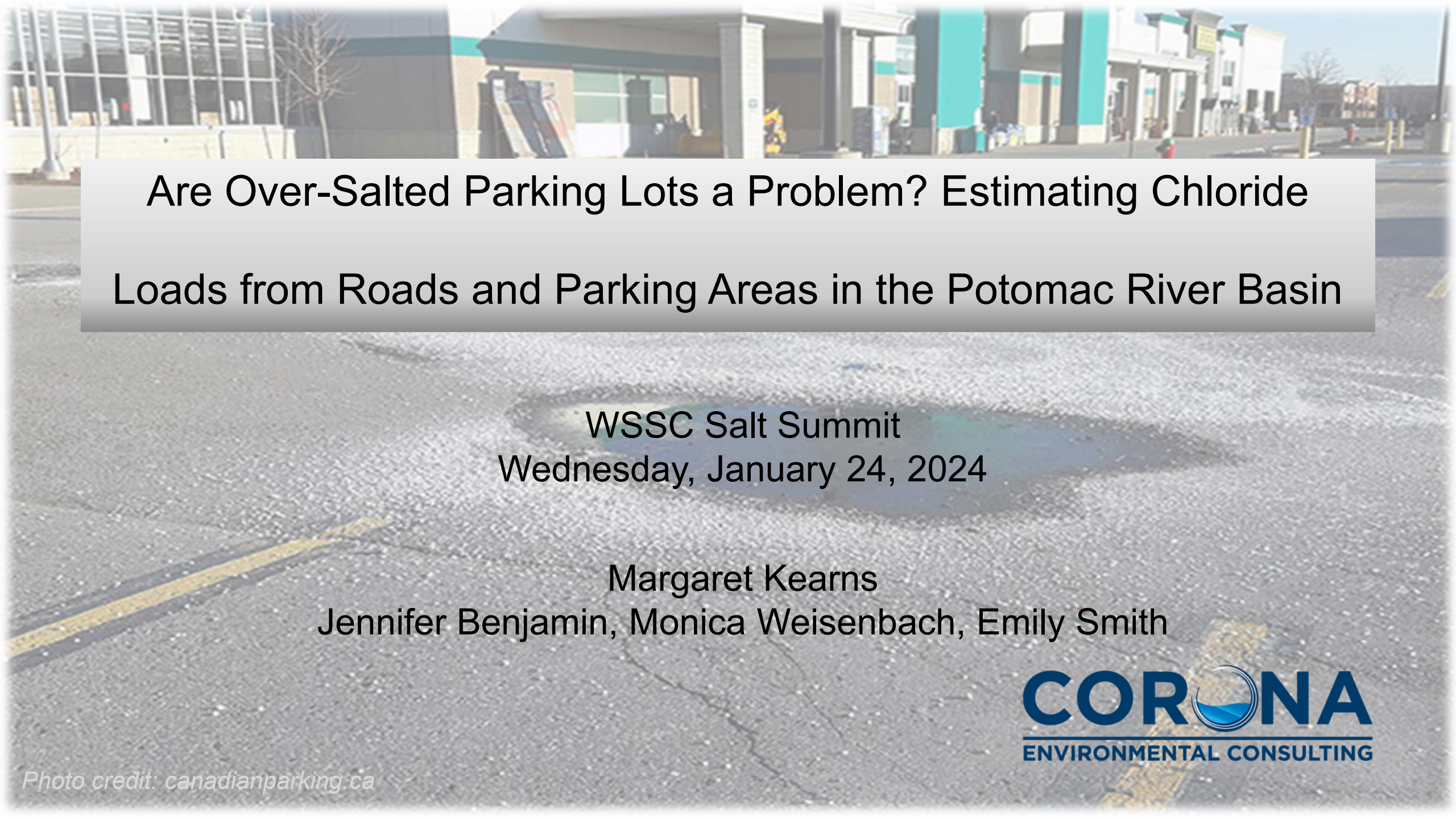


Are Over-Salted Parking Lots a Problem? Estimating Chloride Loads from Roads and Parking Areas in the Potomac River Basin

WSSC Salt Summit
Wednesday, January 24, 2024

Margaret Kearns
Jennifer Benjamin, Monica Weisenbach, Emily Smith

CORONA ENVIRONMENTAL CONSULTING

Photo credit: canadianparking.ca

Image by macrovector on Freepik

Metropolitan Washington Council of Governments (COG)

- Brings regional leaders together to **develop solutions** to address the region's major challenges.
- Public water suppliers and government agencies participate in the **Potomac River Drinking Water Source Protection Partnership (DWSPP)**
- The impact of **roadway salts and de-icers** on drinking water sources is a priority issue

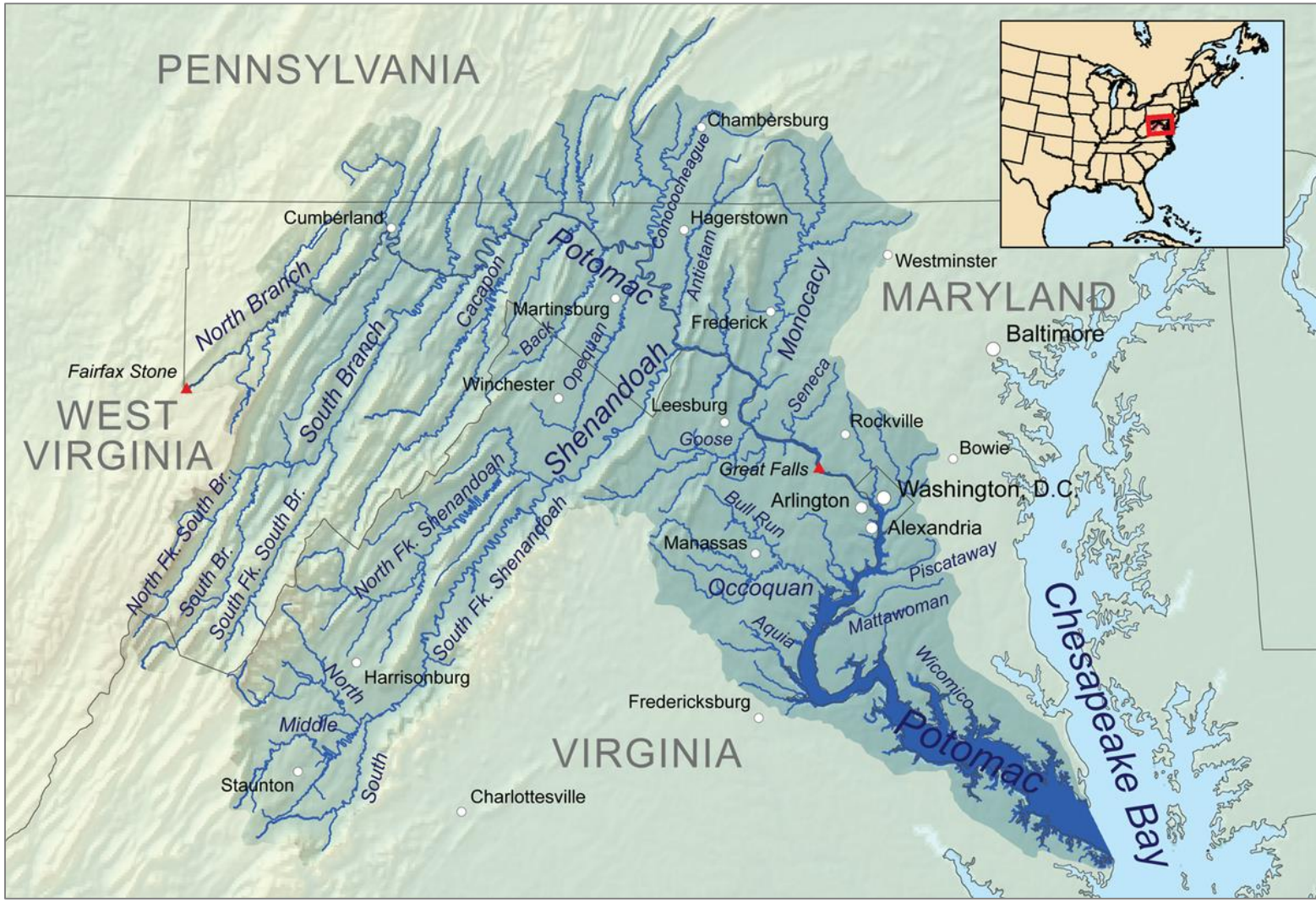
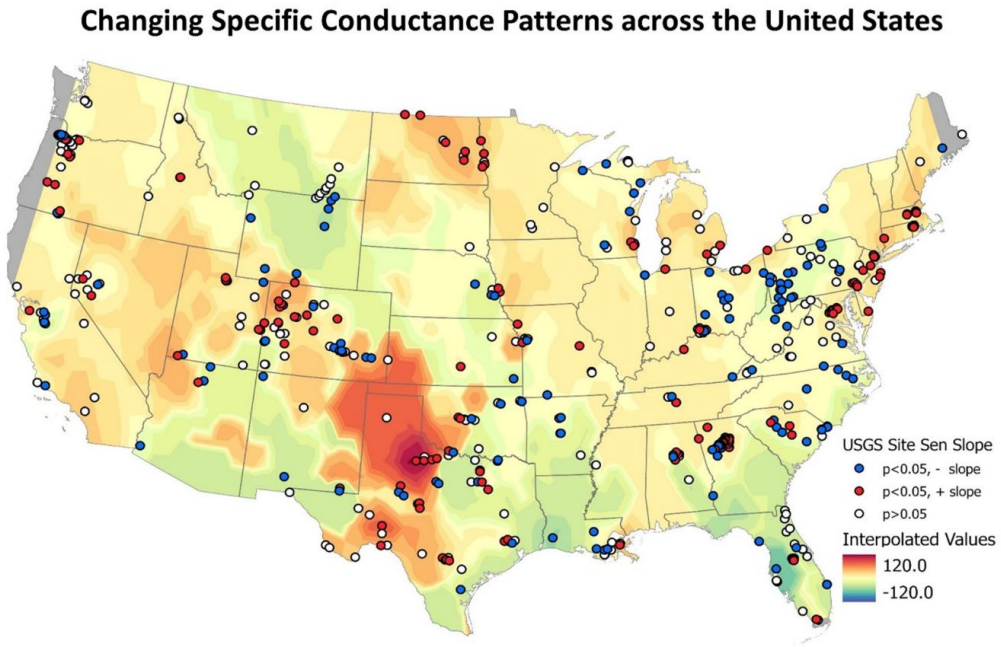
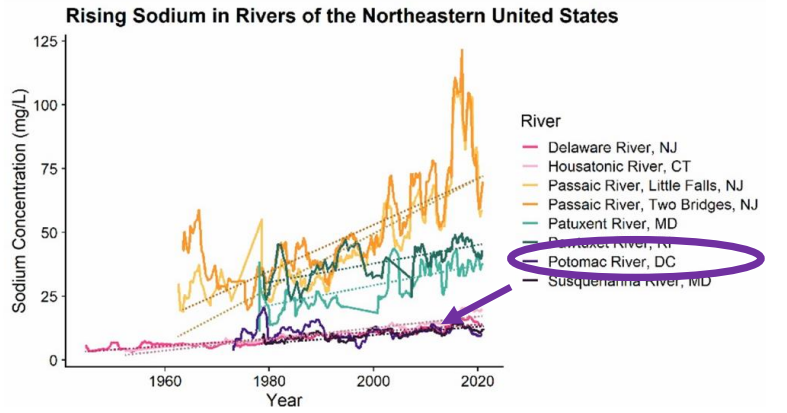


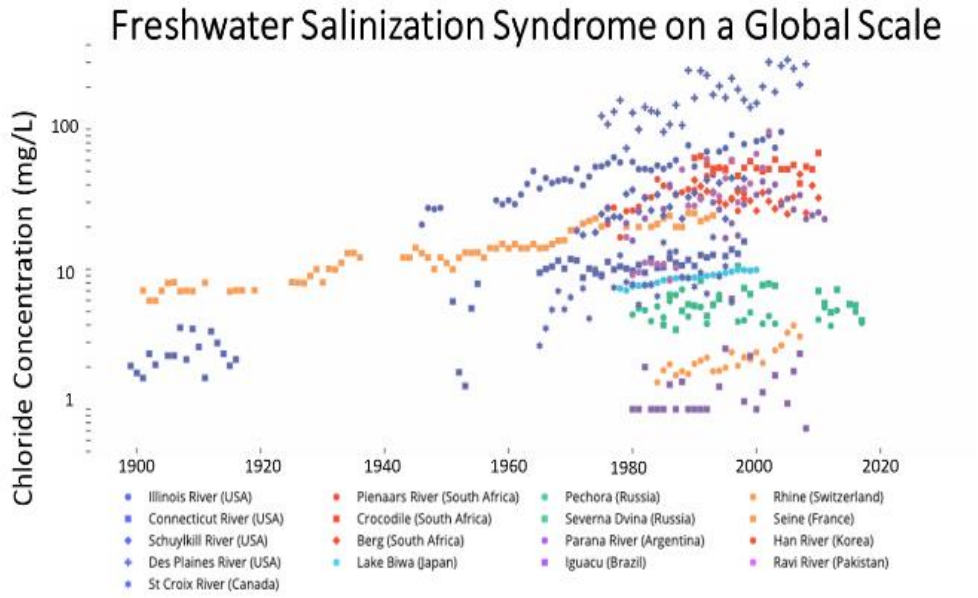
Photo: www.americanrivers.org

Freshwater Salinization Impacts Potomac…and the U.S.



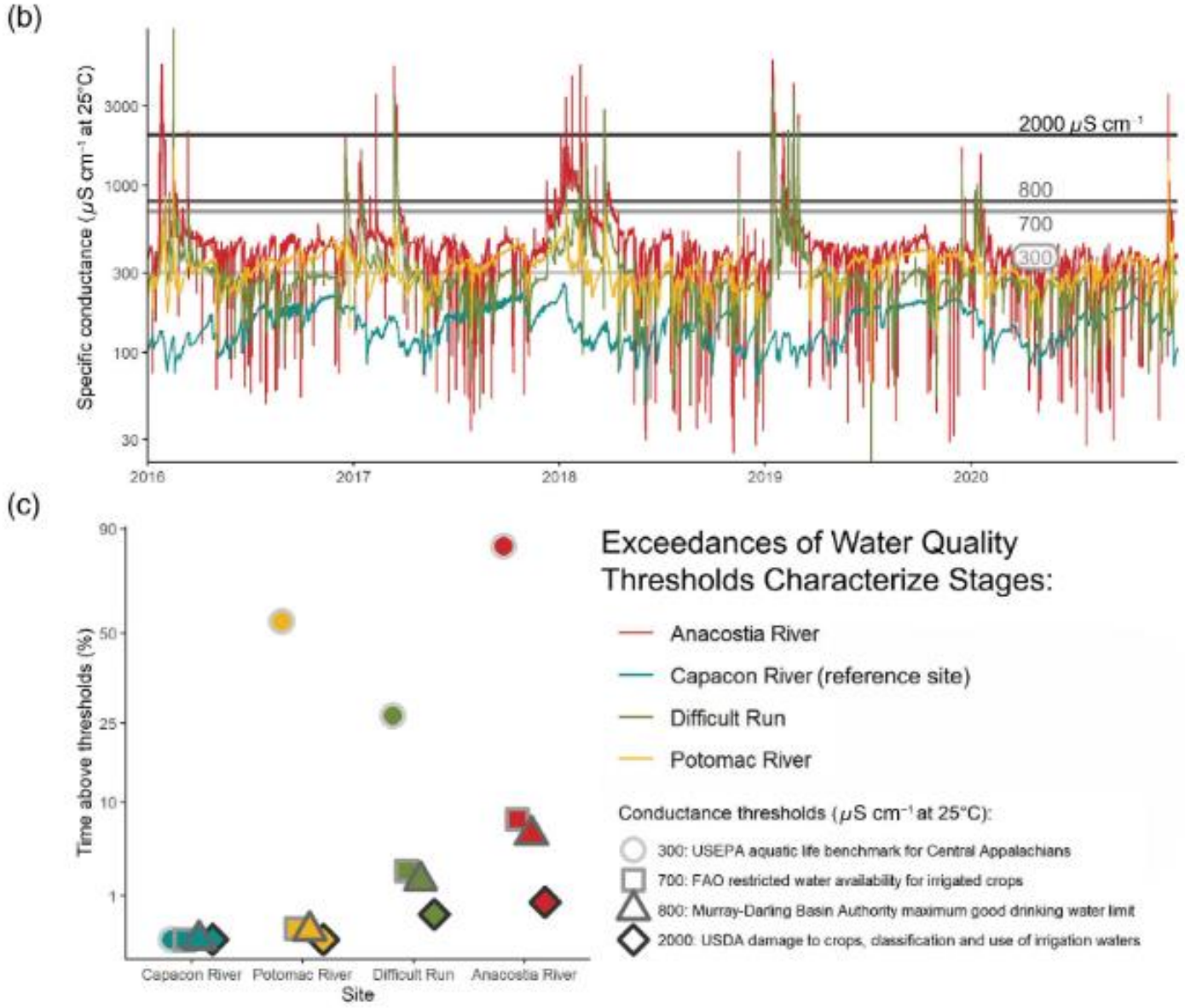
Kaushal et al. (2021, 2022a)





Prior Studies: Kaushal et al. (2009, 2013, 2015, 2016, 2018, 2019)

Salt Thresholds Are Exceeded in Potomac Watershed



Kaushal et al. 2023, *Limnology & Oceanography Letters*

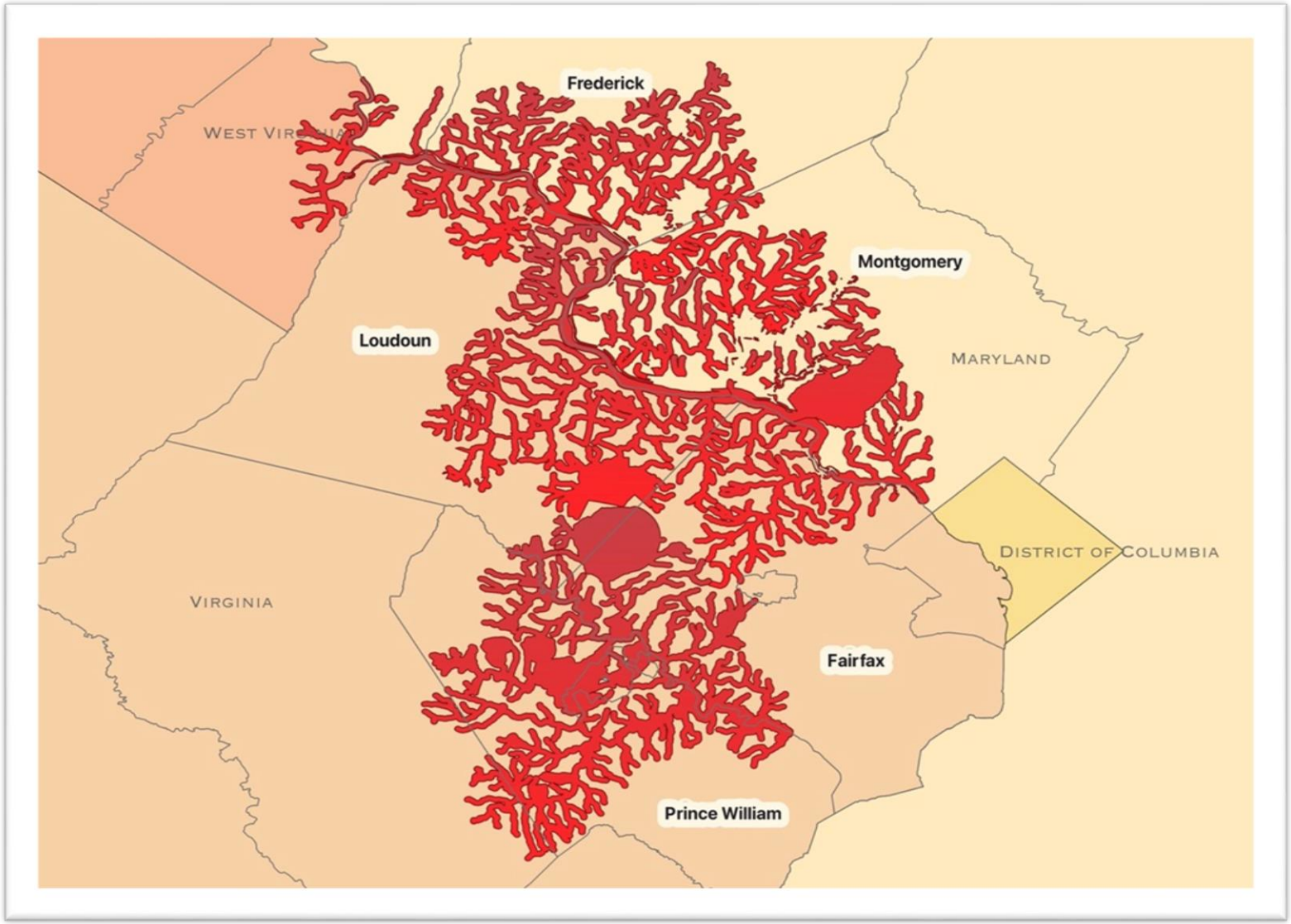
Salt Application Area Assessment Objectives:

1. **Better understand** local, county and state road and parking lot anti- and de-icing practices
2. Develop an **inventory of salt sources** in the Potomac and Occoquan Rivers drinking water zones of concern
3. Estimate **salt loadings**
4. Differentiate loading potential from **roads versus parking areas**
5. Map areas of salt application relative to **MS4 collection systems and outfalls**

Photo: www.epa.gov/risk/salt-resources#winter

Study Area:
Zone of Concern

- 24-hour 10% exceedance high flow travel time with a 1,000-foot waterway buffer
- Developed by the Interstate Commission on the Potomac River Basin (ICPRB)
- Zones of concern for 8 utilities using the Potomac River as a source, plus the Occoquan Reservoir zone



Approach

Parking Lots

- GIS delineation
- Application rate estimates
- Load estimates for each parking lot

Roads

- Data compilation
- Application rate estimates
- Load estimates for each road segment

Geospatial Outputs

MD Roads

- Ownership
- Application rate data source:
  - County
  - State
- 5-year annual & average loads

VA Roads

- Ownership
- Recommended application rate per mobilization level
- 5-year annual & average loads

Parking Lots

- Area
- Estimated application rates (5 methods)
- 5-year annual load estimates
- Distance to nearest MS4 outfall

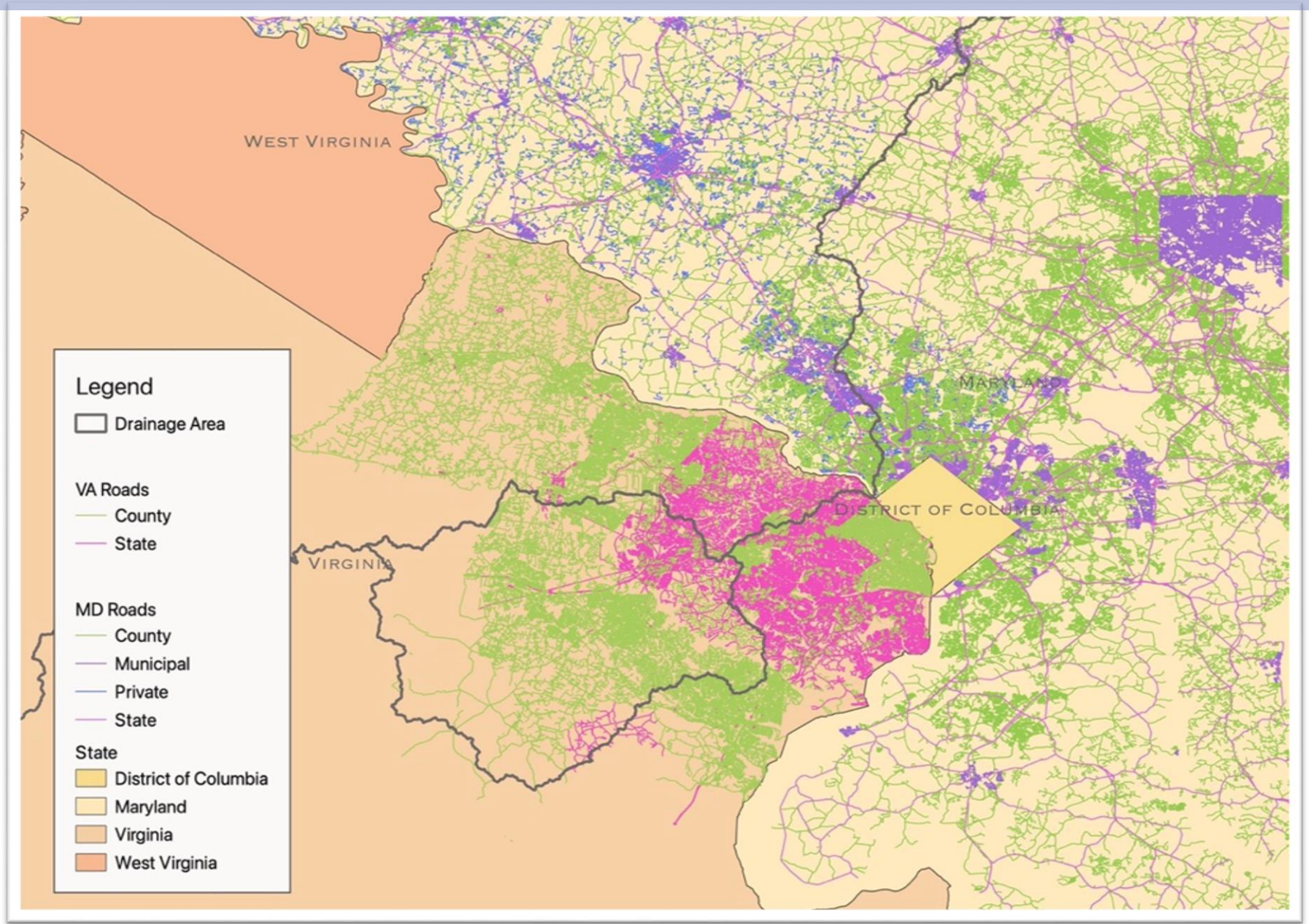
GIS Approach to Quantify Application Areas - Roads

- Lane miles
- Ownership: county / state / private / municipal

Data sources:

- County Maintained Roads
- MD State Highway Administration Roads
- Municipal Maintained Roads
- US Census Bureau Roads

Combined Road Data: Ownership



Parking Lot Area Data Sources

- Parcels
  - MD - Frederick, Montgomery, Washington Counties
  - VA - Prince William, Fairfax, Loudoun Counties, Manassas City
- Building footprints
- Impervious surfaces (VA only)

GIS Approach to Quantify Parking Lot Salt Application Areas

- Filter parcels by land use
- Remove building footprints from impervious surface
- OR
- Remove building footprints from filtered land use data

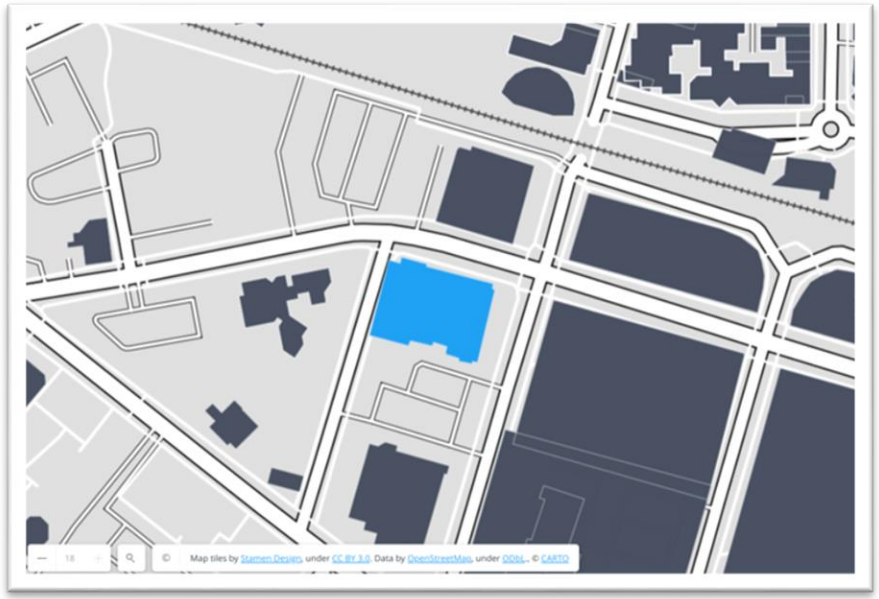


Photo: www.safegraph.com/blog/building-footprint

Parcel Land Use Filtering

Included:

Shopping plazas	Public parking areas	Schools	Libraries	Industrial parks
Large department stores	Shipping sites (e.g., FedEx)	Hospitals	Office Buildings	

Excluded:

Residences	Recreational property	Exceptionally small commercial property	Industrial-use property where most of the impervious surface belongs to equipment storage areas
Utility property	Gas stations	Auto shops	

MD Parking Lots

VA Parking Lots

Application Rate Data Collection & Outreach

Virginia

- Fairfax County MS4 Program Coordinator
- Virginia DOT

Maryland

- Frederick County Division of Energy and Environment
- Montgomery County Watershed Outreach Planner
- WSSC Water
- Maryland Dept. of Transportation
- MD Dept. of Environment – Planning, Outreach, Monitoring Section of Watershed Restoration Division

VA Salt Application Practices

- VDOT:
  - Anti-icing pre-treatment with 23% salt brine
  - De-icing: granular salt prior to snowfall
    - Auger speed & gate height set based on weather forecast & Salt Management Strategy Toolkit recommendations for Northern VA
- Application rate data not collected
- No low salt areas
- Chloride water quality standards
- Chloride TMDL for Accotink Creek
- VDOT pilot study to develop optimal application rates and test Salt Institute recommended rates

MD Salt Application Practices

- MDOT:
  - Anti-icing pre-treatment with 23% salt brine
  - De-icing: granular salt (other materials were researched)
    - Salt brine can be used to pre-wet granular salt to reduce bouncing
  - Some sand/crushed gravel in western hills for traction
  - Developed their own Road Weather Information System & Mobile Advanced Road Weather Information Sensors for weather & pavement conditions
- Snow College training program & annual summary presentations
- Some designated brine only areas (high chloride areas)
- MS4 requires annual reports & salt management plan
- Statewide salt management plan

Considerations for Quantifying Salt Loading

- Road vs. parking lot
- Lane miles
- Ownership type
- Weather conditions – temperature, inches of snow
- Documented vs. estimated rates

MD Annual Road Application rates provided for:

- County MS4 annual report data
  - Montgomery County, MD
  - Frederick County, MD
- MDOT Maintenance Shops (tons & tons/inch snow/lane mile)

Table 6. Winter-Weather Deicing Material for Montgomery County (FY11 - FY21).

Fiscal Year	Winter Storms (no.)	Snow (inches)	Salt (NaCl) (tons)	Sand (tons)	Salt Brine (gallons)
FY11	NR[1]	13[2]	85,600	21,400	NR
FY12	NR	4[2]	15,200	3,800	122,031
FY13	NR	13[2]	31,309	0	93,005
FY14	NR	53[2]	111,787	10,000	121,787
FY15	28	37[2]	87,900	0	36,400
FY16	5	40	133,517	0	43,000
FY17	9	6	20,408	0	147,122
FY18	15	16	53,479	0	168,000
FY19	13	28	57,692	0	500,000
FY20	11	3	6,410	0	97,097
FY21	11	18	68,818	0	485,000

Table 8. Montgomery and Frederick County Maintenance Shop Sodium Chloride Use in Tons, 201

Maintenance Shop Location	Lane Miles	FY 12 (tons)	FY 13 (tons)	FY 14 (tons)	FY 15 (tons)	FY 16 (tons)	FY 17 (tons)	
Montgomery County: Gaithersburg	777	3,403	12,269	33,096	16,770	5,615	2,593	
Montgomery County: Fairland	858	2,498	7,351	18,716	13,497	6,929	4,748	
Frederick County	1,049	8,384	14,569	34,881	21,480	7,314	5,731	

Table 7. Approximate Winter-Weather Deicing Material Usage from FY18 to FY22 for Frederick County.

Material	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022
Road Salt (tons)	30,384	1,845	8,749	20,517	13,807
Liquid Brine (gallons)	158,488	144,328	65,795	21,364	82,874
*The FY 2022 totals represents partial data, as of October 2022.					

Table 9. Montgomery and Frederick County Maintenance Shop Sodium Chloride Use per Lane Mile

Maintenance Shop Location	Lane Miles	FY 14 (lbs/ ln mi/ in)	FY 15 (lbs/ ln mi/ in)	FY 16 (lbs/ ln mi/ in)	FY 17 (lbs/ ln mi/ in)	FY 18 (lbs/ ln mi/ in)				
Montgomery County: Gaithersburg	777	1,220	862	377	345	820	941	572	1,017	454
Montgomery County:										

Northern VA Salt Management Strategy (SaMS) Toolkit - Recommended Application Rates for Roadways

Weather Forecast	Mobilization Level	Response Plan	Salt Application Rate
Precipitation: 20% or greater Accumulation: Ice/Snow Possible Ambient or Pavement Temp: 30-36	Anti-Ice	Spot treatment of critical structures and locations	Application Liquid Mag: 36 gal/ln mi Application liquid salt brine: 50 gal/ln mi Application Salt: 325 lbs/ln mi
Precipitation: 20-49% or greater Accumulation: Snow Possible Ambient or Pavement Temp: 30-36	1	Spot treatment of critical structures and locations	325 lbs/ln mi
Precipitation: 50-100% chance Accumulation: Up to 1 inch of snow Ambient or Pavement Temp: 25-29	2	Light salting operation	400 lbs/ln mi
Precipitation: 50-100% chance Accumulation: Up to 2 inches of snow or up to 1/10 inch of ice Ambient or Pavement Temp: 20-24	3	Salting operation	475 lbs/ln mi
Precipitation: 50-100% chance Accumulation: Up to 6 inches of snow or up to 1/4 inch of ice Ambient or Pavement Temp: 15-19	4	Salting/Plow operation	550 lbs/ln mi
Precipitation: 50-100% chance Accumulation: More than 6 inches of snow or more than 1/4 inch of ice Ambient or Pavement Temp: 10-14	5	Salting/Heavy Plow Operation; All resources are deployed.	625 lbs/ln mi

Parking Lot Application Rates Estimated

	Dry Salt (NaCl) Application Rate in Pounds per 1000 sq. ft.				
Pavement Temp (F) and Trend	Wisconsin - SICOPS	SSI Case Study	Minnesota Guidelines	New Hampshire Guidelines	Snow and Ice Management Association (SIMA) Guidelines
15-20 ↑	18	14	3	10	14
15-20 ↓	18	13.5	2.75	10	14
20-25 ↑	9	13.25	2.75	9.5	13
20-25 ↓	9	12.75	2.25	8.25	13
25-30 ↑	3	12.5	1.5	8.25	12
25-30 ↓	3	11	1.5	6.5	12
30 ↑	3	11	1.5	6.5	11
>30 ↓	3	10	0.75	4.5	11

Sexton, Phillip C. 2017. Sustainability Analysis of the Commercial Winter Management Industry's Use of Salt. Master's thesis, Harvard Extension School

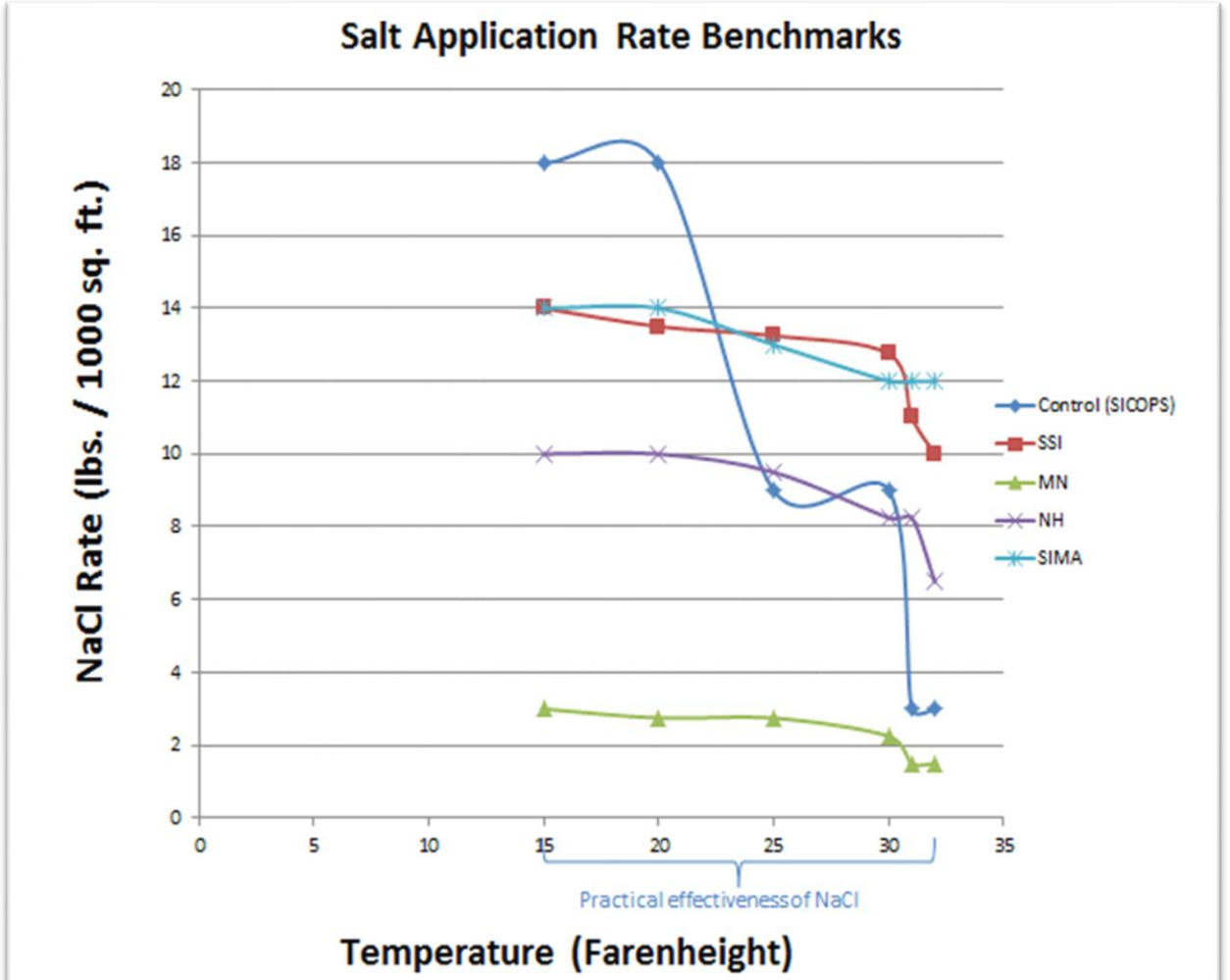
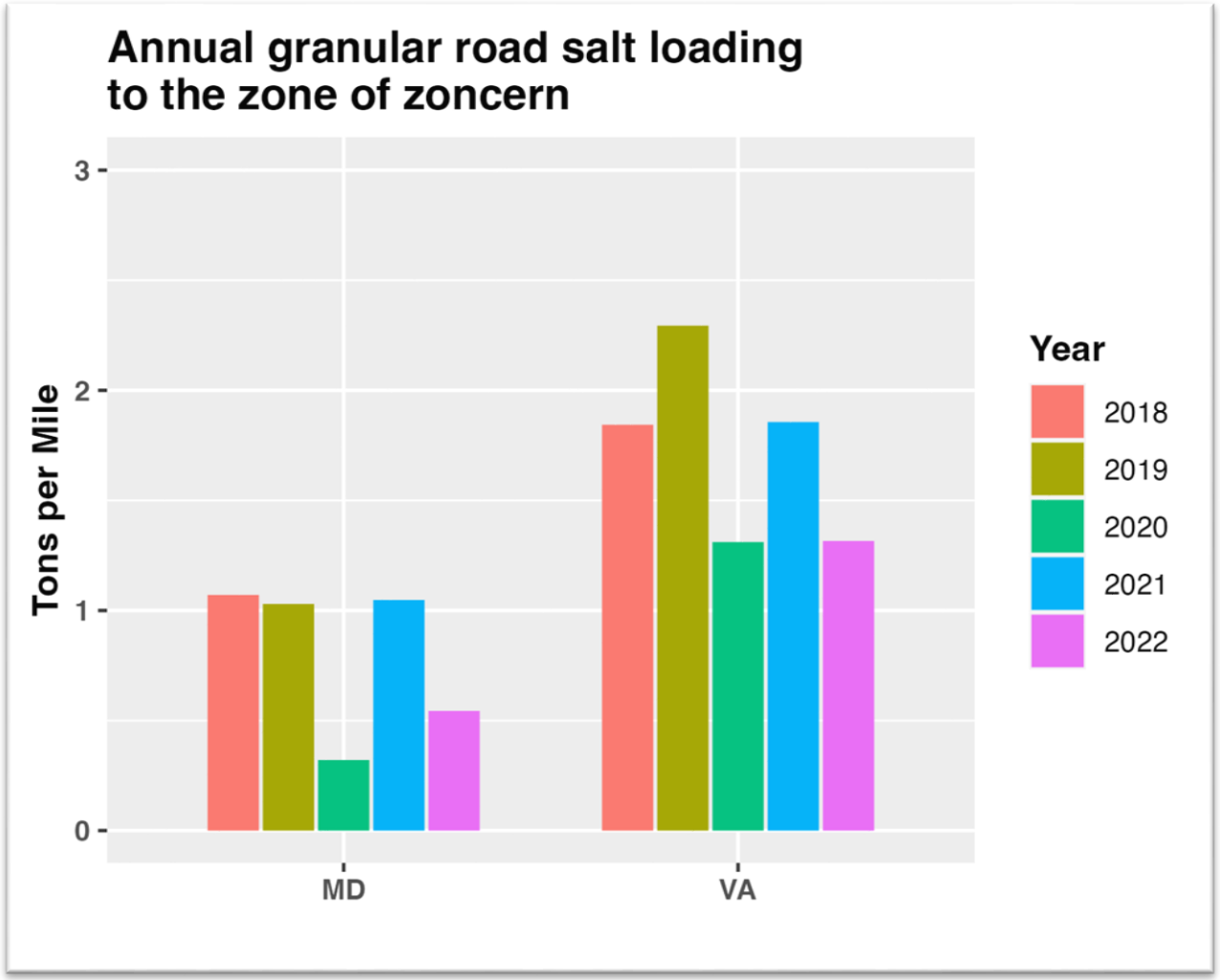


Figure 11. Overlay of salt rates at varied pavement temperature thresholds.

Sexton, Phillip C. 2017. Sustainability Analysis of the Commercial Winter Management Industry's Use of Salt. Master's thesis, Harvard Extension School

Road Results

Photo credit: abcnews.go.com/US/freezing-rain-hits-texas-icy-conditions-cripple-roads/story?id=96760404

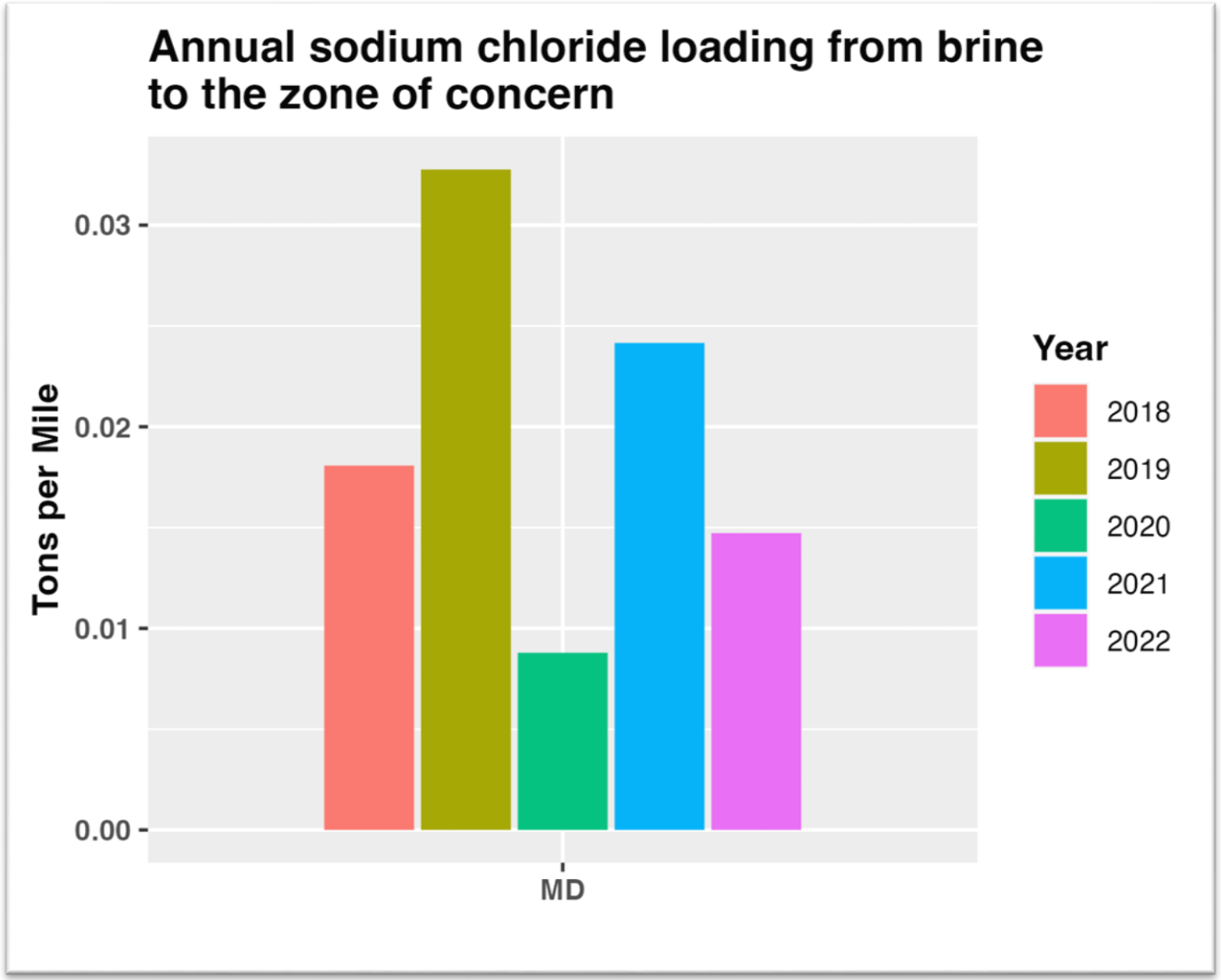


Road salt generally contains 90-98% sodium chloride. 100% assumed here.

Granular Road Salt

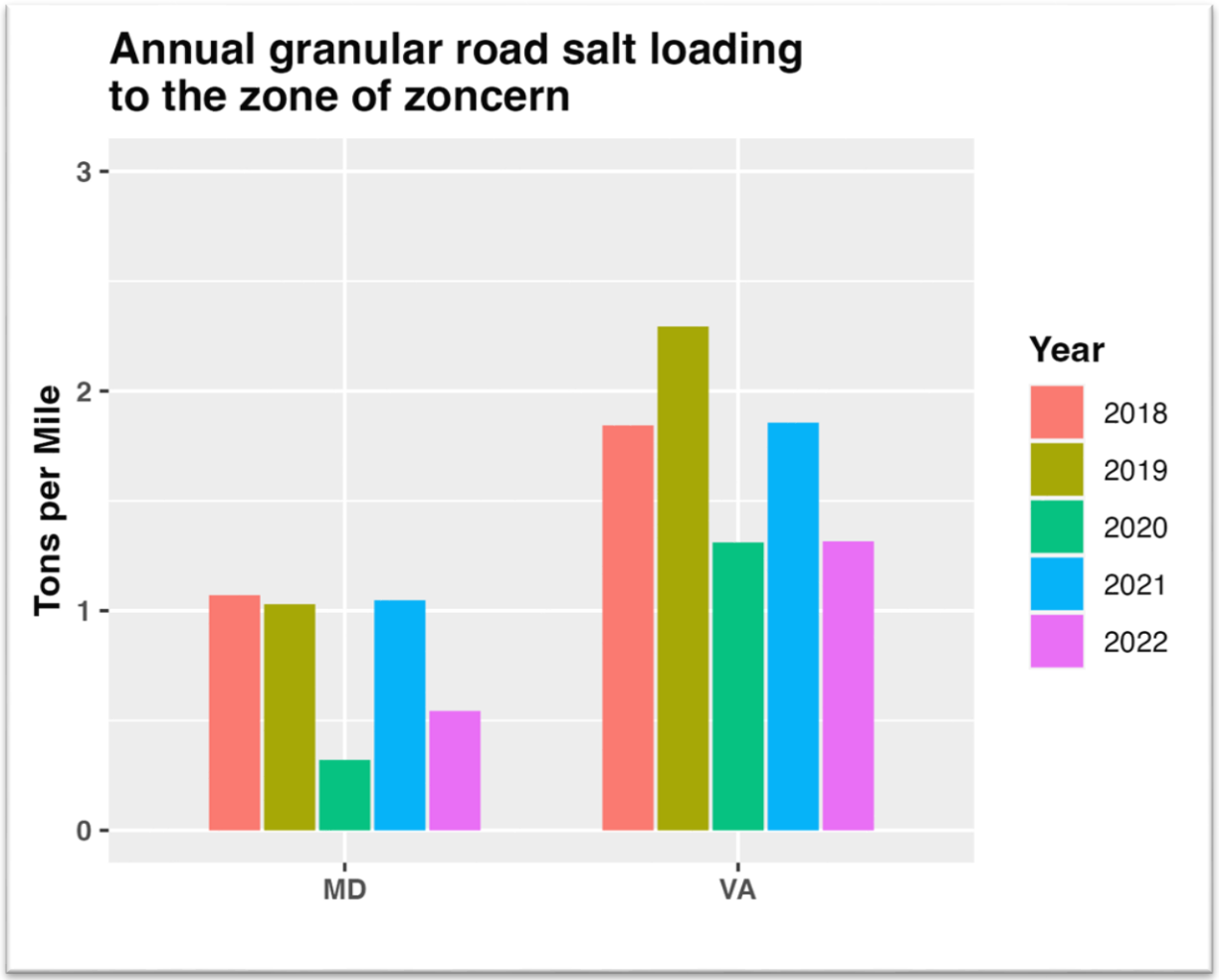
Length of Road Miles in the Zone of Concern:

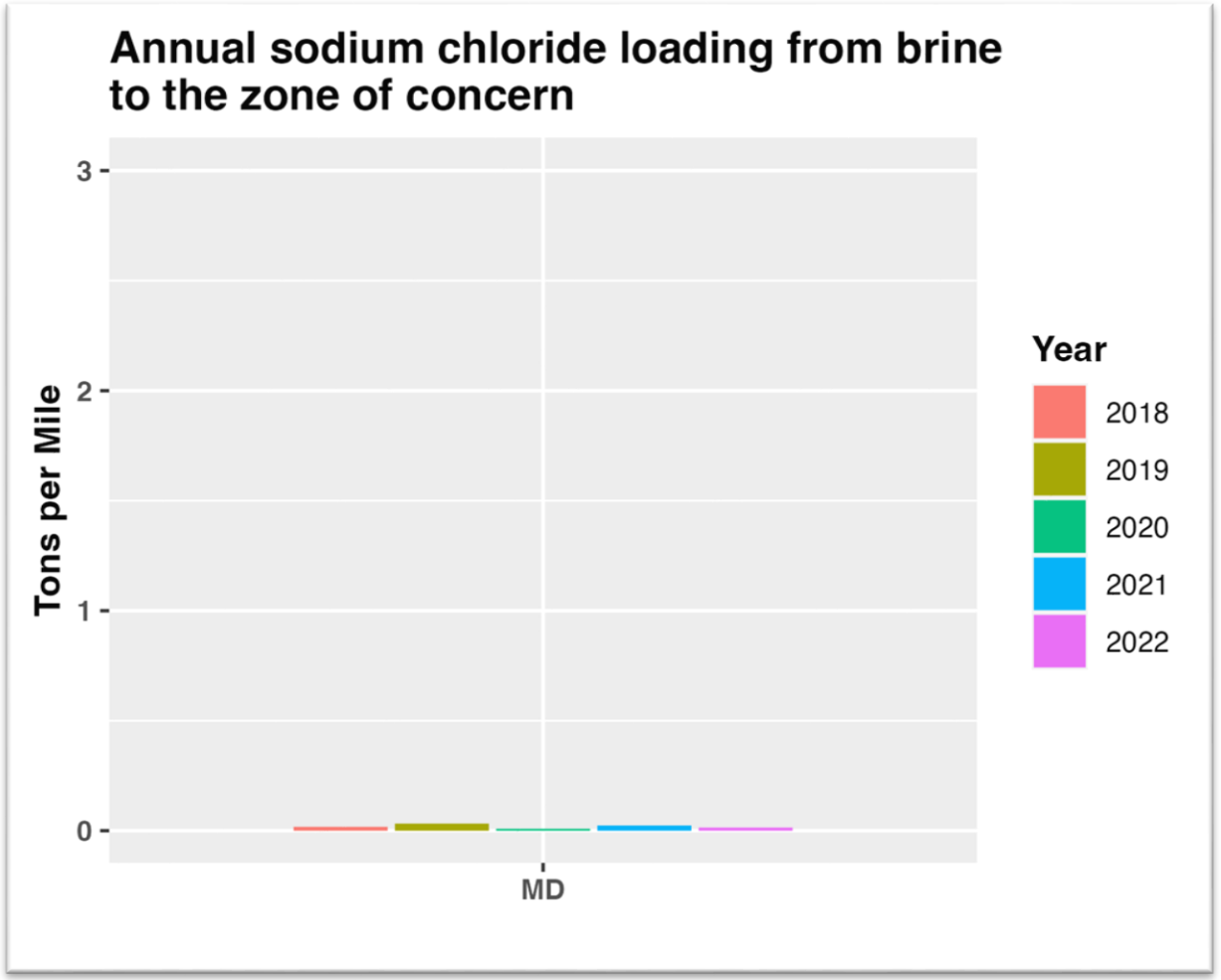
- MD – 19,480 mi
- VA – 27,210 mi (+40%)

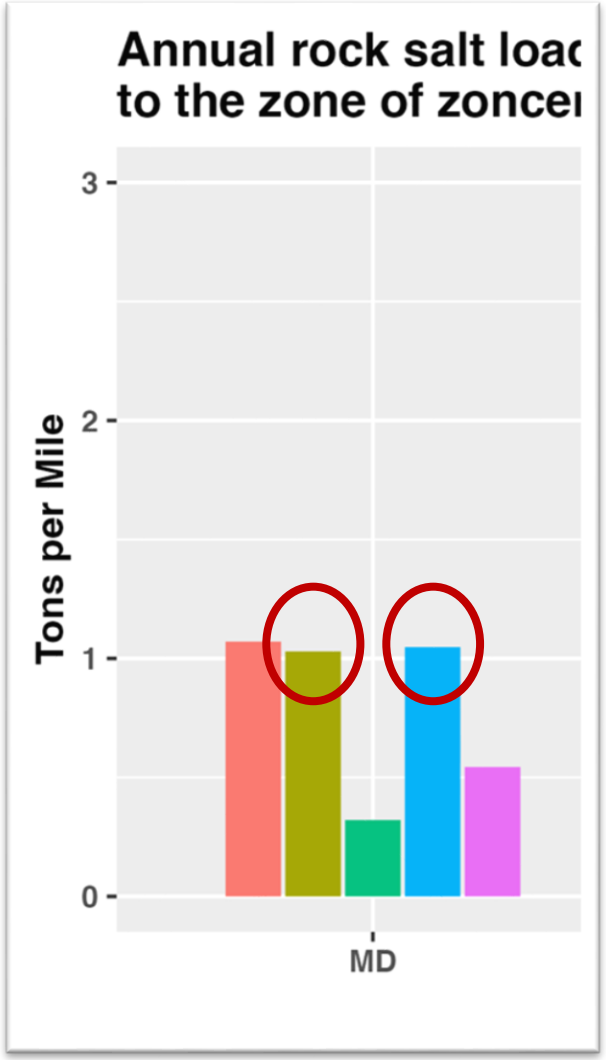

Annual sodium chloride loading from brine to the zone of concern
Tons per Mile
0.03
0.02
0.01
0.00
MD
Year
2018
2019
2020
2021
2022

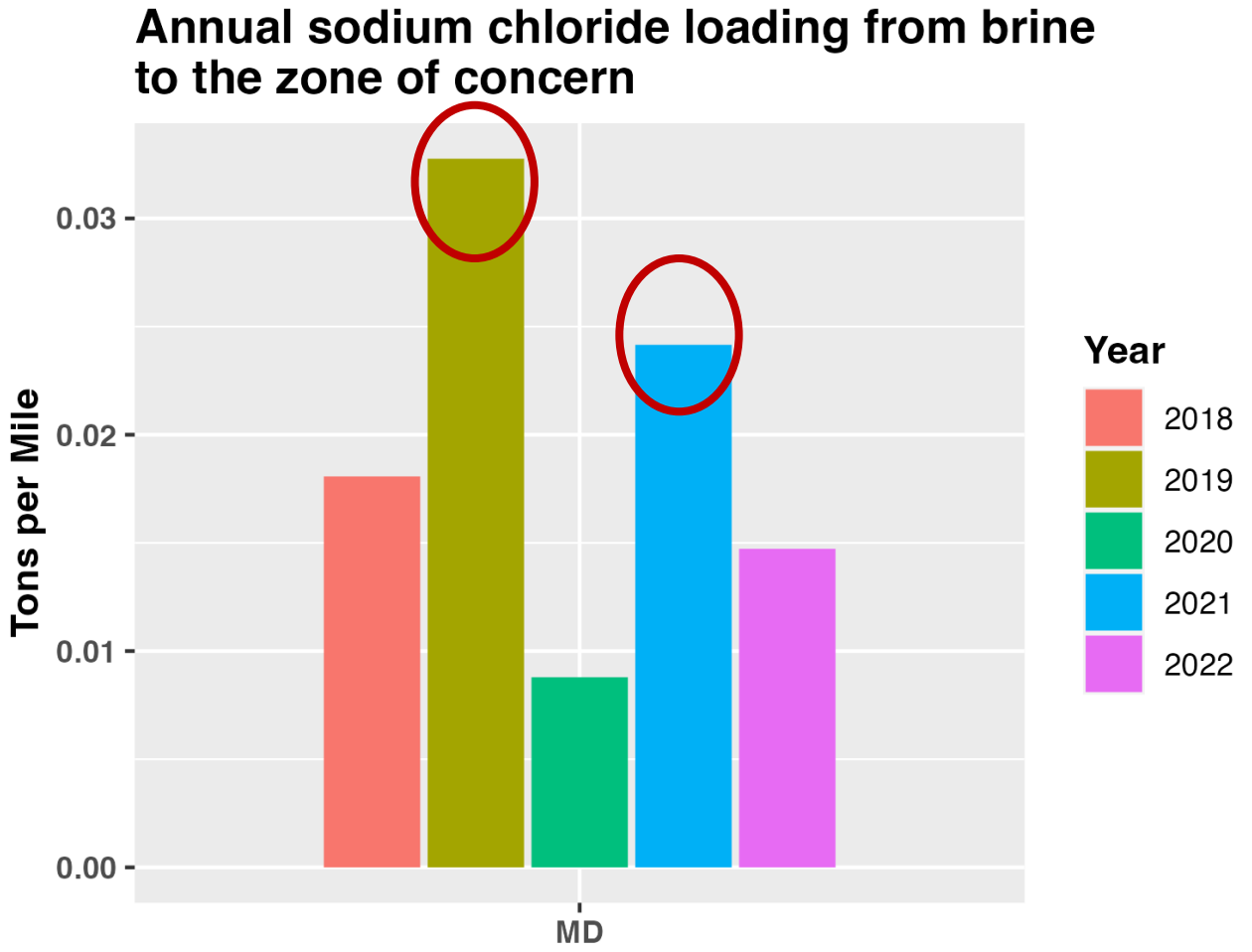

A0874

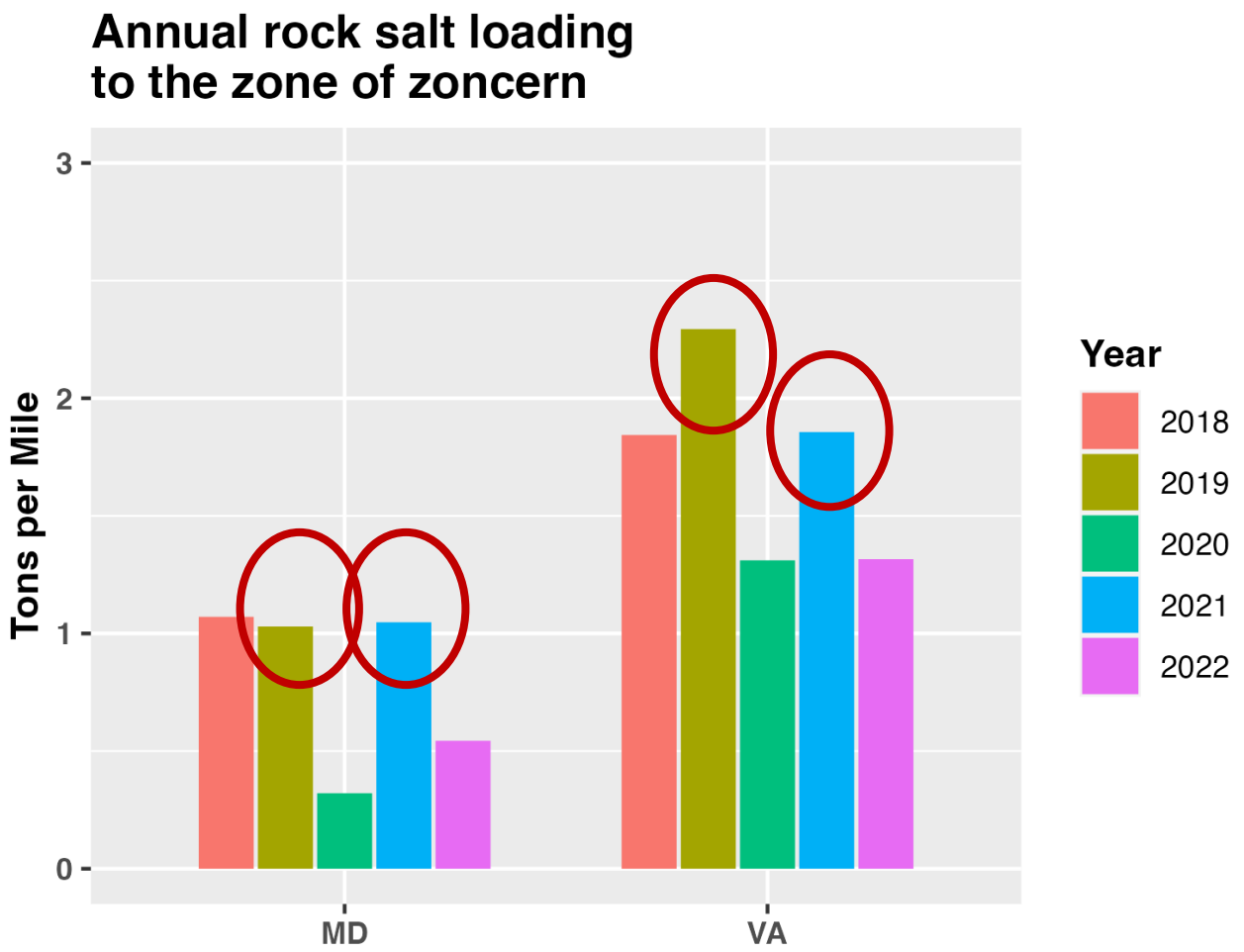
Brine


Annual granular road salt loading
to the zone of zoncern
Tons per Mile
3
2
1
0
MD
VA
Year
2018
2019
2020
2021
2022


Annual sodium chloride loading from brine
to the zone of concern
Tons per Mile
3
2
1
0
MD
Year
2018
2019
2020
2021
2022


Annual rock salt loac
to the zone of zoncei
Tons per Mile
3
2
1
0
MD

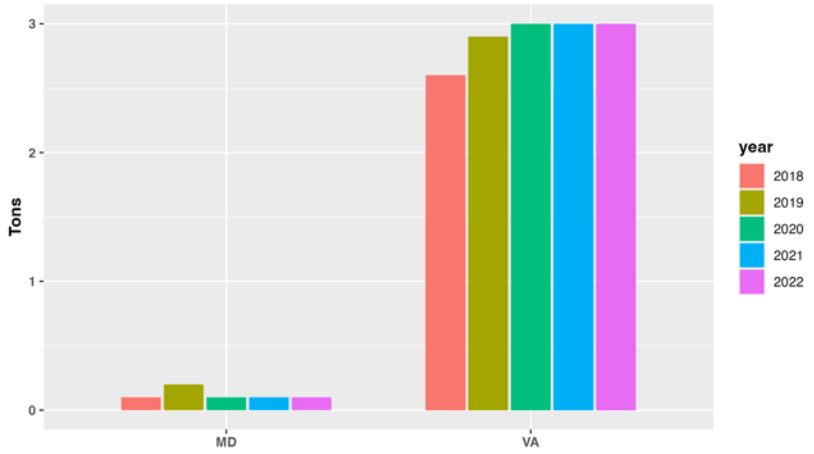

Annual sodium chloride loading from brine
to the zone of concern
Tons per Mile
0.03
0.02
0.01
0.00
MD
Year
2018
2019
2020
2021
2022



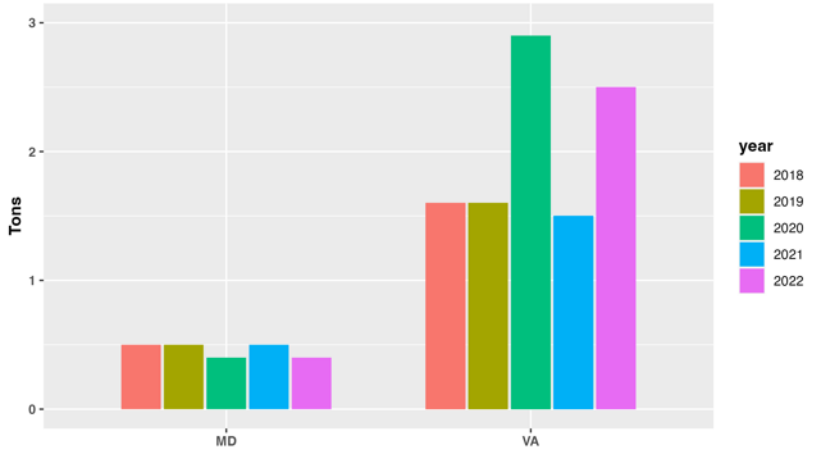
Rock salt generally contains 90-98% sodium chloride. 100% assumed here.

Photo credit: mspmag.com/arts-and-culture/general-interest/snow-emergency-parking-guide-twin-cities

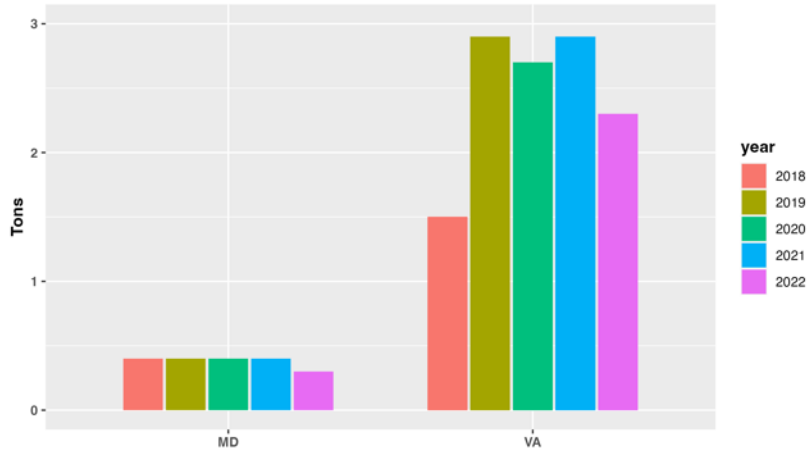
SICOPS



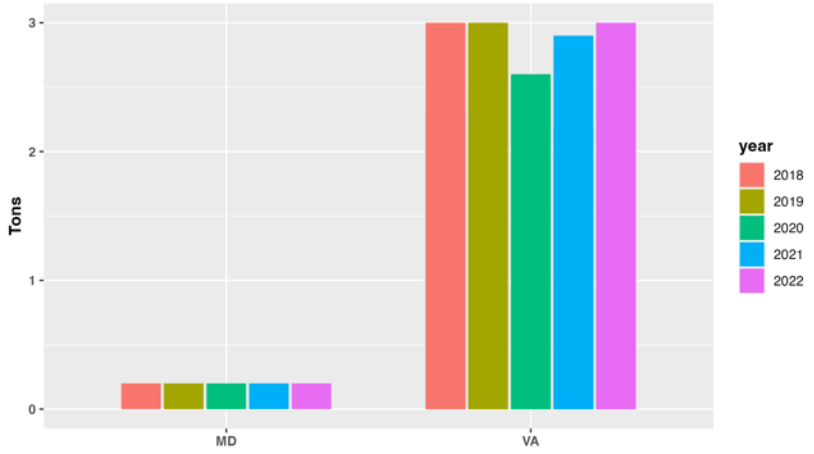
Snow & Ice Mgmt Assoc (SIMA) Guidelines



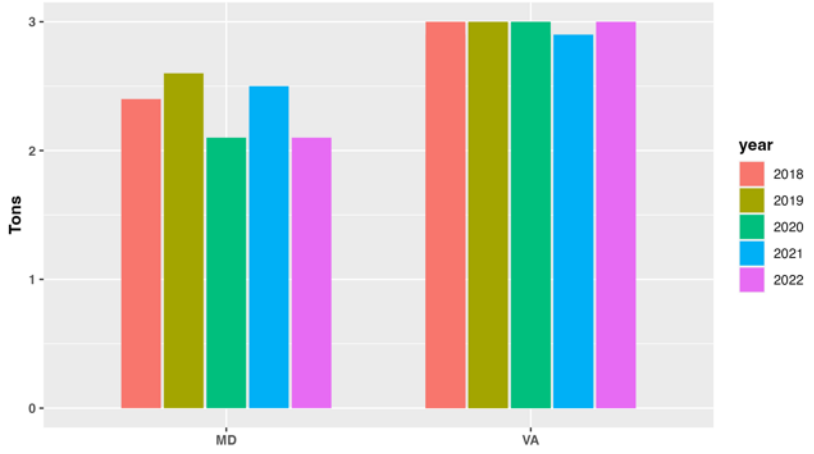
SIMA's Sustainable Salt Initiative (SSI) – **Real-World Data from participants in the program**



NH Guidelines

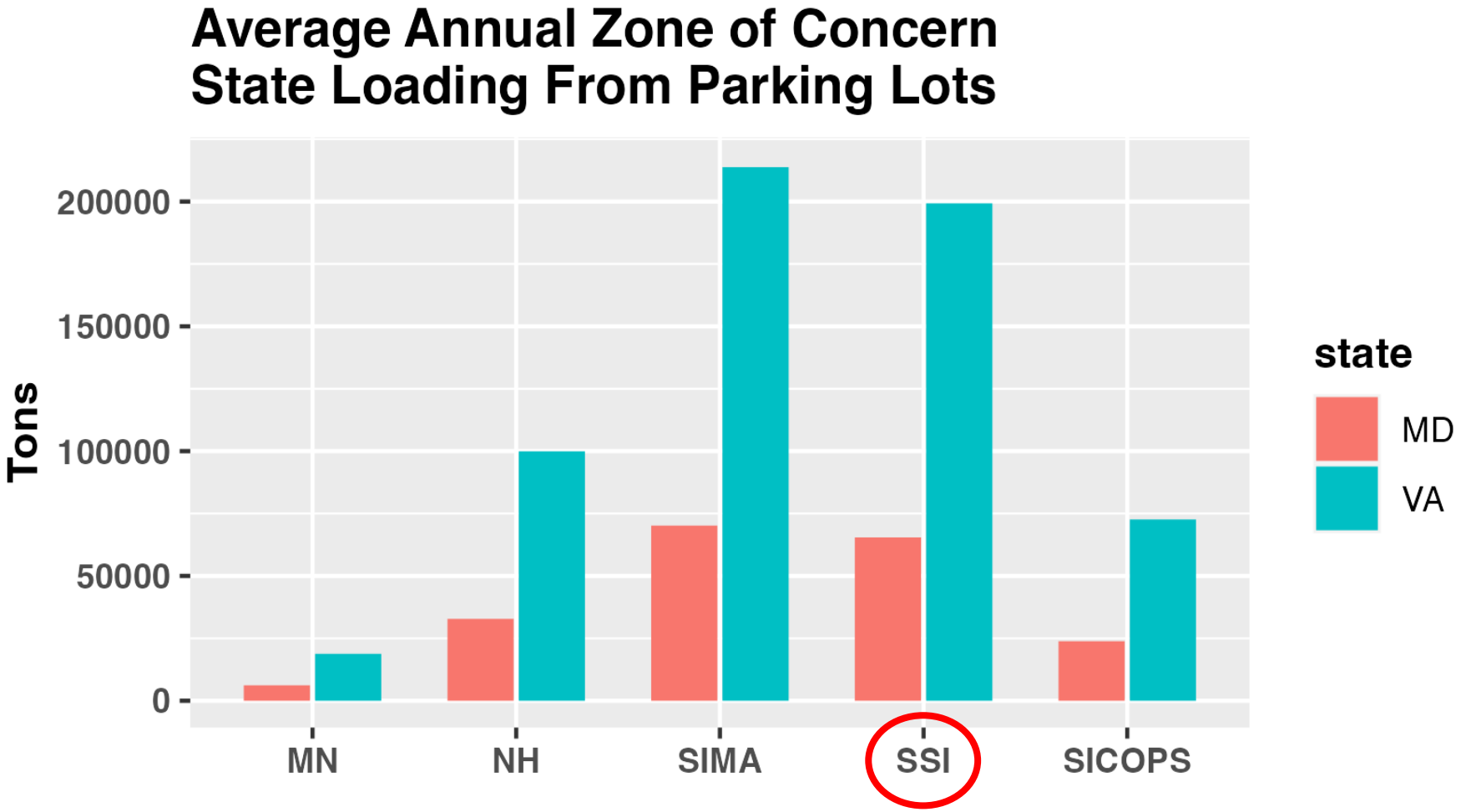


MN Guidelines



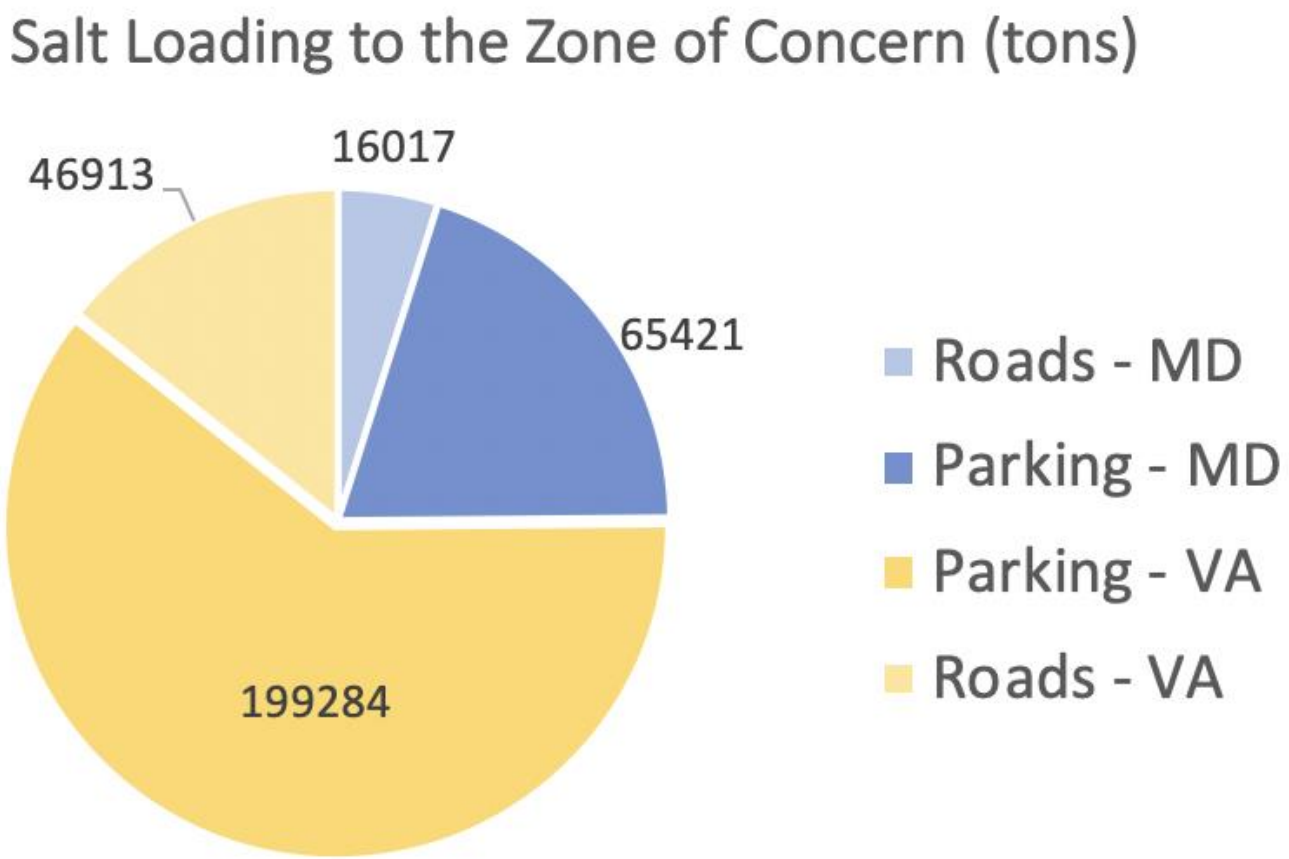
Estimated Parking Lot Sodium Chloride Loads (tons) to the Zone of Concern

(5 methods)

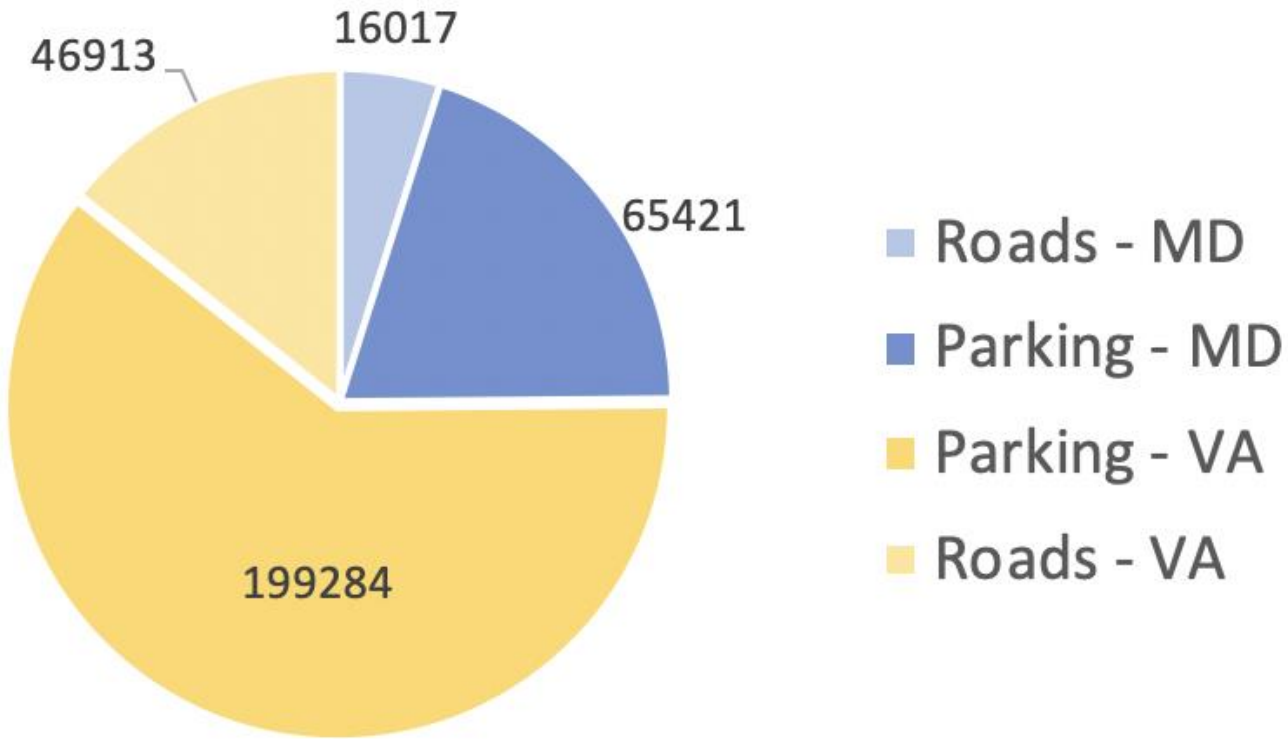


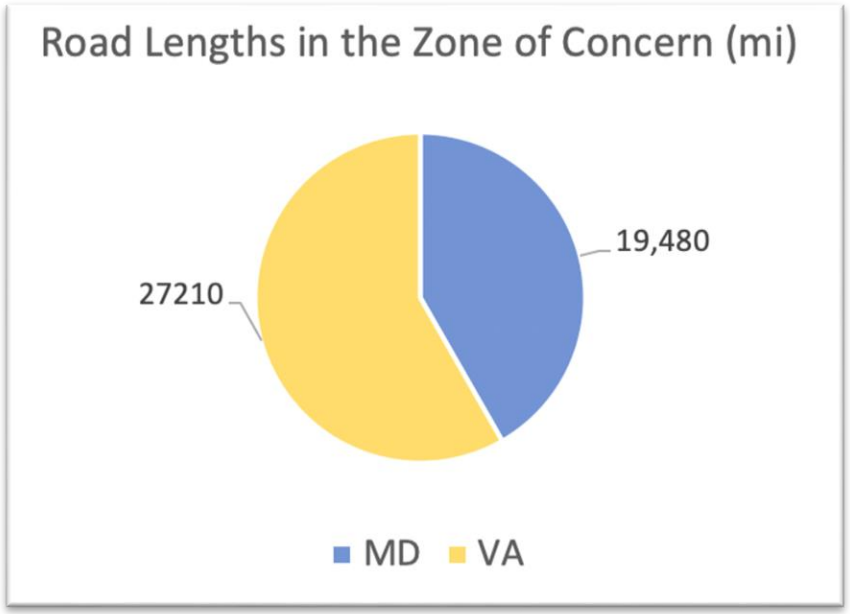
Parking Lot Areas in the Zone of Concern:

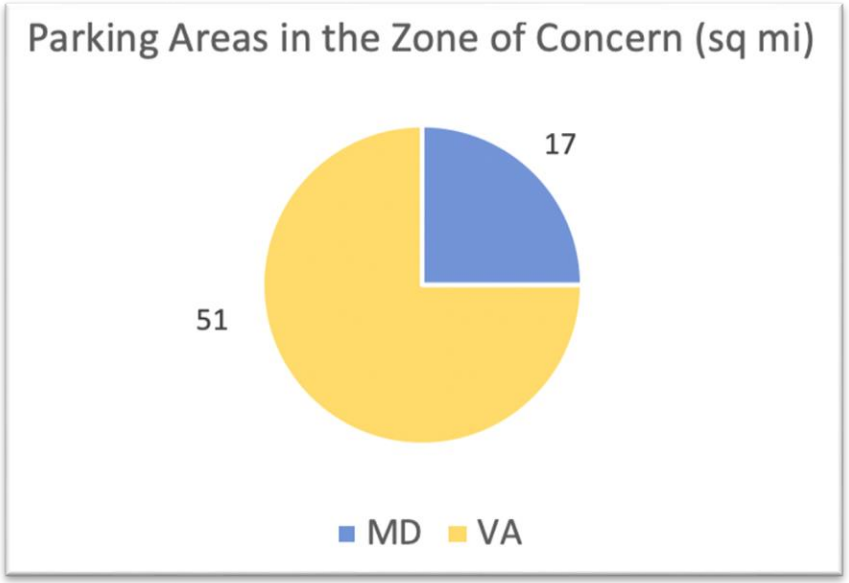
- **MD – 17 mi²**
- **VA – 52 mi²**


Salt Loading to the Zone of Concern (tons)
16017
46913
65421
199284
Roads - MD
Parking - MD
Parking - VA
Roads - VA

Salt Loading to the Zone of Concern (tons)







Data Gaps & Limitations

1. Actual application rates for VA roadways (brine & granular salt)
2. Actual application rates for parking lots
3. Impervious surface data for MD
4. VA MS4 collection areas
5. WV and PA not included in study
6. Groundwater impacts not included in study

Take Homes

1. Salt & brine practices vary widely
2. A standardized data collection/reporting format is needed
3. VA has more salted area contributing to loading in the zone of concern
4. Parking lots contribute greater load than roads in the zone of concern
5. Use of brine reduces road salt load in high use years
6. Training is an important part of reducing overall loads (use of brine, adjustments for weather & pavement conditions)
7. Improvement is possible!

Future Directions

1. Fill data gaps to refine loading estimates:
   - Obtain MD impervious surface data
   - Obtain VA MS4 collection areas
   - Add PA & WV data for full watershed loading capability

2. Ground-truth estimates for individual events:
   - Convert loading estimates to concentrations & specific conductivity at key locations
   - Compare to sensor or grab sample data (magnitude, time lag)

3. Identify high-load areas for future BMP or pilot efforts:
   - Summarize brine & granular salt loadings for roads & parking lots by MS4 collection areas and/or sub-watersheds
   - Low salt area designations

Future Directions (cont.)

4. Build a tool to predict chloride loading, concentration and/or specific conductance at drinking water intakes for specific storm event weather to support operational & planning efforts

5. Evaluate weather event types most likely to contribute higher sodium loads and exceedances of human health, irrigation, drinking water, aquatic life or other benchmarks

Acknowledgments

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Metropolitan Washington Council of Governments

Thank you!

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