

[NOAA Technical Memorandum NWS SR-193, Section 4](#)**Section 4 Table of Contents:****4. Variations by State Weighted by Population**[A. Death and Injury \(Casualty\) Rate per Population](#)[B. Death Rate per Population](#)[C. Injury Rate per Population](#)[D. Damage Report Rate per Population](#)[E. Summary](#)**4. VARIATIONS BY STATE WEIGHTED BY POPULATION**

Section 3 showed results when actual frequencies of *Storm Data* entries were used. Many states with high frequencies of casualties and damage are the most populous, such as New York and other northeast states. However, some states such as Colorado and New Mexico are not so populous but also had large numbers of lightning-caused deaths and/or injuries.

To compensate for this effect, population was considered. Figure 10 shows the ranks by state of the population during the *Storm Data* record. These values were found by averaging the decennial census populations in 1960, 1970, 1980, and 1990. The average populations were then used to calculate rates of casualties, deaths, injuries and damages for each state.

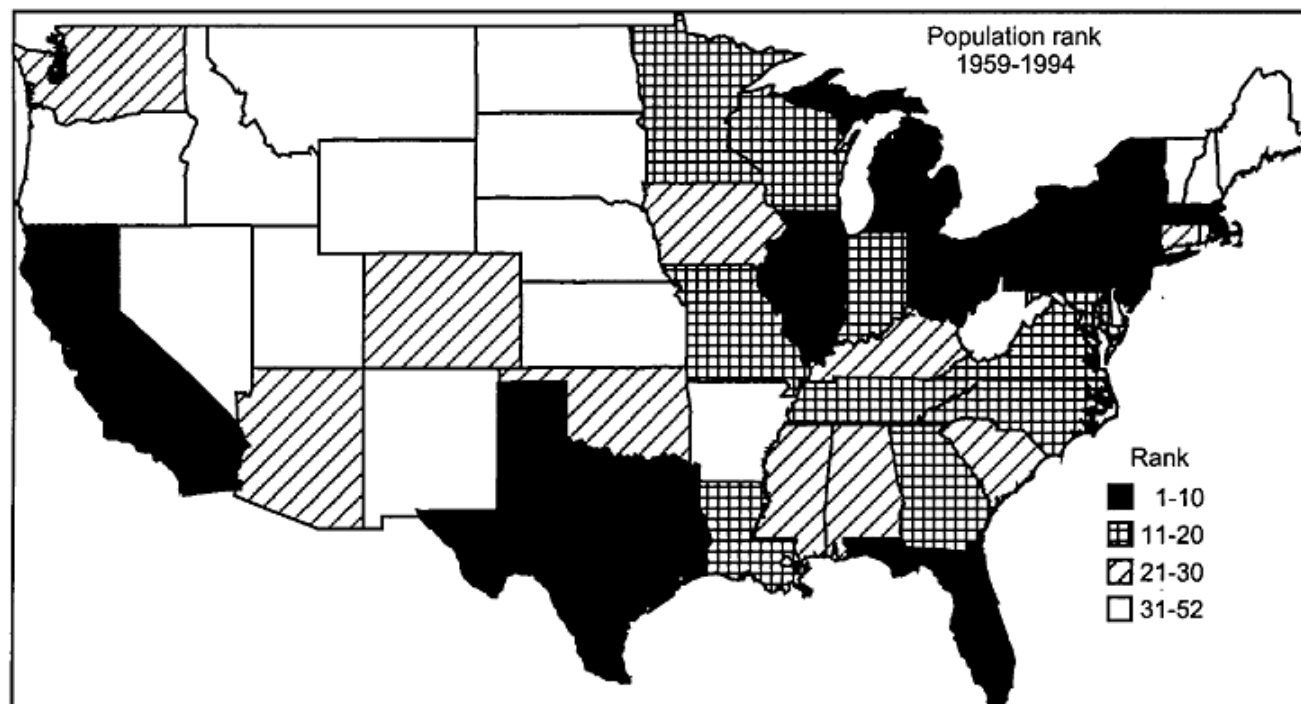


Figure 10: US map of average population ranked by state from 1959 to 1994.

A. DEATH AND INJURY (CASUALTY) RATE PER POPULATION

States with the highest rates of lightning-caused casualties per million people are shown in [Figure 11](#) and [Table 13](#).

[Table 14](#) lists the states with the lowest casualty rates.

The lowest casualty rates in [Table 14](#) continue to be in nearly the same locations. There is a dominance of west-coast states and small eastern states in the list of reports in [Table 5](#) and casualty rate in [Table 14](#).

Casualty rates for each state by population over the US were also shown by Ferrett and Ojala (1992) from 1959 to 1987, and Lopez and Holle (1995) from 1959 to 1990. These studies categorized results by increments of casualty rates rather than the ranks in this report. Lopez et al. (1995) showed casualty rates by county in Colorado.

Data from the National Lightning Detection Network can be used to take into account both population and lightning activity. For the US, a rate is found of 7.7 casualties per million people per 100 million flashes.

TABLE 13. Ten US locations with the highest rates of lightning-caused casualties (deaths and injuries combined) per million people from 1959-1994 in Storm Data.		
Rank	State	Casualties/million people/year
1	Wyoming	7.21
2	New Mexico	5.76
3	Florida	4.91
4	Arkansas	4.73
5	Colorado	4.28
6	Mississippi	3.47
7	Oklahoma	3.31
8	Maine	3.25
9	South Dakota	3.21
10	North Carolina	3.16

TABLE 14. As in Table 13 for lowest casualty rates.		
Rank	State	Casualties/million people/year
43	Illinois	0.91
44	Connecticut	0.82
45	Nevada	0.76
46	New Jersey	0.71
47	Puerto Rico	0.44
48	Oregon	0.31
49	Washington	0.29
50	California	0.10
51	Hawaii	0.10
52	Alaska	0

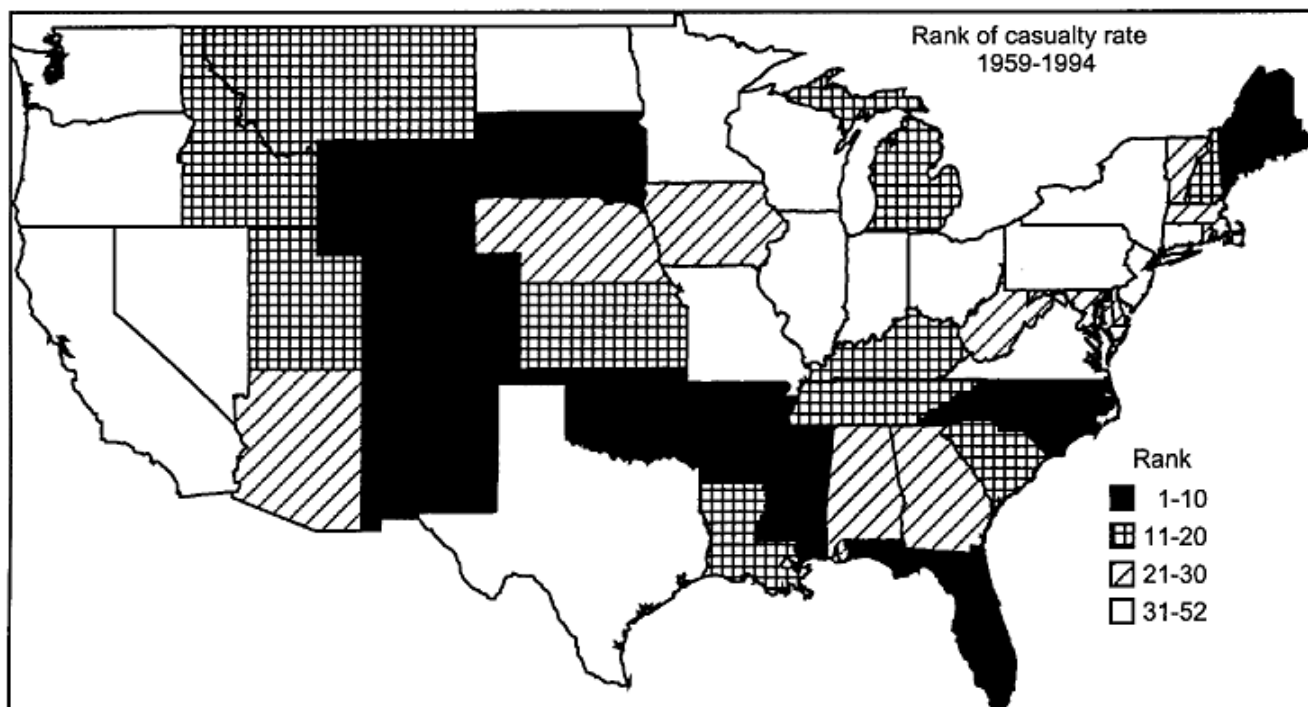


Figure 11: US map of rates of lightning casualties (deaths and injuries combined) ranked by state from 1959 to 1994.

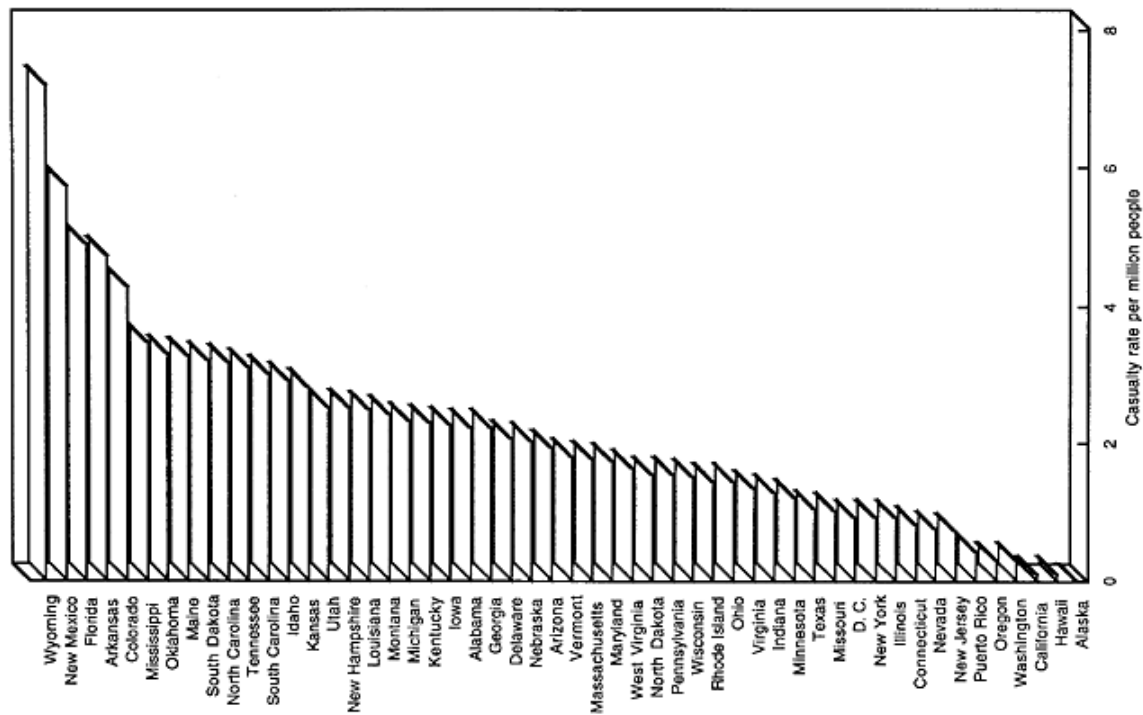


Figure 12: Rate of lightning casualties (deaths and injuries combined) per population ordered by state from 1959 to 1994.

B. DEATH RATE PER POPULATION

States with highest rates of lightning-caused fatalities are shown in [Figure 13](#) and [Table 15](#). [Table 16](#) lists states with the lowest death rates.

New Mexico and Wyoming had the highest lightning-caused death rates, as for casualty rate in [Table 13](#), except for exchanging first and second places. Wyoming had a high death rate in the first half of the record but not the last half (section 5 of this paper), while New Mexico consistently had high rankings. Louisiana replaces Maine compared to casualty rate results. Most states with highest death rates are less populous than other states, or have a medium number of people for a state. The exception is Florida, where there is both a large number of inhabitants and a high lightning death rate.

Lowest death rates ([Table 16](#)) were in Alaska, Hawaii, and mainly Pacific-coast or densely-populated east-coast states. These locations are often the same as states with a small number of reported deaths in [Table 7](#).

Similar maps of death rates per state population based on *Storm Data* were shown by Zegel (1967) from 1959 to 1965, by Duclos and Sanderson (1990) from 1968 to 1985, as well as by Ferrett and Ojala (1992) from 1959 to 1987. These results were categorized by increments rather than ranks. Mogil et al. (1977) listed the fatality rate by state in a table from 1968 to 1976.

The United States average was 0.41 deaths per million people per year from 1959 through 1994. This value is more than two orders of magnitude larger than the 0.01 deaths per 100,000 people per year determined for Australia by Coates et al. (1993) from 1980 to 1989.

TABLE 15. Ten US locations with the highest rates of lightning-caused deaths per million people from 1959-1994 in Storm Data.		
Rank	State	Deaths/million people/year
1	New Mexico	1.88
2	Wyoming	1.47
3	Arkansas	1.46
4	Florida	1.10
5	Mississippi	1.04
6	Colorado	1.04
7	Oklahoma	0.88
8	North Carolina	0.84
9	Louisiana	0.83
10	South Dakota	0.81

TABLE 16. As in Table 15 for the lowest death rates.		
Rank	State	Deaths/million people/year
43	New York	0.20
44	District of Columbia	0.20
45	Connecticut	0.12
46	Rhode Island	0.12
47	Massachusetts	0.12
48	Oregon	0.08

49	California	0.03
50	Washington	0.02
51	Hawaii	0
52	Alaska	0

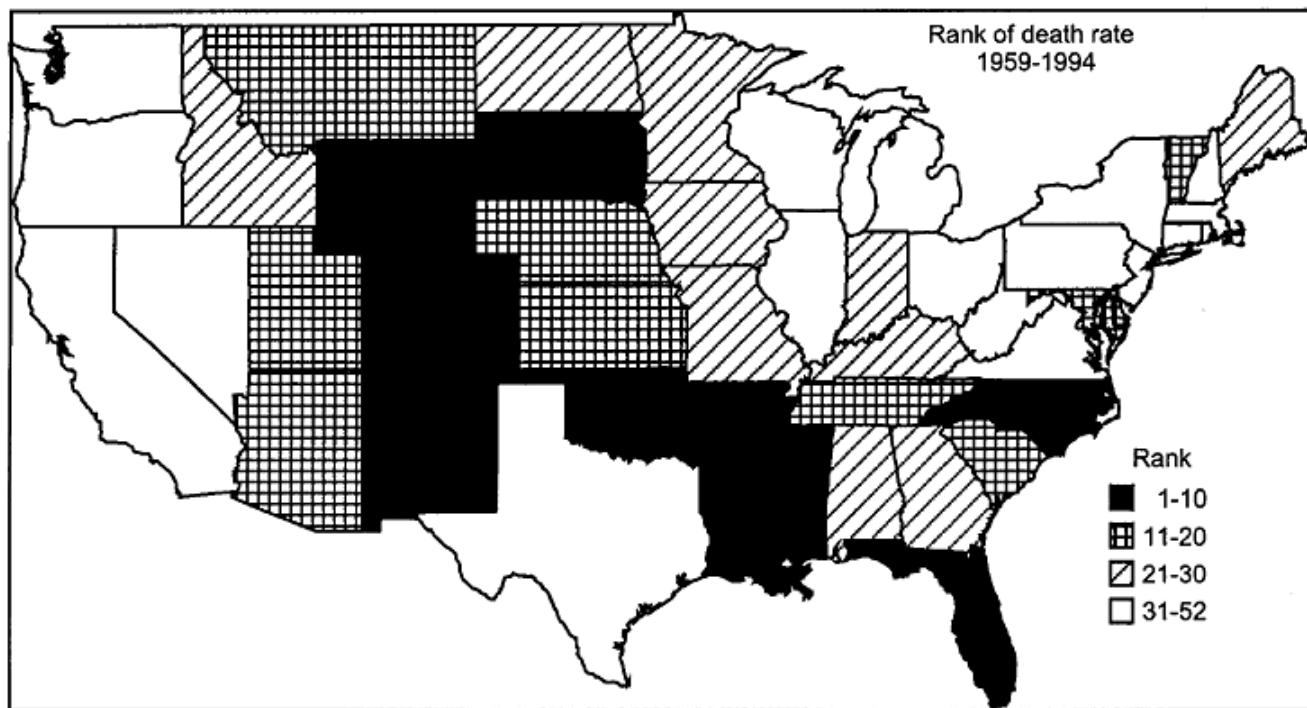


Figure 13: US map of rates of lightning deaths ranked by state from 1959 to 1994.

C. INJURY RATE PER POPULATION

States with highest rates of lightning-caused injuries are in [Figure 14](#) and [Table 17](#). [Table 18](#) lists states with the lowest injury rates.

Locations with the highest rates of injuries ([Table 17](#)) are almost identical with those with high casualty rates in [Table 13](#). The list is almost entirely different from reported injuries in [Table 8](#); Florida and North Carolina are the only states in both tables. States with high injury rates have smaller than average to average populations, while the largest reported frequencies of injuries are from populous states.

Lowest injury rates ([Table 18](#)) are from similar locations as low casualty rates in [Table 14](#) - Alaska, Hawaii, west coast states, and small east coast states. The one exception is Missouri, where less injuries than deaths have been reported ([Table 12](#)); nearly all other states have more injuries than deaths as summarized in section 3C.

Ferrett and Ojala (1992) showed similar injury rates per population from 1959-1987 based on *Storm Data*. Their results were in increments rather than ranks.

TABLE 17. Ten US locations with the highest rates of lightning-caused injuries per million people from 1959-1994 in Storm Data.	
	Injuries/million

Rank	State	people/year
1	Wyoming	5.74
2	New Mexico	3.89
3	Florida	3.80
4	Arkansas	3.26
5	Colorado	3.24
6	Maine	2.68
7	Mississippi	2.42
8	Oklahoma	2.42
9	South Dakota	2.40
10	North Carolina	2.32

TABLE 18. As in Table 17 for lowest injury rates.		
Rank	State	Injuries/million people/year
43	Illinois	0.69
44	Missouri	0.54
45	Nevada	0.52
46	New Jersey	0.49
47	Washington	0.27
48	Oregon	0.23
49	Hawaii	0.10
50	Puerto Rico	0.07
51	California	0.07
52	Alaska	0

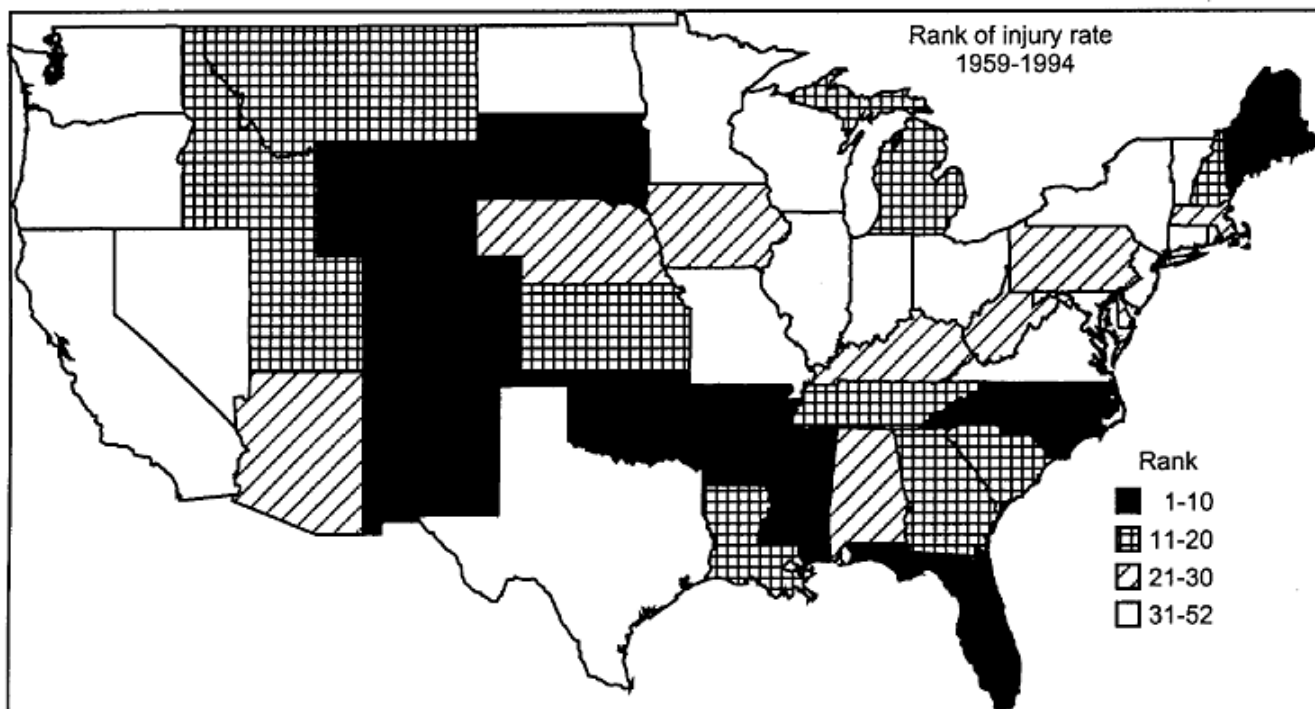


Figure 14: US map of rates of lightning injuries ranked by state from 1959 to 1994.

D. DAMAGE REPORT RATE PER POPULATION

States with the highest rates of lightning-caused damage reports are in [Figure 15](#) and [Table 19](#). [Table 20](#) lists states with lowest damage rates. No previous publication has shown US maps of damage reports normalized by population.

A swath of high rates of damage reports is located in [Figure 15](#) from North Dakota to Oklahoma and Arkansas. This region also had high numbers of reported damages in [Figure 8](#) with two exceptions. North Dakota did not have many actual reports, but this less populous state became twelfth in terms of damage rate. While Texas had numerous reports, its damage rate became small due to its large population. Other populous states in the first ten in terms of numbers of reports ([Table 10](#)), New York, Pennsylvania, and Michigan, rank much lower in the rate of damage reports ([Table 19](#)).

As noted in section 3D, there was usually only one damage report for each casualty in southwestern states, Florida, and several southeast states. The northwest half of the US tended to have about two damage reports for each casualty. These unaccountable variations by state result in the map of [Figure 15](#) that does not seem to have any pattern except for high rates along the plains.

Lowest damage rates ([Table 20](#)) are mostly from the same locations as states with low casualty rates in [Table 14](#). A notable exception is New Mexico, where there was a very low rate of damage reports (41st) while it ranked first or second in the rate of casualties, deaths, and injuries.

TABLE 19. Ten US locations with the highest rates of lightning-caused damage reports per million people from 1959-1994 in Storm Data.		
Rank	State	Damage reports/million people/year

1	South Dakota	17.77
2	Kansas	14.17
3	Nebraska	11.36
4	Idaho	10.17
5	Vermont	8.79
6	Oklahoma	8.30
7	Arkansas	7.67
8	Wyoming	7.35
9	South Carolina	6.88
10	New Hampshire	6.78

TABLE 20. Ten US locations with the lowest rates of lightning-caused damage reports per million people from 1959-1994 in Storm Data.

Rank	State	Damage reports/million people/year
43	Illinois	1.04
44	Arizona	0.99
45	District of Columbia	0.56
46	Hawaii	0.45
47	Nevada	0.44
48	Washington	0.41
49	New Jersey	0.38
50	Alaska	0.23
51	California	0.07
52	Puerto Rico	0.05

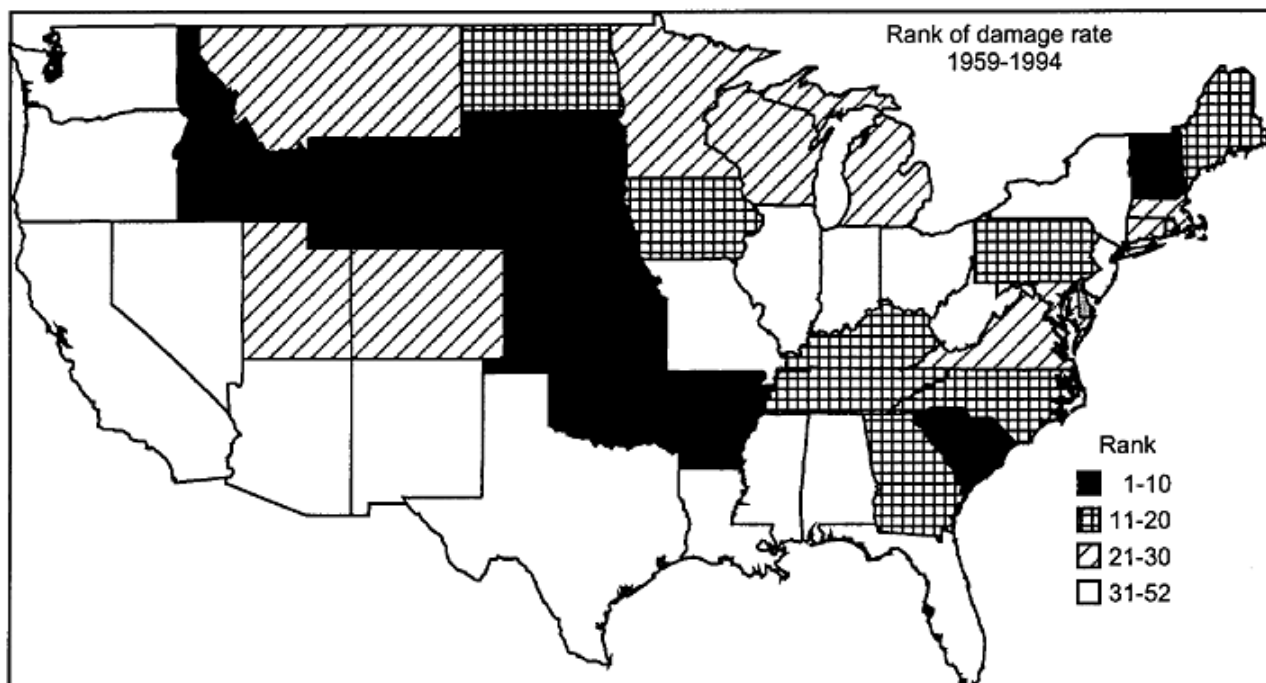


Figure 15: US map of rates of lightning damage reports ranked by state from 1959 to 1994.

E. SUMMARY

[Table 21](#) lists the rates of fatalities, injuries, casualties, and damage reports, and corresponding ranks for the dataset. Information in this table was used to develop the preceding maps and tables.

Wyoming and New Mexico led the nation in rates of lightning-caused deaths, injuries, and casualties. However, Wyoming had almost all of its casualties in the 1960s and 1970s (section 5). States with high rates of casualties (Figures 11 to 14) were as follows:

- Rockies - high rates of casualties but less populous (Arizona, Colorado, Idaho, New Mexico, Montana, Utah, Wyoming).
- Plains - high rates of casualties, and average to less than average populations (Iowa, Kansas, Nebraska, Oklahoma, South Dakota).
- Southeast and adjacent states - moderate to high rates of casualties and average state populations (Arkansas, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee).
- Northeast - moderate to high rates of casualties and less populous (Maine, New Hampshire, Vermont).
- Florida - very high rate of casualties and very populous.

The highest rates of damage reports were in a swath on the plains from North Dakota to Oklahoma. The pattern of damage report rates in many locations was not especially meaningful, since some states have exceptionally high or low ratios of reports to casualties for unknown reasons. For example, New Mexico had a low damage rate while it was second in casualty rates. Puerto Rico, California, and Alaska had very low rates of damage reports.

TABLE 21. Average population, and rate/million people/year of lightning-caused fatalities, injuries, casualties (fatalities and injuries combined), and damage reports for all states, the District of Columbia, and Puerto Rico from 1959 to 1994. Population is average of decennial census values from 1960 to 1990.				
	Average	Fatality	Injury	Casualty

State	population	rate		rate		rate		Damage rate	
	[1000s]	Rate	Rank	Rate	Rank	Rate	Rank	Rate	Rank
Alabama	3,660	0.64	24	1.60	23	2.23	22	2.18	34
Alaska	369	0	52	0	52	0	52	0.23	50
Arizona	2,364	0.69	19	1.23	30	1.93	26	0.99	44
Arkansas	2,086	1.46	3	3.26	4	4.73	4	7.67	7
California	22,275	0.03	49	0.07	51	0.10	50	0.07	51
Colorado	2,536	1.04	6	3.24	5	4.28	5	3.42	21
Connecticut	2,990	0.12	45	0.70	42	0.82	44	2.50	29
Delaware	564	0.74	17	1.33	27	2.07	24	4.09	17
District of Columbia	691	0.20	44	0.89	37	0.92	41	0.56	45
Florida	8,605	1.10	4	3.80	3	4.91	3	1.45	40
Georgia	5,119	0.44	28	1.79	17	2.23	23	3.56	19
Hawaii	869	0	51	0.10	49	0.10	51	0.45	46
Idaho	833	0.67	22	2.23	13	2.90	13	10.17	4
Illinois	11,011	0.21	42	0.69	43	0.91	43	1.04	43
Indiana	5,223	0.39	29	0.87	38	1.26	37	1.86	35
Iowa	2,818	0.64	23	1.60	24	2.24	21	5.71	13
Kansas	2,317	0.67	20	2.13	15	2.80	14	14.17	2
Kentucky	3,401	0.67	21	1.63	21	2.30	20	4.62	16
Louisiana	3,830	0.83	9	1.65	19	2.48	17	2.28	32
Maine	1,078	0.57	25	2.68	6	3.25	8	6.52	11
Maryland	4,005	0.80	12	0.94	36	1.74	29	3.16	23
Massachusetts	5,648	0.12	47	1.63	22	1.75	28	2.97	25
Michigan	8,813	0.28	37	2.03	16	2.31	19	2.57	28
Minnesota	3,918	0.38	30	0.84	39	1.21	38	2.88	26
Mississippi	2,372	1.04	5	2.42	7	3.47	6	2.40	30
Missouri	4,758	0.46	27	0.54	44	1.00	40	1.48	38
Montana	739	0.75	15	1.65	20	2.41	18	3.31	22
Nebraska	1,511	0.75	16	1.27	28	2.02	25	11.36	3
Nevada	694	0.24	40	0.52	45	0.76	45	0.44	47
New Hampshire	844	0.26	38	2.24	12	2.50	16	6.78	10
New Jersey	7,082	0.22	41	0.49	46	0.71	46	0.38	49
New Mexico	1,200	1.88	1	3.89	2	5.76	2	1.25	41
New York	17,642	0.20	43	0.71	41	0.91	42	1.58	37
North Carolina	5,535	0.84	8	2.32	10	3.16	10	4.82	15
North Dakota	635	0.48	26	1.05	34	1.53	31	6.34	12
Ohio	10,501	0.30	34	1.13	32	1.44	35	1.09	42
Oklahoma	2,764	0.88	7	2.42	8	3.31	7	8.30	6
Oregon	2,334	0.08	48	0.23	48	0.31	48	1.79	36

Pennsylvania	11,715	0.26	39	1.26	29	1.52	32	3.42	20
Puerto Rico	2,296	0.36	31	0.07	50	0.44	47	0.05	52
Rhode Island	939	0.12	46	1.33	25	1.45	34	3.61	18
South Carolina	2,895	0.78	13	2.22	14	2.99	12	6.88	9
South Dakota	683	0.81	10	2.40	9	3.21	9	17.77	1
Tennessee	4,240	0.81	11	2.29	11	3.09	11	5.01	14
Texas	12,998	0.35	32	0.71	40	1.06	39	1.47	39
Utah	1,283	0.74	18	1.78	18	2.51	15	2.32	31
Vermont	477	0.76	14	1.05	35	1.80	27	8.79	5
Virginia	5,037	0.28	36	1.06	33	1.35	36	2.69	27
Washington	3,815	0.02	50	0.27	47	0.29	49	0.41	48
West Virginia	1,837	0.30	33	1.33	26	1.63	30	2.21	33
Wisconsin	4,492	0.28	35	1.21	31	1.49	33	3.15	24
Wyoming	397	1.47	2	5.74	1	7.21	1	7.35	8