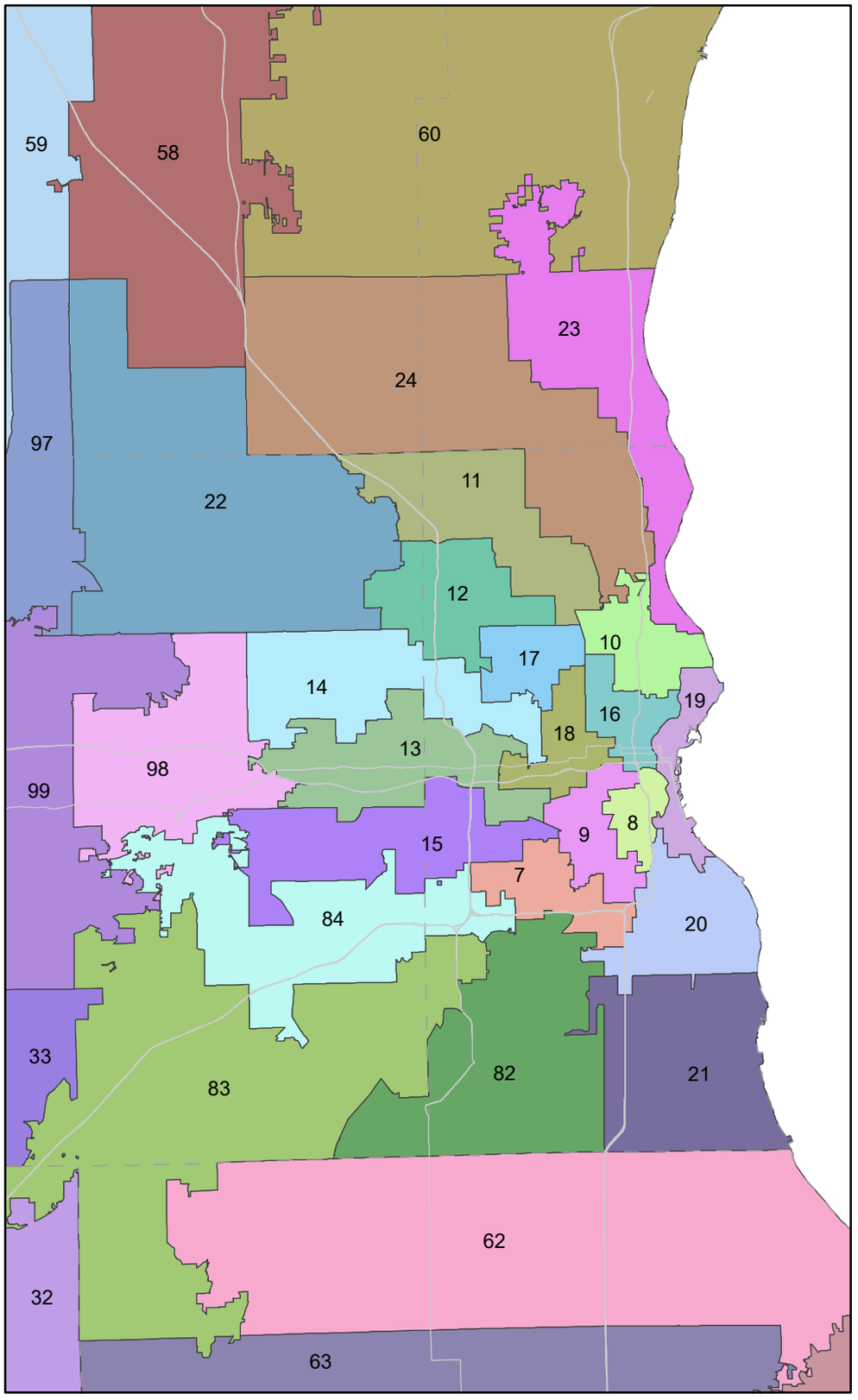

EXHIBIT 1

Bewley Assembly Map - Madison Area

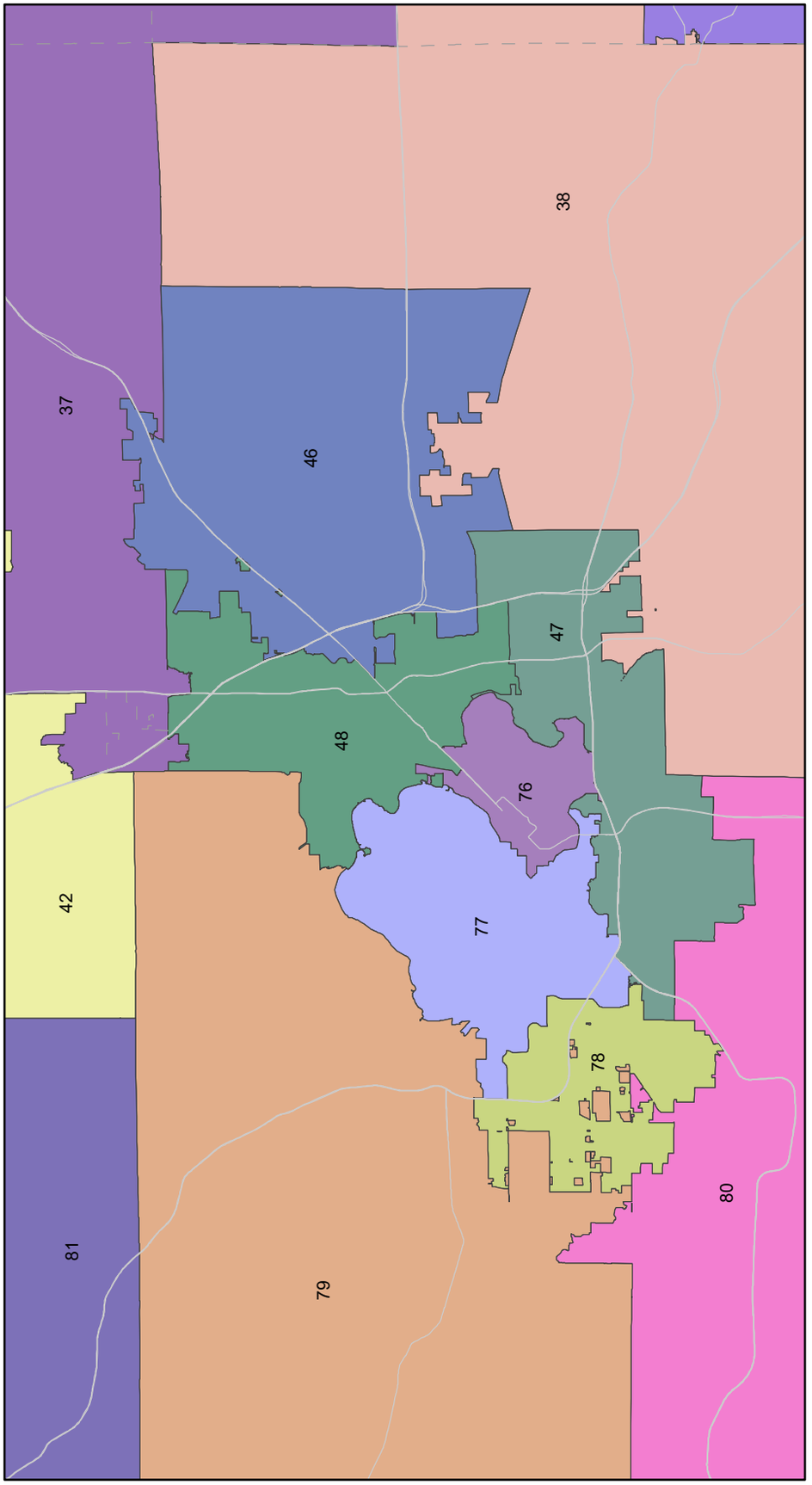

EXHIBIT 1

Bewley Assembly Map - Green Bay/Fox Cities

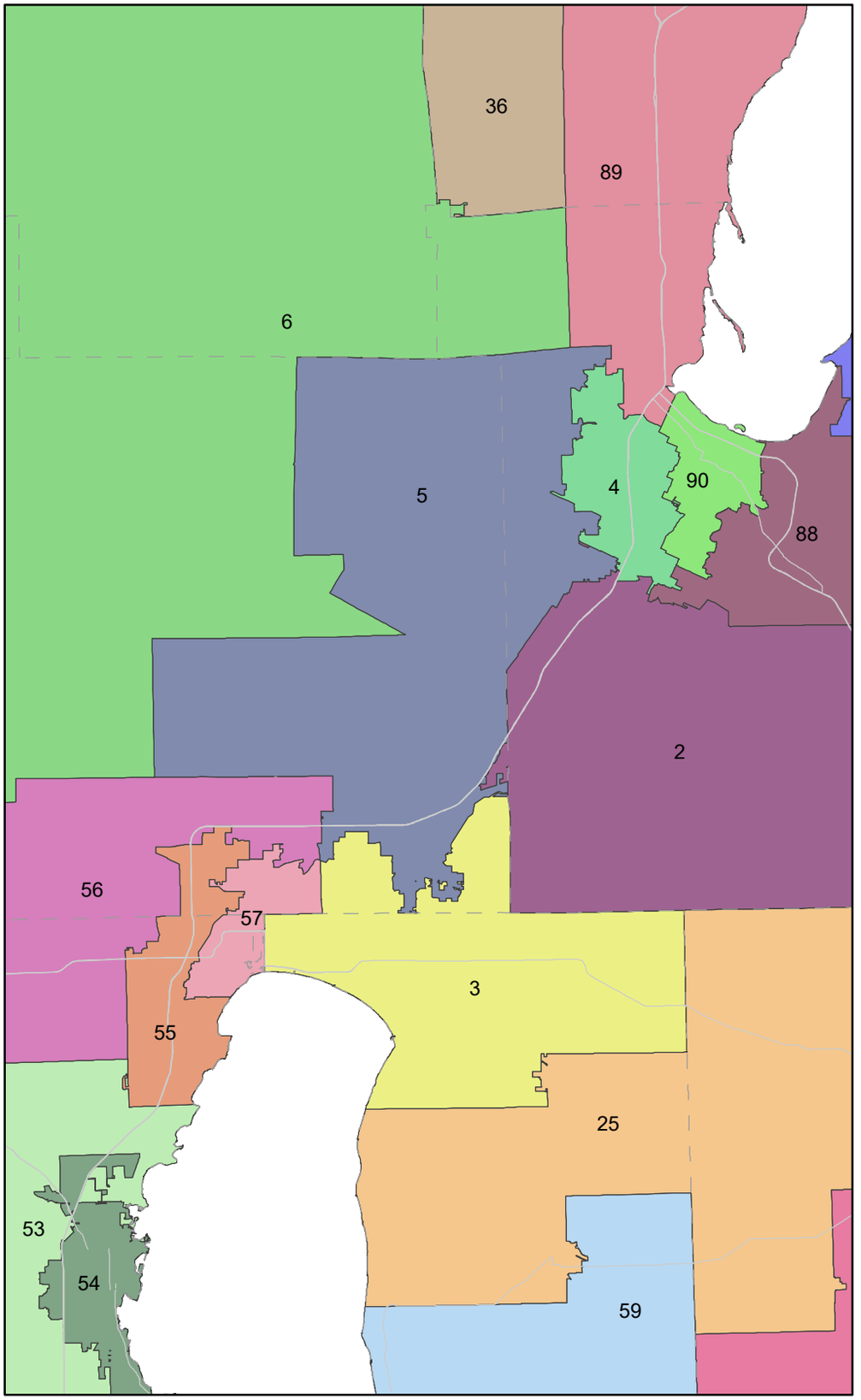

EXHIBIT 1

Bewley Senate Map - Full State

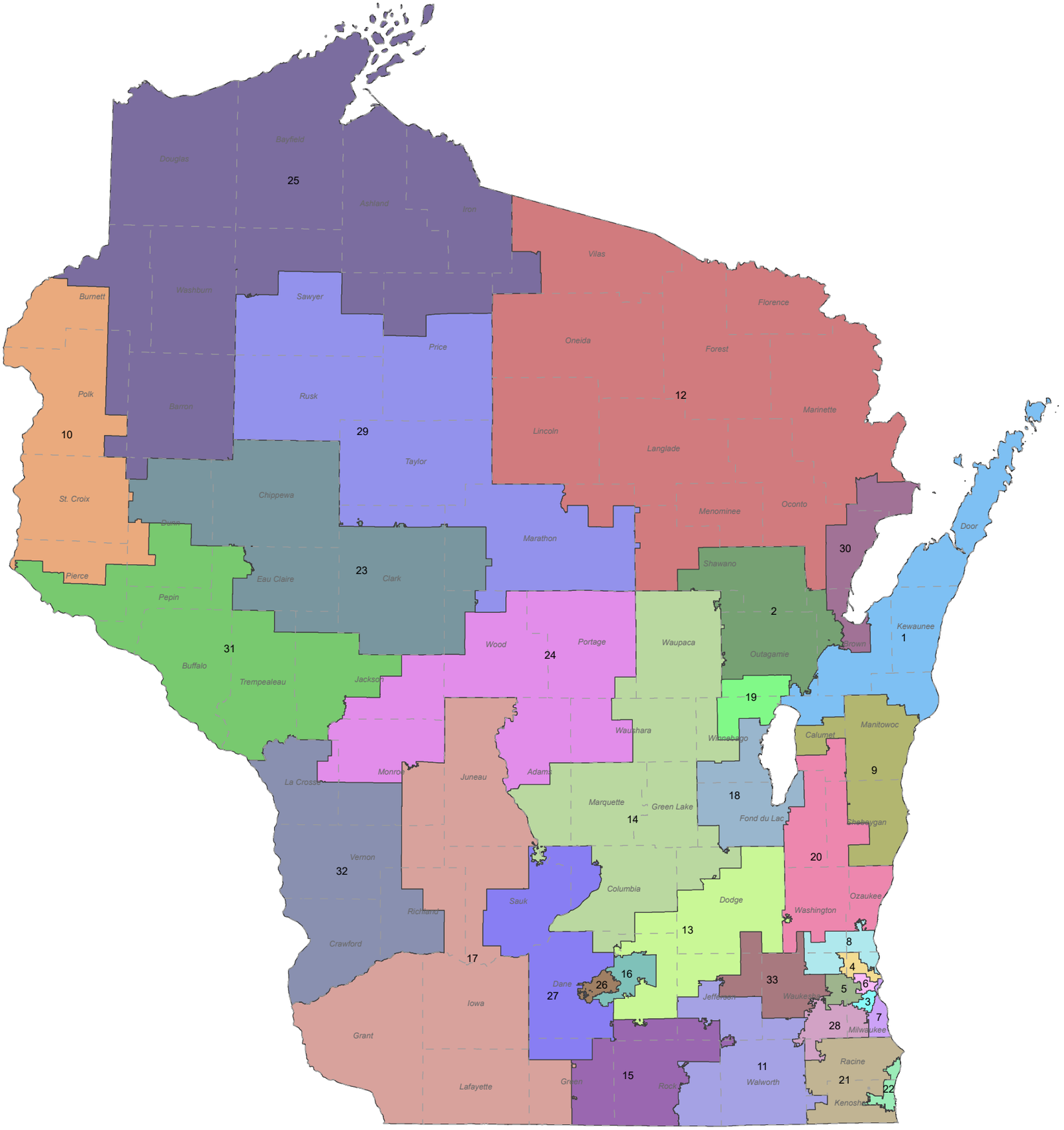

EXHIBIT 1

Bewley Senate Map - Milwaukee Area

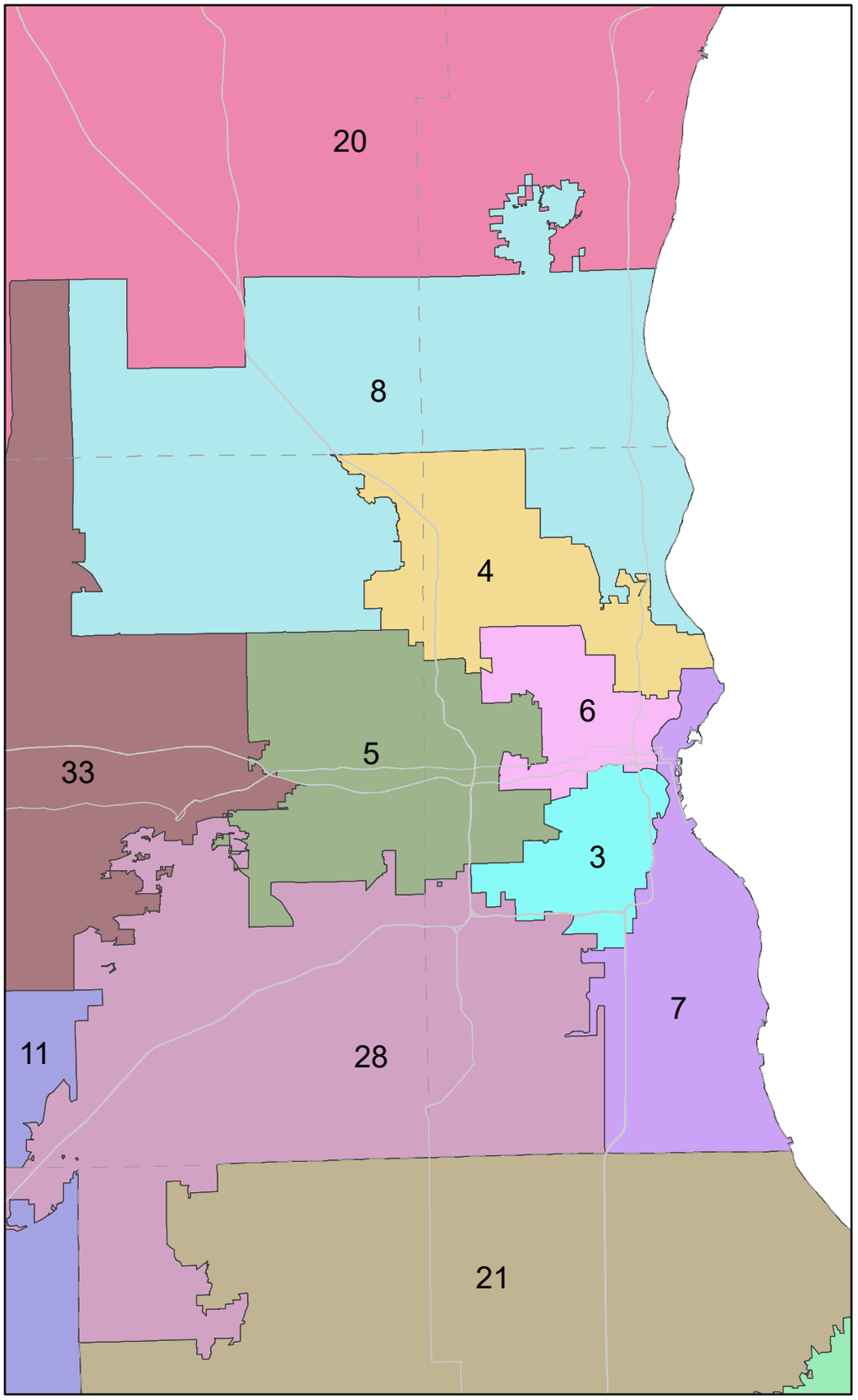

EXHIBIT 1

Bewley Senate Map - Madison Area

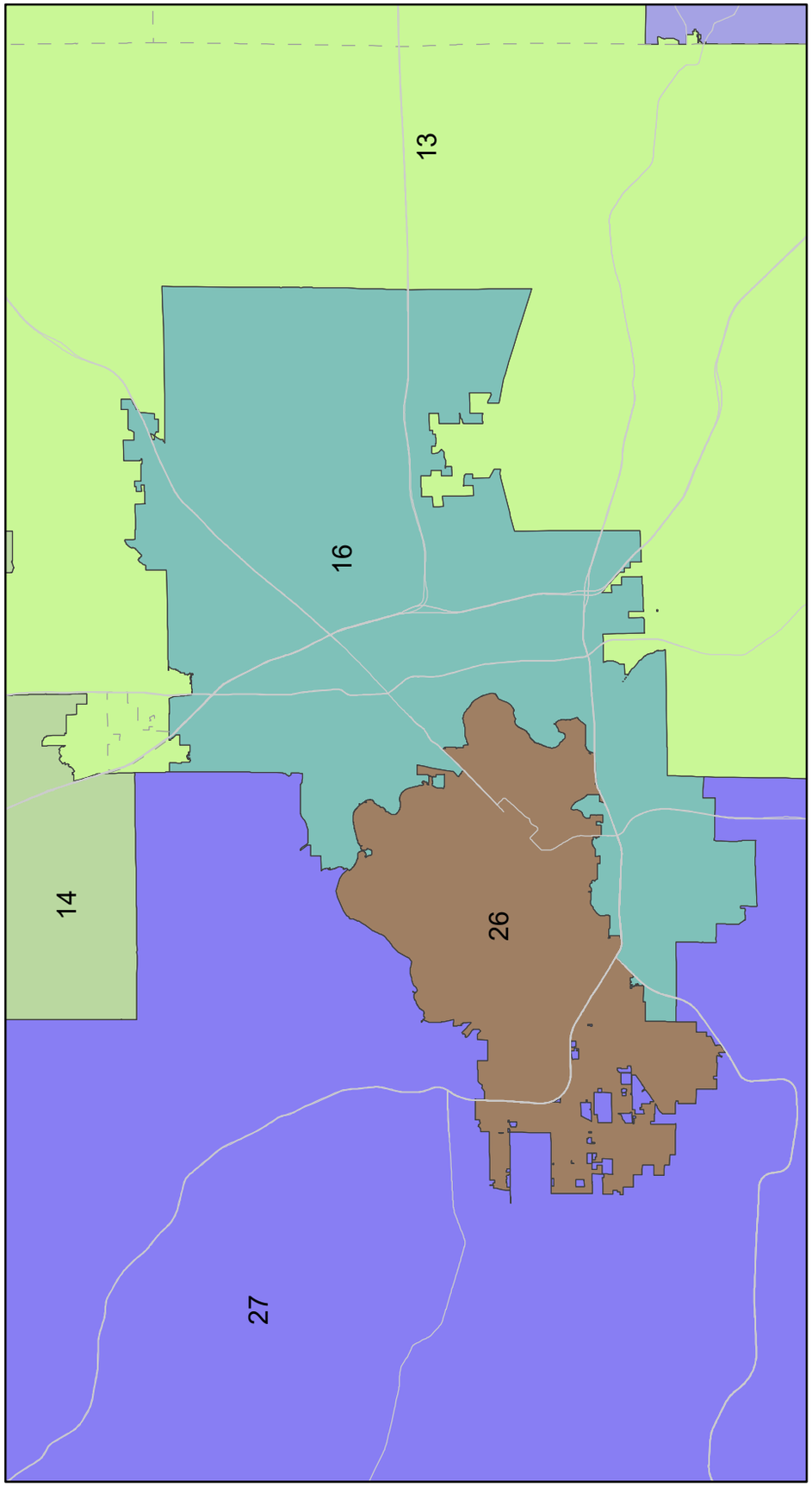

EXHIBIT 1

Bewley Senate Map - Green Bay/Fox Cities

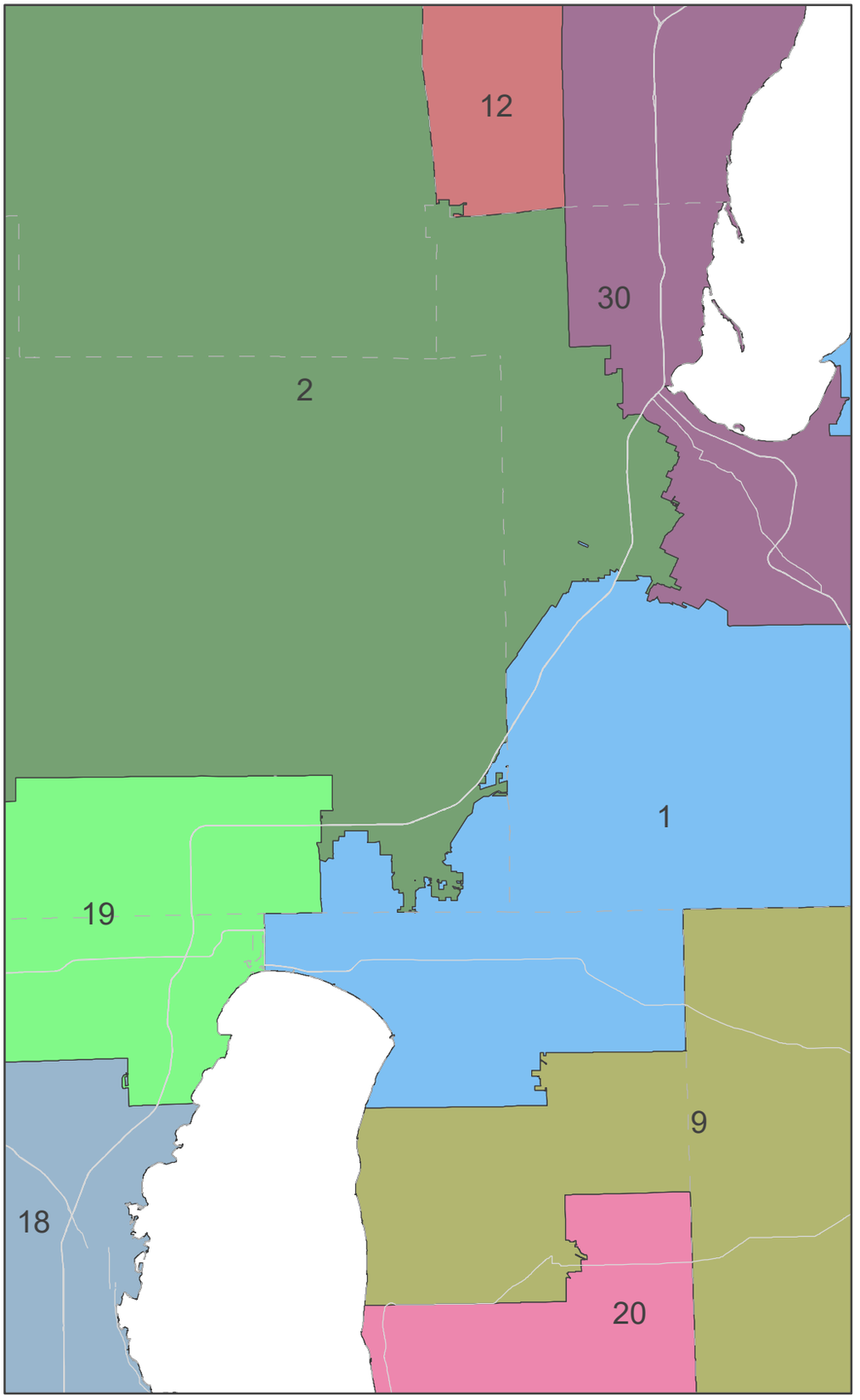

EXHIBIT 1

Richard A. Champagne, Chief
Legal 608.504.5801 • Research 608.504.5802

One East Main Street, Suite 200
Madison, WI 53703 • http://legis.wisconsin.gov/lrb

TO: Minority Leader Janet Bewley

FROM: Legislative Reference Bureau

DATE: October 21, 2021

SUBJECT: 2011 Act 43 State Legislative Data

You requested information related to 2011 Wisconsin Act 43 on state legislative redistricting. Specifically, you asked for data on the act's population deviation, core retention, disenfranchised population, compactness, split geographies, and incumbent pairings.

The data provided in this memo is derived from the Legislative Technology Services Bureau's WISE-District Application unless otherwise stated.

Population deviation

Ideal population represents the target population for each legislative district in a redistricting plan. This figure is calculated by dividing the total population of the state by the number of legislative districts. According to the 2010 U.S. Census, Wisconsin's total population was 5,686,986. Because Wisconsin has 33 senate districts and 99 assembly districts, the ideal population for each senate district was 172,333 and the ideal population for each assembly district was 57,444.

The following table presents deviation scores for legislative districts. Courts will presume that a state legislative plan is constitutional if it has an overall range in deviation of 10 percent or less.[1]

	Deviation from Ideal Population	Persons	Percent
Assembly	Mean Deviation	93	0.16
	Largest Positive Deviation	214	0.37
	Largest Negative Deviation	−224	−0.39
	Overall Range in Deviation	±438	± 0.76

[1] Brown v. Thomson, 462 U.S. 835, 842–3 (1983).

	Deviation from Ideal Population	Persons	Percent
Senate	Mean Deviation	149	0.09
	Largest Positive Deviation	466	0.27
	Largest Negative Deviation	−610	−0.35
	Overall Range in Deviation	±1,076	± 0.62

Core retention

The average core retention rate for assembly districts was 58.82 percent and the average core retention rate for senate districts was 78.81 percent.[2]

Disenfranchisement

300,102 voters from even-numbered senate districts were moved to odd-numbered senate districts. These voters, had they not been moved, would have voted in the state senate election at the 2012 general election, but did not have the opportunity to vote in a state senate election until the 2014 general election. This movement from one district to another involved 17 senate districts.

Compactness

Compactness, in the redistricting context, refers to the "tightness" of a district's geometric shape. Compactness is measured by comparing a district to the shape of a perfect circle, but no district is expected to be perfectly compact. The two most common mathematical models to measure compactness are the Reock Degree of Compactness Score and the Polsby–Popper Test. A perfectly compact district would have a compactness score of 1.0 under either model.

The Reock Degree of Compactness Score is calculated by dividing the area of the voting district by the area of the smallest circle that would completely enclose it.

The Polsby–Popper Test is calculated by dividing the area of a circle with the same perimeter as the district by the square of the perimeter of the district.

Assembly	Reock Degree of Compactness Score	Polsby–Popper Test
Mean	0.378	0.245
Maximum	0.67	0.574
Minimum	0.158	0.05

Senate	Reock Degree of Compactness Score	Polsby–Popper Test
Mean	0.397	0.202
Maximum	0.655	0.44
Minimum	0.13	0.052

[2] Experts use different measures of core constituency retention. This memo uses "simple core constituency retention," which measures how much of the population of district #X in the outgoing map is in district #X in the new map.

Split geographies

The assembly map split 58 counties and 78 municipalities, while the senate map split 46 counties and 48 municipalities.

According to the Department of Administration's Demographic Services Center, there currently are 57 municipalities that are split between two or more counties as of January 2021.[3] Therefore, the data on split geographies may reflect the overall number of municipal splits rather than being an indicator of a district not drawn according to traditional redistricting principles.

Incumbent pairings

There were 11 incumbent pairings in the assembly.[4]

2011 Wis. Act 43	Elected District	Name	Party
Assembly District 7	Assembly District 7	Rep. Margaret Krusick	Democrat
	Assembly District 9	Rep. Josh Zepnick	Democrat
Assembly District 14	Assembly District 13	Rep. David Cullen	Democrat
	Assembly District 14	Rep. Dale Kooyenga	Republican
Assembly District 22	Assembly District 12	Rep. Fred Kessler	Democrat
	Assembly District 99	Rep. Don Pridemore	Republican
Assembly District 23	Assembly District 22	Rep. Sandy Pasch	Democrat
	Assembly District 23	Rep. Jim Ott	Republican
Assembly District 31	Assembly District 32	Rep. Tyler August	Republican
	Assembly District 45	Rep. Amy Loudenbeck	Republican
Assembly District 33	Assembly District 31	Rep. Steve Nass	Republican
	Assembly District 37	Rep. Andy Jorgensen	Democrat
Assembly District 48	Assembly District 48	Rep. Joe Parisi	Democrat
	Assembly District 81	Rep. Kelda Helen Roys	Democrat
Assembly District 61	Assembly District 65	Rep. John Steinbrink	Democrat
	Assembly District 66	Rep. Samantha Kerkman	Republican
Assembly District 88	Assembly District 2	Rep. Andre Jacque	Republican
	Assembly District 88	Rep. John Klenke	Republican
Assembly District 89	Assembly District 89	Rep. John Nygren	Republican
	Assembly District 90	Rep. Karl Van Roy	Republican
Assembly District 92	Assembly District 91	Rep. Chris Danou	Democrat
	Assembly District 92	Rep. Mark Radcliffe	Democrat

[3] "Population and Housing Unit Estimates – Minor Civil Division Final Population Estimates," Department of Administration, Demographic Services Center, accessed October 19, 2021, https://doa.wi.gov/pages/home.aspx. We assume that the number of split geographies reported by DOA in 2021 is substantially similar to 2011.
[4] Please note that the memo counts incumbency pairings as of the date of passage of Act 43.

There was one incumbent pairing in the senate.

2011 Wis. Act 43	Elected District	Name	Party
Senate District 21	Senate District 21	Rep. Van Wanggaard	Republican
	Senate District 22	Rep. Robert Wirch	Democrat

We hope you find this information useful. Please let us know if you have any questions or if we can provide any additional assistance.

Bewley Assembly Map
Core Constituency

New Dist	Total Pop
Old Dist	Pop
2	**1,435**
1	390
88	1,045
4	**19,467**
2	1,940
5	3,192
88	3,620
90	10,715
5	**2,984**
4	1,519
56	1,465
6	**11,221**
5	7,701
36	3,520
7	**35,009**
9	4,828
82	1,689
84	28,492
8	**8,224**
9	8,224
9	**14,559**
7	11,628
8	2,931
10	**5,706**
11	3,355
19	1,220
23	1,131
11	**25,462**
12	20,267
24	5,195
12	**28,217**
11	9,297
14	2,074
17	1,814
22	15,032
13	**19,300**
7	5,007
14	4,420
15	9,873
14	**9,651**
13	9,651
15	**14,086**
7	8,995
13	4,263

Total Moved	**965,264**
State Population	**5,893,718**
% Moved	**16.4%**
% Retained	**83.6%**

AMOS EXHIBIT 3

Bewley Assembly Map
Core Constituency

97	828
16	**8,762**
18	7,379
19	1,383
17	**10,114**
12	4,690
14	2,334
18	3,090
18	**11,115**
7	4,343
13	6,772
19	**1,248**
20	1,248
20	**3,227**
7	1,504
19	1,723
21	**2,098**
82	2,098
22	**19,499**
24	4,942
58	1,720
98	12,837
23	**12,121**
60	12,121
24	**6,542**
11	5,367
23	1,175
25	**4,382**
2	2,251
3	2,131
26	**4,364**
27	4,364
27	**4,649**
25	2,124
26	2,525
28	**1,585**
29	1,585
29	**22,491**
30	10,200
75	638
93	11,653
30	**6,510**
93	6,510
31	**11,510**
32	9,760
43	1,433
45	317

Bewley Assembly Map
Core Constituency

32	**12,220**
31	10,397
33	833
83	990
33	**7,811**
38	4,700
43	737
97	2,374
34	**4,663**
35	3,448
36	1,215
35	**9,817**
6	4,296
36	2,762
85	1,148
86	1,611
36	**9,698**
6	1,803
34	5,400
89	2,495
37	**12,165**
38	3,906
39	594
42	2,250
79	5,415
38	**38,369**
46	23,519
47	14,850
39	**2,689**
42	831
59	1,858
40	**6,542**
6	2,794
56	2,464
71	623
72	661
41	**16,001**
40	3,677
42	2,736
53	7,568
72	2,020
42	**11,436**
37	6,992
79	2,416
81	2,028
43	**4,143**
31	1,947

Bewley Assembly Map
Core Constituency

46	1,205
80	991
44	**1,262**
43	1,262
45	**1,382**
80	1,382
46	**19,286**
47	389
48	17,234
79	1,663
47	**14,605**
77	11,350
80	3,255
48	**15,482**
47	1,436
76	11,638
79	2,408
49	**5,361**
51	5,361
50	**9,064**
49	591
51	158
70	1,056
96	7,259
51	**10,504**
45	0
50	697
80	7,477
81	2,330
52	**1,747**
53	1,747
53	**17,478**
41	9,177
42	1,917
54	4,615
56	1,769
54	**12,288**
53	12,288
55	**7,911**
56	7,911
56	**10,806**
55	10,806
57	**1,822**
56	1,822
58	**3,288**
59	2,743
60	545

AMOS EXHIBIT 3

Bewley Assembly Map
Core Constituency

59	**6,638**
22	2,823
25	774
27	451
52	1,594
58	996
60	**12,747**
23	11,023
58	911
59	813
61	**1,275**
32	1,275
62	**5,765**
63	1,513
83	4,252
63	**941**
32	941
64	**2,589**
61	0
66	2,589
65	**4,422**
61	1,573
64	2,849
66	**6,228**
62	4,598
63	1,630
67	**3,080**
29	2,475
68	605
68	**6,987**
87	0
93	6,987
69	**8,310**
68	6,111
86	2,199
70	**4,141**
94	1,711
96	2,430
71	**3,000**
70	2,161
72	839
72	**4,980**
41	4,783
71	197
73	**1,196**
74	1,196
74	**10,351**

AMOS EXHIBIT 3

Bewley Assembly Map
Core Constituency

87	10,351
75	**1,651**
28	1,106
73	545
76	**4,733**
77	4,733
77	**11,570**
47	595
76	3,392
78	7,583
78	**1,490**
47	3
77	1,487
79	**3,683**
48	1,523
80	2,160
80	**7,603**
43	866
47	1,884
79	4,853
81	**4,351**
42	2,051
50	883
51	1,417
82	**5,213**
21	1,877
83	1,478
84	1,858
83	**11,811**
33	6,274
82	2,091
84	1,930
97	1,516
84	**31,120**
15	2,340
83	4,133
97	24,647
85	**10,200**
86	10,200
86	**14,806**
35	2,074
69	3,951
85	7,834
87	947
87	**14,173**
35	827
68	1,935

Bewley Assembly Map
Core Constituency

69	2,891
74	8,520
88	**5,461**
90	5,461
89	**2,213**
4	2,213
90	**16,915**
4	14,156
88	2,759
91	**963**
93	963
92	**321**
93	321
93	**25,113**
29	20,258
67	4,046
91	809
94	**1,778**
95	1,778
95	**2,695**
94	2,695
96	**10,957**
49	3,587
50	6,829
51	541
97	**59,062**
22	1,702
37	6,707
38	32,297
99	18,356
98	**20,588**
13	3,535
97	17,053
99	**20,766**
97	10,780
98	9,986

Bewley Senate Map
Core Constituency

New Dist	Total Pop
Old Dist	Pop
1	**1045**
30	1045
2	**21260**
1	1940
12	3520
19	1465
30	14335
3	**30181**
28	30181
4	**26466**
5	2074
6	1814
7	1220
8	21358
5	**14830**
3	14002
33	828
6	**19522**
3	4343
4	4690
5	9106
7	1383
7	**3602**
3	1504
28	2098
8	**32045**
4	5367
20	13841
33	12837
9	**4382**
1	4382
10	**18801**
25	638
31	18163
11	**10551**
13	4700
15	2487
28	990
33	2374
12	**11353**
2	6099
29	2759
30	2495
13	**48723**

Total Moved	**562,072**
State Population	**5,893,718**
% Moved	**9.5%**
% Retained	**90.5%**

AMOS EXHIBIT 4

Bewley Senate Map
Core Constituency

14	3081
16	38369
20	1858
27	5415
14	**27566**
2	2794
13	6992
18	7568
19	2464
24	3304
27	4444
15	**5525**
11	1947
16	1205
27	2373
16	**30314**
26	22988
27	7326
17	**18122**
15	0
24	1056
27	9807
32	7259
18	**12863**
14	11094
19	1769
20	**16665**
8	13846
9	1225
18	1594
21	**6468**
11	2216
28	4252
22	**7801**
21	7801
23	**11661**
10	2475
29	2199
31	6987
24	**8924**
14	4783
32	4141
25	**11457**
10	1106
29	10351
26	**598**
16	598

Bewley Senate Map
Core Constituency

27	**8624**
14	2051
15	866
16	3407
17	2300
28	**36654**
5	2340
7	1877
11	6274
33	26163
29	**20198**
12	2901
23	8777
25	8520
30	**16369**
2	16369
31	**24304**
10	20258
23	4046
32	**10957**
17	10957
33	**44241**
5	3535
8	1702
13	39004

Bewley Senate Map
Disenfranchised

New Dist	Total Pop
Old Dist	Pop
2	**3405**
1	1940
19	1465
4	**3294**
5	2074
7	1220
6	**14832**
3	4343
5	9106
7	1383
8	**12837**
33	12837
10	**18801**
25	638
31	18163
12	**2759**
29	2759
14	**13900**
13	6992
19	2464
27	4444
16	**7326**
27	7326
18	**1769**
19	1769
20	**1225**
9	1225
22	**7801**
21	7801
28	**36654**
5	2340
7	1877
11	6274
33	26163
32	**10957**
17	10957

Total Moved Odd to Even	**135,560**
State Population	**5,893,718**
% Disenfranchised	**2.3%**
% Not Disenfranchised	**97.7%**

Bewley Assembly Map
Population Deviation

District	Population	Deviation	Deviation %
1	59,444	-89	-0.15%
2	59,191	-342	-0.57%
3	59,436	-97	-0.16%
4	59,907	374	0.63%
5	59,998	465	0.78%
6	59,725	192	0.32%
7	59,252	-281	-0.47%
8	59,108	-425	-0.71%
9	59,385	-148	-0.25%
10	59,769	236	0.40%
11	60,039	506	0.85%
12	59,921	388	0.65%
13	59,372	-161	-0.27%
14	59,185	-348	-0.58%
15	59,456	-77	-0.13%
16	59,135	-398	-0.67%
17	59,068	-465	-0.78%
18	59,550	17	0.03%
19	59,746	213	0.36%
20	59,057	-476	-0.80%
21	59,390	-143	-0.24%
22	59,488	-45	-0.08%
23	60,062	529	0.89%
24	59,654	121	0.20%
25	59,492	-41	-0.07%
26	60,073	540	0.91%
27	59,583	50	0.08%
28	59,753	220	0.37%
29	59,343	-190	-0.32%
30	59,621	88	0.15%
31	59,093	-440	-0.74%
32	59,606	73	0.12%
33	59,205	-328	-0.55%
34	60,066	533	0.90%
35	59,899	366	0.61%
36	59,914	381	0.64%
37	59,119	-414	-0.70%
38	59,178	-355	-0.60%
39	60,042	509	0.85%
40	60,015	482	0.81%
41	59,833	300	0.50%
42	59,514	-19	-0.03%
43	59,285	-248	-0.42%
44	59,314	-219	-0.37%
45	59,341	-192	-0.32%
46	59,305	-228	-0.38%

AMOS EXHIBIT 6

Bewley Assembly Map
Population Deviation

47	59,147	-386	-0.65%
48	59,683	150	0.25%
49	59,135	-398	-0.67%
50	59,368	-165	-0.28%
51	59,894	361	0.61%
52	60,007	474	0.80%
53	59,789	256	0.43%
54	59,955	422	0.71%
55	59,951	418	0.70%
56	60,080	547	0.92%
57	59,780	247	0.41%
58	59,724	191	0.32%
59	59,680	147	0.25%
60	59,440	-93	-0.16%
61	59,458	-75	-0.13%
62	59,395	-138	-0.23%
63	59,145	-388	-0.65%
64	59,470	-63	-0.11%
65	59,018	-515	-0.87%
66	59,154	-379	-0.64%
67	59,547	14	0.02%
68	60,067	534	0.90%
69	59,876	343	0.58%
70	59,201	-332	-0.56%
71	59,884	351	0.59%
72	59,307	-226	-0.38%
73	59,158	-375	-0.63%
74	59,645	112	0.19%
75	59,764	231	0.39%
76	59,016	-517	-0.87%
77	58,976	-557	-0.94%
78	59,018	-515	-0.87%
79	59,776	243	0.41%
80	59,272	-261	-0.44%
81	59,883	350	0.59%
82	59,150	-383	-0.64%
83	58,976	-557	-0.94%
84	59,052	-481	-0.81%
85	59,900	367	0.62%
86	59,973	440	0.74%
87	59,926	393	0.66%
88	59,827	294	0.49%
89	59,651	118	0.20%
90	59,794	261	0.44%
91	59,540	7	0.01%
92	59,657	124	0.21%
93	59,522	-11	-0.02%

		Bewley Assembly Map Population Deviation	
94	59,414	-119	-0.20%
95	59,659	126	0.21%
96	59,621	88	0.15%
97	59,062	-471	-0.79%
98	59,003	-530	-0.89%
99	59,396	-137	-0.23%

Bewley Senate Map
Population Deviation

District	Population	Deviation	Deviation %
1	178,071	-527	-0.30%
2	179,630	1,032	0.58%
3	177,745	-853	-0.48%
4	179,729	1,131	0.63%
5	178,013	-585	-0.33%
6	177,753	-845	-0.47%
7	178,193	-405	-0.23%
8	179,204	606	0.34%
9	179,148	550	0.31%
10	178,717	119	0.07%
11	177,904	-694	-0.39%
12	179,879	1,281	0.72%
13	178,339	-259	-0.15%
14	179,362	764	0.43%
15	177,940	-658	-0.37%
16	178,135	-463	-0.26%
17	178,397	-201	-0.11%
18	179,751	1,153	0.65%
19	179,811	1,213	0.68%
20	178,844	246	0.14%
21	177,998	-600	-0.34%
22	177,642	-956	-0.54%
23	179,490	892	0.50%
24	178,392	-206	-0.12%
25	178,567	-31	-0.02%
26	177,010	-1,588	-0.89%
27	178,931	333	0.19%
28	177,178	-1,420	-0.80%
29	179,799	1,201	0.67%
30	179,272	674	0.38%
31	178,719	121	0.07%
32	178,694	96	0.05%
33	177,461	-1,137	-0.64%

Bewley Assembly Maps
Splits

County	Districts
Adams	41,72
Barron	67,75
Brown	1,2,4,5,6,88,89,90
Burnett	28,73,75
Calumet	3,25,27,59
Chippewa	67,68,91
Clark	68,69,87
Columbia	37,41,42,81
Dane	37,38,42,43,46,47,48,76,77,78,79,80,81
Dodge	37,39,42,53,97
Dunn	29,67,75,93
Eau Claire	68,91,93
Fond du La	41,52,53,59
Forest	34,36
Green	45,51,80
Green Lake	41,42
Iowa	49,51
Jackson	68,70,92
Jefferson	33,37,38,43,97
Juneau	41,50
Kenosha	32,61,64,65
La Crosse	70,94,95
Lafayette	49,51
Manitowoc	2,25,27
Marathon	35,69,85,86,87
Marinette	36,89
Marquette	41,42
Milwaukee	7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,23,24,82,83,84
Monroe	50,70,96
Oconto	6,35,36,89
Outagamie	2,3,5,6,40,55,56,57
Ozaukee	23,24,60
Pierce	29,30,93
Polk	28,75
Portage	40,70,71,72
Price	74,87
Racine	32,62,63,64,66,83
Richland	50,51,96
Rock	31,43,44,45
Sauk	41,50,51,81
Sawyer	74,87
Shawano	6,35,36,40,86
Sheboygan	26,27,59,60
St. Croix	28,29,30
Trempeale	68,92
Vernon	50,96

Municipality	CTV
Appleton	C
Ashwaubenon	V
Beloit	C
Beloit	T
Blooming Grove	T
Brookfield	C
Brookfield	T
Burke	T
Burlington	T
Calumet	T
Cottage Grove	T
Cottage Grove	V
De Pere	C
DeForest	V
Delavan	T
East Troy	T
Eau Claire	C
Empire	T
Erin	T
Fitchburg	C
Fox Crossing	V
Franklin	C
Glendale	C
Grafton	V
Grand Chute	T
Green Bay	C
Greenfield	C
Hartford	C
Hartland	V
Hobart	V
Howard	V
Hull	T
Janesville	C
Kaukauna	C
Kenosha	C
Kingston	T
Koshkonong	T
Kossuth	T
Ledgeview	T
Little Chute	V
Madison	C
Madison	T
Menasha	C
Menomonee Falls	V
Mequon	C
Middleton	T

Bewley Assembly Maps
Splits

Vilas	34,74
Walworth	31,32,33,43,63,83
Washburn	73,75
Washingto	22,24,39,58,59,60,97
Waukesha	11,12,13,14,15,22,33,82,83,84,97,98,99
Waupaca	6,40
Waushara	40,41,72
Winnebagc	40,41,53,54,55,56,57
Wood	69,70,71,72,86

Milwaukee	C
Mount Pleasant	V
Mukwonago	V
Muskego	C
New Berlin	C
Onalaska	T
Oregon	V
Osborn	T
Oshkosh	C
Oshkosh	T
Pewaukee	C
Pleasant Prairie	V
Quincy	T
Racine	C
Richfield	V
Rock	T
Rothschild	V
Scott	T
Sheboygan	C
Slinger	V
Somers	V
Trimbelle	T
Washington	T
Waterford	T
Waukesha	C
Waukesha	T
Wauwatosa	C
West Allis	C
West Bend	C
Weston	V
Wheatland	T
Whitefish Bay	V
Windsor	V

Bewley Assembly Maps
Splits

MCD FIPS	Districts
2375	3,5,55,56,57
3425	4,5
6500	31,45
6525	31,45
8350	46,47,48
10025	13,14
10050	13,14,98
11150	46,48
11225	32,63
12075	52,59
17200	38,46
17175	38,46
19775	2,4,88
19350	37,42
19475	31,32
22125	32,83
22300	68,91,93
24050	52,59
24225	59,97
25950	47,80
26982	55,56,57
27300	21,82,83
29400	10,24
30000	23,60
30075	55,56
31000	1,4,88,90
31175	7,82,84
33000	39,59
33100	97,99
35150	4,5
35950	4,5,89
36350	70,71
37825	31,43,44
38800	3,5
39225	64,65
39775	41,42
40375	33,43
40425	2,25
43090	2,88
44950	3,5
48000	46,47,48,76,77,78,79
48025	47,48,77,78
50825	3,57
51000	11,12,22
51150	23,24
51600	79,80

Bewley Assembly Maps
Splits

53000 7,8,9,10,11,12,13,14,16,17,18,19,20,24
54875 62,63,64,66
55050 33,83
55275 82,83,84
56375 13,15,83,84
59950 94,95
60200 43,80
60400 5,6
60500 53,54
60525 53,54
62240 98,99
63300 61,65
65825 41,72
66000 62,64,66
67475 22,58
68600 43,44
69725 85,86
72350 59,60
72975 26,27
74400 58,59
74625 61,64
80700 29,93
83612 68,91,93
83850 62,83
84250 84,98,99
84275 15,83,84,98,99
84675 12,13,14,18
85300 9,13,15
85350 58,60
86025 85,86
86500 32,61
86700 10,23
87725 37,42

Bewley Senate Map
Splits

County	Districts
Adams	14,24
Barron	23,25
Brown	1,2,30
Burnett	10,25
Calumet	1,9,20
Chippewa	23,31
Clark	23,29
Columbia	13,14,27
Dane	13,14,15,16,26,27
Dodge	13,14,18,33
Dunn	10,23,25,31
Eau Claire	23,31
Fond du La	14,18,20
Green	15,17,27
Jackson	23,24,31
Jefferson	11,13,15,33
Juneau	14,17
Kenosha	11,21,22
La Crosse	24,32
Manitowoc	1,9
Marathon	12,23,29
Marinette	12,30
Milwaukee	3,4,5,6,7,8,28
Monroe	17,24,32
Oconto	2,12,30
Outagamie	1,2,14,19
Ozaukee	8,20
Pierce	10,31
Polk	10,25
Portage	14,24
Price	25,29
Racine	11,21,22,28
Richland	17,32
Rock	11,15
Sauk	14,17,27
Sawyer	25,29
Shawano	2,12,14,29
Sheboygan	9,20
Trempeale	23,31
Vernon	17,32
Vilas	12,25
Walworth	11,15,21,28
Washingto	8,13,20,33
Waukesha	4,5,8,11,28,33
Waupaca	2,14
Waushara	14,24

Municipality	CTV
Appleton	C
Beloit	C
Beloit	T
Brookfield	T
Burlington	T
Calumet	T
Cottage Grove	T
Cottage Grove	V
De Pere	C
DeForest	V
East Troy	T
Eau Claire	C
Empire	T
Erin	T
Fitchburg	C
Franklin	C
Glendale	C
Grafton	V
Green Bay	C
Greenfield	C
Hartford	C
Howard	V
Janesville	C
Kaukauna	C
Koshkonong	T
Kossuth	T
Ledgeview	T
Little Chute	V
Madison	C
Madison	T
Menasha	C
Menomonee Falls	V
Milwaukee	C
Mount Pleasant	V
Mukwonago	V
New Berlin	C
Oregon	V
Pleasant Prairie	V
Quincy	T
Racine	C
Richfield	V
Somers	V
Trimbelle	T
Washington	T
Waterford	T
Waukesha	C

Bewley Senate Map
Splits

Winnebagc	14,18,19
Wood	23,24,29

Waukesha	T
Wauwatosa	C
West Allis	C
Wheatland	T
Whitefish Bay	V
Windsor	V

Bewley Senate Map
Splits

MCD FIPS	Districts
2375	1,2,19
6500	11,15
6525	11,15
10050	5,33
11225	11,21
12075	18,20
17200	13,16
17175	13,16
19775	1,2,30
19350	13,14
22125	11,28
22300	23,31
24050	18,20
24225	20,33
25950	16,27
27300	7,28
29400	4,8
30000	8,20
31000	1,2,30
31175	3,28
33000	13,20
35950	2,30
37825	11,15
38800	1,2
40375	11,15
40425	1,9
43090	1,30
44950	1,2
48000	16,26,27
48025	16,26
50825	1,19
51000	4,8
53000	3,4,5,6,7,8
54875	21,22
55050	11,28
56375	5,28
60200	15,27
63300	21,22
65825	14,24
66000	21,22
67475	8,20
74625	21,22
80700	10,31
83612	23,31
83850	21,28
84250	28,33

Bewley Senate Map
Splits

84275 5,28,33
84675 4,5,6
85300 3,5
86500 11,21
86700 4,8
87725 13,14

Bewley Assembly Maps
Compactness

Bewley

District	Area (sq mi)	Perimeter (mi)	Area of Bounding Circle (sq mi)	Polsby-Popper	Reock
1	925.9	354.5	6237.1	0.0926	0.1485
2	409.6	120.3	1047.6	0.3559	0.3910
3	130.7	84.2	282.4	0.2316	0.4630
4	30.3	43.8	84.1	0.1988	0.3603
5	249.6	125.4	577.2	0.1995	0.4325
6	890.0	196.2	1603.1	0.2906	0.5552
7	10.0	23.6	28.6	0.2271	0.3512
8	4.6	13.0	10.4	0.3426	0.4464
9	8.6	22.1	19.5	0.2231	0.4418
10	10.2	22.5	20.6	0.2521	0.4944
11	23.6	32.3	90.3	0.2846	0.2613
12	17.0	24.0	35.4	0.3706	0.4796
13	23.6	42.1	85.8	0.1680	0.2755
14	26.2	39.8	98.1	0.2081	0.2670
15	26.0	49.3	112.6	0.1344	0.2313
16	7.1	15.9	16.8	0.3567	0.4244
17	7.8	15.0	14.4	0.4390	0.5427
18	8.3	19.8	21.5	0.2655	0.3865
19	6.7	27.1	39.2	0.1137	0.1699
20	17.7	25.2	35.1	0.3506	0.5038
21	34.2	33.1	64.8	0.3908	0.5270
22	86.3	52.4	201.8	0.3941	0.4275
23	35.7	63.0	222.6	0.1131	0.1604
24	77.1	55.3	236.8	0.3171	0.3255
25	390.5	141.8	1052.3	0.2440	0.3711
26	161.5	98.8	410.8	0.2079	0.3930
27	309.3	125.8	578.3	0.2457	0.5347
28	1248.5	216.9	3020.8	0.3335	0.4133
29	858.0	180.9	1588.6	0.3296	0.5401
30	154.2	82.6	493.5	0.2840	0.3124
31	404.7	147.2	734.8	0.2347	0.5508
32	317.4	127.8	706.4	0.2442	0.4493
33	390.1	173.3	1124.9	0.1633	0.3468
34	2482.7	266.0	5501.2	0.4408	0.4513
35	2334.4	302.4	5193.1	0.3208	0.4495
36	3628.2	423.3	8498.6	0.2545	0.4269
37	502.9	137.2	1081.2	0.3357	0.4651
38	248.9	128.3	575.5	0.1899	0.4325
39	483.1	134.9	898.7	0.3338	0.5375
40	1017.2	199.1	1894.7	0.3224	0.5369
41	1291.7	300.1	3678.5	0.1802	0.3511
42	904.4	227.5	2738.4	0.2195	0.3302
43	450.6	239.5	1084.1	0.0987	0.4156

AMOS EXHIBIT 10

Bewley Assembly Maps
Compactness

44	33.5	80.5	84.7	0.0649	0.3953
45	469.2	124.8	994.6	0.3788	0.4718
46	68.4	63.0	109.6	0.2167	0.6240
47	34.9	52.1	132.6	0.1614	0.2633
48	30.5	53.5	71.0	0.1338	0.4295
49	1466.6	193.5	3245.6	0.4920	0.4519
50	1515.8	221.0	3124.8	0.3900	0.4851
51	1622.5	247.7	4853.0	0.3324	0.3343
52	194.1	88.6	600.5	0.3105	0.3233
53	396.0	187.2	1214.0	0.1419	0.3262
54	39.9	82.6	181.5	0.0734	0.2197
55	34.7	47.7	127.7	0.1910	0.2714
56	201.5	88.5	595.8	0.3235	0.3382
57	17.8	30.5	54.1	0.2400	0.3286
58	102.8	84.3	252.3	0.1818	0.4076
59	676.5	209.0	3121.4	0.1946	0.2167
60	304.3	139.1	575.8	0.1975	0.5285
61	220.7	120.3	543.3	0.1915	0.4062
62	135.2	75.8	497.7	0.2956	0.2717
63	163.1	81.7	504.4	0.3072	0.3233
64	33.4	67.5	155.5	0.0920	0.2147
65	10.7	26.1	22.8	0.1966	0.4689
66	10.9	24.6	28.5	0.2270	0.3843
67	1312.2	211.9	3200.2	0.3674	0.4100
68	912.7	187.1	1547.3	0.3276	0.5899
69	1234.7	172.1	2063.7	0.5237	0.5983
70	1609.4	301.6	6899.5	0.2224	0.2333
71	451.9	123.8	991.7	0.3706	0.4557
72	946.2	174.3	1666.1	0.3912	0.5679
73	2219.1	260.0	4940.4	0.4125	0.4492
74	4503.4	599.0	8720.9	0.1577	0.5164
75	1574.5	207.8	3475.7	0.4580	0.4530
76	9.5	20.7	17.4	0.2801	0.5493
77	29.1	37.0	55.9	0.2679	0.5211
78	17.2	52.6	34.4	0.0782	0.4989
79	162.2	90.4	372.3	0.2494	0.4357
80	414.6	118.5	776.2	0.3708	0.5341
81	725.6	207.4	1374.7	0.2120	0.5278
82	46.6	43.4	110.5	0.3101	0.4213
83	110.9	108.1	304.6	0.1194	0.3642
84	40.8	80.6	161.1	0.0789	0.2531
85	73.8	89.6	178.5	0.1155	0.4132
86	967.9	256.0	2372.8	0.1856	0.4079
87	3913.4	346.2	8052.7	0.4104	0.4860
88	47.3	48.1	136.4	0.2571	0.3472
89	431.3	162.2	1657.5	0.2061	0.2602
90	19.8	31.6	51.1	0.2494	0.3878

Bewley Assembly Maps
Compactness

91	26.2	60.9	57.8	0.0889	0.4544
92	1988.9	230.8	4502.8	0.4693	0.4417
93	993.2	253.9	3568.4	0.1937	0.2783
94	375.0	184.5	789.1	0.1385	0.4752
95	56.0	103.1	248.8	0.0661	0.2250
96	1814.1	218.2	3832.0	0.4790	0.4734
97	262.5	145.8	711.1	0.1551	0.3691
98	34.1	56.9	76.0	0.1321	0.4485
99	128.4	113.0	303.0	0.1263	0.4237
			Average	0.2536	0.4054
			Min	0.0649	0.1485
			Max	0.5237	0.6240

Bewley Assembly Maps
Compactness

2011 Benchmark

District	Area (sq mi)	Perimeter (mi)	Area of Bounding Circle (sq mi)	Polsby-Popper	Reock
1	940.8	368.8	6402.9	0.0869	0.1469
2	415.8	139.5	1041.1	0.2685	0.3993
3	168.3	100.6	410.6	0.2091	0.4098
4	31.2	49.7	88.0	0.1586	0.3545
5	362.8	130.8	773.9	0.2663	0.4688
6	1023.8	239.3	2535.9	0.2247	0.4037
7	10.7	25.9	40.3	0.1993	0.2646
8	4.4	10.7	6.6	0.4819	0.6624
9	8.0	23.3	24.3	0.1841	0.3282
10	7.7	23.4	19.3	0.1775	0.4002
11	14.2	30.5	39.0	0.1914	0.3631
12	17.3	26.2	50.6	0.3172	0.3412
13	25.7	32.9	88.0	0.2981	0.2920
14	28.0	33.3	89.8	0.3182	0.3118
15	22.7	27.0	74.5	0.3907	0.3050
16	6.7	16.1	16.9	0.3270	0.3986
17	7.2	15.5	14.7	0.3786	0.4927
18	5.6	15.1	14.5	0.3112	0.3880
19	6.9	26.5	35.9	0.1242	0.1928
20	17.2	22.7	31.9	0.4194	0.5402
21	34.0	29.5	59.7	0.4913	0.5698
22	114.6	86.7	400.3	0.1917	0.2862
23	51.9	64.4	287.3	0.1571	0.1805
24	80.2	57.0	230.8	0.3104	0.3473
25	388.2	109.8	825.6	0.4044	0.4702
26	155.8	99.0	405.8	0.1997	0.3840
27	260.8	118.4	531.6	0.2336	0.4906
28	1286.9	210.8	3027.7	0.3640	0.4250
29	614.0	143.2	1667.0	0.3762	0.3683
30	245.1	74.0	509.8	0.5623	0.4807
31	397.2	140.2	719.2	0.2540	0.5523
32	289.0	135.3	568.1	0.1983	0.5088
33	337.6	149.9	1146.3	0.1888	0.2945
34	2879.2	321.2	7775.0	0.3507	0.3703
35	2149.7	244.3	5012.1	0.4527	0.4289
36	3210.5	347.4	5245.5	0.3343	0.6120
37	343.8	169.1	1477.7	0.1510	0.2326
38	407.5	152.7	1275.8	0.2197	0.3194
39	469.2	133.9	902.6	0.3290	0.5198
40	938.7	189.4	2135.4	0.3288	0.4396
41	1069.1	226.8	2939.6	0.2611	0.3637
42	1131.9	258.5	2736.9	0.2128	0.4136
43	493.1	209.7	1209.9	0.1410	0.4075

AMOS EXHIBIT 10

Bewley Assembly Maps
Compactness

44	29.4	76.7	75.3	0.0628	0.3910
45	421.2	110.8	899.9	0.4310	0.4681
46	119.9	86.6	430.1	0.2011	0.2788
47	82.6	113.0	260.5	0.0813	0.3169
48	28.5	86.0	132.2	0.0485	0.2155
49	1470.2	230.1	4287.8	0.3489	0.3429
50	1375.4	255.6	3981.7	0.2646	0.3454
51	1580.0	233.5	4500.1	0.3641	0.3511
52	180.5	86.3	600.8	0.3046	0.3004
53	423.9	182.0	1043.8	0.1608	0.4061
54	20.5	68.6	82.3	0.0548	0.2494
55	83.2	48.3	156.1	0.4481	0.5334
56	257.5	127.3	850.7	0.1997	0.3027
57	16.7	23.2	46.2	0.3899	0.3610
58	90.4	88.8	200.6	0.1442	0.4508
59	636.9	189.6	2105.6	0.2225	0.3025
60	266.3	114.5	560.6	0.2550	0.4750
61	217.8	122.8	545.4	0.1813	0.3992
62	124.2	62.7	392.7	0.3967	0.3162
63	162.5	78.3	503.1	0.3332	0.3229
64	30.8	71.7	155.4	0.0754	0.1983
65	9.9	23.6	17.5	0.2230	0.5662
66	10.2	26.2	29.0	0.1864	0.3511
67	1344.1	228.1	2802.8	0.3246	0.4796
68	1176.0	229.9	2096.3	0.2797	0.5610
69	1078.9	180.3	2373.6	0.4171	0.4545
70	1532.1	339.1	6202.5	0.1674	0.2470
71	494.5	152.5	946.3	0.2672	0.5226
72	928.6	170.5	1851.1	0.4014	0.5016
73	2072.7	285.3	4174.6	0.3199	0.4965
74	5148.7	656.8	12480.7	0.1500	0.4125
75	1501.2	208.4	3789.4	0.4343	0.3961
76	6.6	18.0	29.3	0.2544	0.2243
77	33.3	72.2	70.6	0.0803	0.4713
78	19.5	60.3	35.6	0.0675	0.5477
79	193.9	205.8	484.7	0.0576	0.4001
80	750.6	161.7	1243.4	0.3609	0.6037
81	717.2	184.5	1808.8	0.2647	0.3965
82	41.6	34.5	86.1	0.4398	0.4839
83	135.0	84.9	401.7	0.2355	0.3362
84	31.1	34.4	102.6	0.3316	0.3036
85	349.3	149.7	821.6	0.1958	0.4252
86	607.6	216.9	1814.5	0.1623	0.3349
87	3310.2	341.8	9892.7	0.3561	0.3346
88	79.6	69.9	259.7	0.2050	0.3067
89	482.2	171.5	1671.8	0.2061	0.2884
90	17.9	35.9	40.6	0.1744	0.4398

Bewley Assembly Maps
Compactness

91	25.8	68.1	62.3	0.0700	0.4144
92	1946.2	231.8	4487.2	0.4552	0.4337
93	1248.2	290.7	4194.5	0.1856	0.2976
94	442.1	152.7	808.8	0.2381	0.5466
95	37.7	73.6	158.8	0.0875	0.2371
96	1765.3	254.0	4774.5	0.3440	0.3697
97	52.4	52.4	134.0	0.2399	0.3913
98	48.3	46.9	132.3	0.2761	0.3652
99	147.0	79.0	375.4	0.2957	0.3915
		Average		0.2603	0.3898
		Min		0.0485	0.1469
		Max		0.5623	0.6624

Bewley Senate Maps
Compactness

Bewley

District	Area (sq mi)	Perimeter (mi)	Area of Bounding Circle (sq mi)	Polsby-Popper	Reock
1	1524.8	522.5	11960.2	0.0702	0.1275
2	1417.8	297.8	3421.9	0.2010	0.4143
3	23.0	26.9	40.6	0.3979	0.5663
4	39.1	46.5	119.7	0.2277	0.3270
5	76.4	45.5	114.6	0.4639	0.6668
6	19.6	27.6	42.7	0.3241	0.4598
7	58.1	59.4	231.8	0.2070	0.2508
8	246.6	154.1	745.6	0.1305	0.3307
9	804.9	179.7	1954.2	0.3131	0.4119
10	2145.9	307.3	5786.2	0.2856	0.3709
11	1023.8	255.6	2225.1	0.1969	0.4601
12	8239.4	552.2	15857.5	0.3396	0.5196
13	1220.5	264.7	2886.3	0.2189	0.4229
14	3139.7	506.6	9602.1	0.1537	0.3270
15	943.7	208.6	2390.8	0.2727	0.3947
16	231.0	199.8	523.5	0.0727	0.4411
17	4425.5	445.4	12694.9	0.2803	0.3486
18	624.9	186.8	1193.3	0.2251	0.5237
19	357.4	103.1	850.7	0.4223	0.4201
20	993.6	216.9	2260.4	0.2655	0.4396
21	504.4	175.9	920.4	0.2047	0.5480
22	50.9	92.1	228.3	0.0755	0.2231
23	3599.0	406.0	8866.0	0.2744	0.4059
24	2955.1	391.1	7780.2	0.2428	0.3798
25	8722.6	927.6	20786.9	0.1274	0.4196
26	59.4	118.4	139.3	0.0532	0.4262
27	1661.7	434.0	3704.5	0.1109	0.4486
28	207.8	93.7	537.4	0.2975	0.3868
29	4267.1	486.8	16985.0	0.2263	0.2512
30	579.7	248.8	2628.0	0.1177	0.2206
31	3220.2	392.8	10354.4	0.2623	0.3110
32	2245.1	295.3	5014.8	0.3235	0.4477
33	247.7	122.1	437.4	0.2088	0.5664
			Average	0.2301	0.4018
			Min	0.0532	0.1275
			Max	0.4639	0.6668

Bewley Senate Maps
Compactness

2011 Benchmark

District	Area (sq mi)	Perimeter (mi)	Area of Bounding Circle (sq mi)	Polsby-Popper	Reock
1	1466.2	487.7	10669.9	0.0775	0.1374
2	1169.9	236.6	2140.3	0.2626	0.5466
3	23.3	30.0	47.1	0.3241	0.4944
4	50.8	59.1	175.9	0.1824	0.2885
5	75.9	72.5	138.7	0.1816	0.5473
6	23.3	33.5	47.5	0.2601	0.4895
7	58.5	62.0	231.1	0.1913	0.2532
8	199.1	128.6	485.0	0.1513	0.4104
9	861.2	204.3	1968.6	0.2593	0.4375
10	2260.6	292.9	6115.7	0.3312	0.3696
11	1112.2	306.6	2174.6	0.1487	0.5115
12	8445.3	560.3	15844.2	0.3381	0.5330
13	1234.9	311.6	3698.1	0.1598	0.3339
14	3213.2	495.5	9195.6	0.1644	0.3494
15	953.3	253.8	2121.3	0.1859	0.4494
16	133.8	110.0	377.3	0.1388	0.3547
17	4605.0	484.9	12658.0	0.2461	0.3638
18	630.0	202.6	1218.4	0.1928	0.5170
19	253.9	84.2	595.8	0.4505	0.4262
20	1083.6	257.9	3121.4	0.2047	0.3472
21	519.0	189.2	920.9	0.1821	0.5635
22	55.0	92.4	228.1	0.0810	0.2411
23	3459.7	377.8	8986.9	0.3046	0.3850
24	3007.5	394.4	8593.7	0.2430	0.3500
25	8297.0	835.8	19943.3	0.1493	0.4160
26	55.8	82.9	126.2	0.1020	0.4425
27	1302.4	332.0	3097.5	0.1485	0.4205
28	198.3	149.9	419.8	0.1108	0.4723
29	4955.1	492.4	15434.8	0.2568	0.3210
30	498.5	211.6	2123.5	0.1399	0.2347
31	3008.4	379.8	10144.4	0.2621	0.2966
32	2245.1	269.1	5004.9	0.3895	0.4486
33	424.9	169.4	876.7	0.1860	0.4847
			Average	0.2123	0.4011
			Min	0.0775	0.1374
			Max	0.4505	0.5635

Brian Amos

Curriculum Vitae, December 2021

Email: brian.amos@wichita.edu

Education

University of Florida

Ph.D., Political Science, 2018

M.A., Political Science, 2013

Cornell University

B.A., Linguistics, 2007

Employment

Wichita State University, Assistant Professor, 2019-present.

University of North Florida, Visiting Assistant Professor, 2018-2019

Peer-Reviewed Articles

Amos, Brian and Michael P. McDonald. 2020. "A Method to Audit the Assignment of Registered Voters to Districts and Precincts." *Political Analysis* 28(3): 356-371.

Amos, Brian, Diana Forster, and Daniel A. Smith. 2018. "Who Signs? Ballot Petition Signatures as Political Participation." *American Review of Politics* 36(2): 19-37.

Amos, Brian, Michael P. McDonald, and Russell Watkins. 2017. "When Boundaries Collide: Constructing a National Database of Demographic and Voting Statistics." *Public Opinion Quarterly* 81(S1): 385-400.

Amos, Brian, Daniel A. Smith and Casey Ste. Claire. 2017. "Reprecincting and Voting Behavior." *Political Behavior* 39(1): 133-156.

Book Chapters

Amos, Brian. 2021. "Gerrymandering," in *A Divided Union: Structural Challenges to Bipartisanship in America*, eds. David Moerno, Eduardo Gamarra, Patrick E. Murphy, and David Jolly. New York: Routledge.

Smith, Daniel A., Brian Amos, Carl Klarner, Daniel Maxwell, Thessalia Merivaki, and Tyler Richards. 2019. "Rigged? Assessing Election Administration in Florida's 2016 General Election," in *Florida and the 2016 Election of Donald J. Trump*, Michael Binder and Matthew Corrigan, eds. Gainesville, FL: University Press of Florida.

Articles in Progress

Amos, Brian and Michael P. McDonald. "The Geography of United States Racial Voting Patterns in the 2008 Presidential Election." Working paper.

Altman, Micah, Brian Amos, Michael P. McDonald, and Daniel A. Smith. "Revealing Preferences: Why Gerrymanders are Hard to Prove, and What to Do about It." Working paper. <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2583528>

Conferences

"Extending State Theories to County Redistricting." American Political Science Association, September 2001.

"The Behavioral Effects of Redistricting," with Seth C. McKee, Enrijeta Shino, and Daniel A. Smith. Florida Political Science Association, March 2021.

"Determinants of County Redistricting." Southern Political Science Association, January 2021.

"The Black Box of Local Redistricting." State Politics and Policy Conference, March 2020. (Accepted, but conference cancelled due to COVID-19.)

"What do County Commission Districts Look Like?" Southern Political Science Association, January 2020.

"The Challenges of Assigning Voters to the Correct District," with Michael P. McDonald. American Political Science Association, August 2018.

"Fabricating Precinct Boundaries," with Michael P. McDonald and Ekam Kalsy. Building Better Elections Pre-APSA Workshop, August 2018.

"A Method to Audit the Assignment of Registered Voters to Districts and Precincts," with Michael P. McDonald. Election Sciences, Reform, and Administration, July 2018.

"Verifying Voter Registration Records," with Michael P. McDonald, Enrijeta Shino, and Daniel A. Smith. Paper. Midwest Political Science Association, April 2018.

"Assessing Automated Redistricting Algorithms," with Micah Altman, Michael P. McDonald, and Justin Solomon. Midwest Political Science Association, April 2018.

"When Boundaries Collide," with Michael P. McDonald and Russell Watkins. DC-AAPOR POQ Special Issue Conference, March 2018.

"Validating the Voter File," with Carl Klarner, Michael Martinez, Christopher McCarty, Michael P. McDonald, Colleen Porter, Enrijeta Shino, and Daniel A. Smith. (Poster.) PolMeth, July 2017.

"The Geography of Racial Voting and Consequences on Racial Representation," with Michael P. McDonald. Southern Political Science Association, January 2016.

"Reprecincting and Voting Behavior," with Daniel A. Smith and Casey Ste. Claire. American Political Science Association, September 2015.

"Racially Polarized Voting and Roll Call Behavior in the U.S. House," with Michael P. McDonald. Midwest Political Science Association, April 2014.

"The New and Old South," with Michael P. McDonald. Southern Political Science Association, January 2015.

"Engaging Potential Voters? The Collection of Signatures on Ballot Petitions," with Daniel A. Smith and Diana Forster. American Political Science Association, August 2014.

"Communities of Interest and Legislator Behavior." (Poster.) State Politics and Policy Conference, May 2014.

"Communities of Interest and Legislator Behavior." Southern Political Science Association, January 2014.

"Automated Legislative Redistricting Based on Communities of Interest." (Poster.) State Politics and Policy Conference, May 2013.

Courses Taught

Political Data Analysis (graduate)
Research Methods in Political Science
Introduction to American Politics
State and Local Government
American Presidency
Political Parties and Elections
Congress and the Legislative Process
Redistricting Seminar

Grants and Awards

Alfred P. Sloan Foundation, co-principal investigator with Michael P. McDonald, $843,119. 2020.
MIT New Initiatives Grant in Election Science, $17,000. Summer 2017.
James W. Button Memorial Award, $1000. Spring 2017.

Service

Journal of Election Administration Research & Practice, Editorial Board (2021-)
CLAS College Council, Wichita State University. Political Science representative (2019-2021)
Program Committee, 2020 Election Sciences, Reform, and Administration Conference.
United Faculty of Florida, University of Florida. Senator (2017-2018).
Political Science Graduate Student Council, University of Florida. Methodology Field Chair (2010-2011), Graduate Assistants United Representative (2009-2010).

External Work

Voter turnout team, Edison Research election night coverage. November 2020.
Auditing, state of Virginia, 2019-2020. Identifying and correcting errors in the voter registration file for the state.
Consulting expert, Plaintiffs in *Benisek v. Lamone*, 2016-2019. A partisan gerrymandering challenge in Maryland.
Consulting expert, Florida League of Women Voters, December 2011 – June 2016. Several related cases challenging Florida House, Senate, and congressional maps. Assistant to Daniel A. Smith's expert reports prior to 2014 and worked directly with the LWV team for the congressional and senate cases 2014-2016.
Assistant to expert reports in other voting rights cases in Florida, Georgia, Ohio, and Texas, 2014-present.

Software and Languages (Proficient)

Stata, R, SPSS, ArcGIS, Python, Perl, PHP, MySQL