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Impact of Socioeconomic and Demographic Factors on Causes of Death in the U.S.

by

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Abstract

The incidence of diseases and accidents that lead to death is not uniform throughout the U.S. but rather varies widely among different regions. This study uses county-level data on numbers and causes of death for the entire U.S. in an effort to link these causes of death to various county-level social and economic variables. Examples of causes of death for which county-level data are available include cancer, heart disease, infectious diseases, motor vehicle accidents, and other causes such as non-motor vehicle accidents and drownings.

A series of econometric equations is specified. Each equation includes socioeconomic and demographic variables thought to be related to the particular cause of death. For example, infectious diseases may be more prevalent in areas with high population densities; the incidences of cancer and heart disease may be age-related. Computer cartography (GIS) is employed to generate county-level maps illustrating the differences in causes of deaths across counties for the entire U.S.

Impact of Socioeconomic and Demographic Factors on Causes of Death in the U.S.

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The incidence of diseases and accidents that lead to death is not uniform throughout the U.S. but rather varies widely among different communities. This study uses county-level data on the numbers and causes of death for the entire U.S. in 1988. An effort is made to link these causes of death to various county-level social, demographic and economic variables. Examples of causes of death for which county-level data are available include cancer, heart disease, infectious diseases, motor vehicle accidents, and other causes such as non-motor vehicle accidents and drownings.

There has been some discussion recently about the health status of rural residents. For example, some authors have argued that those living in rural areas are more likely to have chronic (but not necessarily acute) illnesses (e.g., Cordes, 1989; Rowland and Lyons, 1989). Others, such as Hines and Rutrough (1994), contend that the elderly in rural areas visit doctors less frequently than do the elderly in urban areas, *not* because of differences in medical needs, but because fewer physicians are available in rural areas. Issues of physician availability, and the population size neeed to support a doctor's office, has been discussed in recent papers such as Cowper and Kushman (1987) and Hicks and Glenn (1991).

The general objective of this paper is to determine whether the major causes of death are statistically related to specific socio-economic and demographic variables. For example, do people living in areas with greater population density have a higher incidence of heart disease? Do deaths from cancer tend to be concentrated in particular geographic areas? A series of econometric equations is specified containing the socioeconomic and demographic variables thought to be related to the particular cause of death. Computer cartography (GIS) is employed to generate county-level maps illustrating the differences across counties for the entire U.S.

Conceptual Framework

Biometrics is frequently concerned with the problem of finding a statistical relationship between specific human behavioral patterns such as the choice of diet and the incidence of disease. For example, a biometrician might attempt to establish whether a statistical link exists between smoking and the incidence of cancer, or between animal fat in the diet and the occurrence of certain kinds of heart disease. Generally, theses studies employ panel data and observations on individuals.

In this analysis, we have taken a somewhat different, more macro-oriented approach. To illustrate, infectious diseases may be more prevalent in areas with high population densities; the incidence of cancer and heart disease may be age-related. The incidence of heart disease may be diet-related, with dietary differences from one region of the U.S. to another reflecting spatially varying tastes and preferences. Regional and rural-urban differences in access to medical care may lead to differential death rates.

In our analysis, the county, not the individual, is the unit of observation (i.e., the county comprises the 'representative' individual). The general approach we use here has been employed in other studies, both inside and outside of heath-related research. The approach used is similar to that employed by Schoor, Crabtree, Wagner and Wetterass. They used county-level data for Ohio to study rural-urban differences in mortality for the 10 leading causes of death, using Ohio counties as units of observation. They found that mortality related to cardiovascular disease, cerebrovascular disease, accidents and influenza/pneumonia were significantly higher in rural counties while deaths due to chronic liver disease were significantly greater in urban Ohio counties.

Theoretical and Empirical Modeling

In our model building efforts, we rely on data for the ten leading causes of death, which are the same causes as used by Schorr et al. These are (1) Infectious and Parainfectious diseases (PIPD); (2) Malignant Neoplasms (Includes various kinds of cancers--PNEO) (3) Ischemic Heart Disease (PIHD) ; (4) Other Cardiovascular diseases (includes strokes--POCD); (5) Influenza and Pneumonia (PIPN); (6) Bronchitis, Emphysema and Asthma (PBEA); (7) Cirrhosis of the Liver (PCLI); (8) Motor Vehicle Accidents; (9) Other External Causes (Includes murders--POEC); and (10) All Other Causes (PDFOC). The Data we used were from the year 1988. The measure was the per capita death rate based on the 1990 Population Census. The observations consisted of 3140 individual U.S. counties.

A general model specification is;

$$d_{ij} = f(POP90, INC90, POV, ED90, POV65, DENS, LCOAST, BLACK, OTHER, VEH, D1, D2, D3, BEALE)$$

where d_{ij} is the death rate from cause i in county j, and $i = 1, \ldots, 10$ indexes the ten leading causes of death. That is, the d_{ij} vector consists of county-level data for 1988 (the most recent year available) for the following causes of death:

PIPD=Infectious and Para. Disease
PNEO=Malignant Neoplasms
PIHD=Ischemic Heart Disease
POCD=Other Cardiovascular Disease
PIPN=Influenza and Pneumonia
PBEA=Bronchitis, Emphysema, Asthma
PCLI=Cirrhosis of the Liver
PMVA=Motor Vehicle Accidents
POEC= Other External Causes
PDFOC=All Other Causes

and the social and demographic variables are

POP90=1990 Population for county *j*
INC90=1990 Per Capita Income for county *j*
POV=1990 Percent of the Population in Poverty in county *j*
ED90=1990 Educational Level for county *j*
POV65=1990 Percent of total population Over 65 in county *j*
DENS=1990 Population Density in county *j*
LCOAST=The Log of Miles of Coast for county *j*
BLACK=1990 % Black for county *j*
OTHER=1990 % Other Nonwhite for county *j*
VEH=Motor Vehicles per household (appears only in motor vehicle deaths equation) for county *j*
D1=northeast dummy
D2=south dummy
D3=midwest dummy
(*D4*, the dummy for the west, was the omitted category)
BEALE= a code that measures rural-urban differences and contiguity with central cities

With one exception, the equations developed for each cause of death included an identical set of explanatory variables. The only exception was the deaths from motor vehicle accidents equation, which included as an additional explanatory variable the number of vehicles per household.

Measures of the degree of urbanization were a predominant feature of the model. Measures linked to urbanization included in the model were the population of the county from the 1990 U.S. population census (POP90) and the Beale code (*BEALE*), which also measures the geographic position of the county in relation to urbanized areas. The Beale code, developed by Calvin Beale at the USDA, Economic Research Service, is an integer assigned to each U.S. county (see Hady and Ross). The value for the Beale code ranges from 0 (a metropolitan county with a population of a million or more) to 9 (a rural county with no town larger than 2,500 people and not adjacent to a metropolitan area. Population density (*POP90*) also is a measure of urbanization. In addition, population density may be linked to the spread of serious infectious diseases.

Some of these causes of death are strongly linked to age; others are not. For example, cancer deaths tend to occur with higher frequency among the elderly; whereas deaths from drowning do not. Some diseases tend to occur primarily in the elderly; others do not. Deaths from influenza and pneumonia are rare among young people, but occur with some frequency among the elderly. A basic problem in developing a model that links demographic data to causes of death is to ensure that the consequences of age are fully accounted for.

Some diseases that lead to death are almost exclusively age-related, but others are not age related at all. Still other diseases may lead to deaths primarily in the elderly. For example, deaths from pneumonia and influenza are uncommon except among the elderly. To adjust for age-related differences, each equation included the percent of the population over 65 (*POV65*).

A series of socioeconomic and demographic variable capture potential differences in access to medical care, which, in turn, may have an impact on death rates, at least for certain type of causes, such as cancer and heart disease. Obviously, high income people are likely to have comprehensive health insurance. Those in poverty, through medicaid, might even have better access to medical care than those at incomes only slightly above the poverty level.

Death rates are potentially linked not only to access to health care, but also related to other factors such as diet, exercise, and stress. Many of these factors are not directly measurable at the county level; but they can sometimes be measured indirectly. For example, highly educated individuals would be more aware of the need for proper diet and exercise and the need to follow recommendations regarding preventative medicine. In our model, the variable *ED90* was created from the 1990 census data to provide a county level measure of educational attainment. The U.S. Bureau of the Census no longer provides county estimates for median educational level, as was done for the 1980 and prior census years. We calculated a measure based on counts of people over 25 in each census category using the following equation

$$EDUC90_j = \sum_{k=1}^{7} w_k n_k / (\sum_{k=1}^{7} n_k)$$

where

η_k = the number of people in the kth educational category

w_k = the weight used for the kth educational category, in years

n_1 = Number of people in county j with less than an eighth grade education.
w_1 = 6.0 years

n_2 = Number of people in county j with eight to twelve years of education, but no high school diploma.
w_2 = 10.5

n_3 = Number of people in county j who completed high school only.
w_3 = 12.0

n_4 = Number of people in county j who attended college but did not receive a degree.
w_4 = 13.5

n_5 = Number of people in county j who attended college and received an Associate degree or equivalent.
w_5 = 14.0

n_6 = Number of people in county j who graduated from a four year college with a B.S., B.A. or equivalent degree.
w_6 = 16.0

n_7 = Number of people in county j who did post graduate work or completed a professional degree (i.e. Law; Medicine).
w_7 = 18.5

To test for differences in racial composition of counties on death rates, two variables were used. *BLACK* is the percent of the total county population that is black, and *OTHER* is the percent of the population that is other non-white. This category includes primarily those of hispanic origin, but native-americans also are placed in this category. In a number of states where there are reservations that either consist of an entire county, or a county is predominately on a reservation. The unique demographics of these reservations may have significant impacts on the types of diseases and causes of deaths.

Empirical Results

Table 1 lists the simple means for the 3140 county level observations used in the analysis. These are averages of county level observations. Death rates are per thousand from the various causes. Population is measured in thousands. Table 2 presents the simple correlations for all variables used in the analysis. Table 3 contains the regression results. The results presented here are largely based on the significance or lack of significance of individual regression coefficients in each equation.

Infectious and Parainfectious diseases: Based on the significance of *POV65* in this equation in comparison with the other equations, deaths from infectious and parainfectious diseases (*PIPD*) are somewhat age-related. However, the most interesting result in this equation was the significance of the population density variable (*DENS*), indicating that population density is positively related to transmission of infectious diseases, and that this linkage can be identified with econometric analysis. The coefficients on the *BLACK* and *OTHER* variables indicates that death rates from infectious diseases are higher for blacks and hispanics than for whites, ceteris, paribus.

Malignant Neoplasms: In contrast with the results for infectious diseases, deaths from malignant neoplasms (*PNEO*, that is, all types of cancers) are highly age-related. There also appears to be a higher incidents of deaths among the poorly educated, who may be less likely to seek early treatment. In comparison with whites, death rates appear to be higher, but lower among other non-whites, primarily hispanic. Unlike infectious diseases, death rates from cancers do not appear to be linked to population density.

Ischemic Heart Disease: Not surprisingly, deaths from ischemic heart disease tend to be strongly age-related. Counties with high average educational levels tend to have fewer deaths due to heart disease. This could be the

result of a number of education-related behaviors. The highly educated may be quicker to seek medical treatment for symptoms related to heart disease. They may be better informed about diet and linkages to heart disease; or they may engage in more consistent exercise programs. Unlike cancer, there appears to be no linkage between race (*BLACK* and *OTHER*) and heart disease. There is a reduced incidence along the coasts (*LCOAST*), and a slightly reduced incidence in rural relative to urban areas (a positive sign on *DENS* but a negative sign on *BEALE*).

Other Cardiovascular Disease: Deaths from other cardiovascular disease includes deaths from strokes other similar causes. Once again, deaths are strongly age related. The other factors are quite different from heart disease, however. Blacks have a higher incidence than whites, but not other non-whites. People living along the coast have a strongly lower incidence. There also appears to be some regional differences (*D1 - D3*).

Influenza and Pneumonia: It is usually the elderly that die from influenza and pneumonia, and these data confirm that result. Those living along the coast have a lower incidence. This could be due to the milder climate often found along the coast. Blacks have lower death rates than whites.

Bronchitis, Emphysema and Asthma: Deaths from Bronchitis, Emphysema and Asthma (*PBEA*) also tend to be age-related. In addition, these deaths are positively related to the percent of persons in poverty (*POV*). When the effects of age and poverty are taken into consideration, non-whites have lower death rates from this cause than whites.

Cirrhosis of the Liver: Cirrhosis of the liver is frequently a disease of the aging. However, cirrhosis of the liver is primarily linked to alcoholism. Some of the variables in this equation may act as partial proxies for alcohol consumption. For example, non-whites (i.e., blacks, hispanics, native americans) could have higher average alcohol consumption rates than whites, leading to greater numbers of deaths in the non-white population from this cause. Note the significance of the (*BLACK*) and (*OTHER*) coefficients.

Motor Vehicle Accidents: The specification of this equation differed slightly from the other equations in that it contained motor vehicles per capita as an explanatory variable, but this variable did not have a coefficient significant at the 0.05 level. Motor vehicle deaths are not age related. Counties where the average educational level is high have fewer motor vehicle deaths. Income and percent in poverty *both* have negative signs--those in poverty presumably have not only have fewer vehicles but also less money to spend on gasoline and other travel costs. Once the effects of income and education are accounted for, non-whites have higher motor vehicle death rates than whites. The Beale code measure of urban/rural appears to be linked to motor vehicle death rates, with the more urbanized counties having higher death rates.

Other External Causes: These causes includes deaths from murders, manslaughters, drownings and the like.The Beale code significance suggests these deaths are far more common in urban than in rural areas. These deaths are also higher among non-whites (*BLACK* and *OTHER*). Once these variables were included, neither the income nor the poverty variables were significant at the 0.05 level.

All Other Causes: This category includes all other causes of deaths that are not included in the other nine categories. Many of these causes appear to be age-related. Some occur more frequently among non-whites and among those in poverty.

Table 4 summarizes the important social and demographic factors in each kind of death. Variables in Table 4 were listed according to the magnitude of the t ratio for each cause of death.

Concluding Comments

When we began this research, we were skeptical that the patterns representing geographic differences in

death rates from the various causes would be readily apparent. We were surprised to find that these patterns were in many cases were quite obvious, not only in the econometric results but also in the maps. In future work, we will add more variables unique to each cause of death, making possible an SUR estimation procedure.

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Table 1. County Mean Values for Variables

		Mean
PIPD	Infectious and Para. Disease	0.1437034
PNEO	Malignant Neoplasms	2.1822107
PIHD	Ischemic Heart Disease	2.4370604
POCD	Other Cardiovascular Disease	2.3169490
PIPN	Influenza and Pneumonia	0.3993979
PBEA	Bronchitis, Emphysema, Asthma	0.4053338
PCLI	Cirrhosis of the Liver	0.0920542
PMVA	Motor Vehicle Accidents	0.2827819
POEC	Other External Causes	0.4605238
PDFOC	Other Causes	1.5332937
POP90	1990 Population	78.95274837
INC90	1990 Per Capita Income	15.1180337
POV	1990 Percent in Poverty	16.7206586
ED90	1990 Educational Level	11.8907034
POV65	1990 % Over 65	14.9150278
DENS	1990 Population Density	0.2287481
LCOAST	Log of Miles of Coast	0.3282235
BLACK	1990 % Black	8.9989800
OTHER	1990 % Other Nonwhite	4.0154400
VEH	Motor Vehicles per household	1.8130244
D1	northeast dummy	0.0677340
D2	south dummy	0.4621305
D3	midwest dummy	0.3257389
BEALE	Code measures contiguity	5.8169104

Table 2. Simple Correlation Coefficients

	PIPD	PNEO	PIHD	POCD	PIPN	PBEA	PCLI	PMVA	POEC	PDFOC	POP90	INC90
PIPD Infectious and Para. Disease	1.00000	0.13145	0.08941	0.16632	0.06961	0.04875	0.07108	-0.00356	0.09328	0.18362	0.11343	0.01335
PNEO Malignant Neoplasms	0.13145	1.00000	0.50908	0.51229	0.34492	0.31374	0.12517	0.02727	0.09641	0.39501	-0.09918	-0.03721
PIHD Ischemic Heart Disease	0.08941	0.50908	1.00000	0.36997	0.38640	0.25152	0.05433	0.04384	0.03852	0.30889	-0.11201	-0.08158
POCD Other Cardiovascular Disease	0.16632	0.51229	0.36997	1.00000	0.31199	0.26432	0.06292	0.09559	0.15140	0.43613	-0.14364	-0.15011
PIPN Influenza and Pneumonia	0.06961	0.34492	0.38640	0.31199	1.00000	0.18790	0.01820	0.04758	0.06109	0.26178	-0.09101	-0.02550
PBEA Bronchitis, Emphysema, Asthma	0.04875	0.31374	0.25152	0.26432	0.18790	1.00000	0.02283	-0.00855	0.10469	0.20910	-0.08822	-0.05300
PCLI Cirrhosis of the Liver	0.07108	0.12517	0.05433	0.06292	0.01820	0.02283	1.00000	0.06282	0.11557	0.04608	0.04068	0.04223
PMVA Motor Vehicle Accidents	-0.00356	0.02727	0.04384	0.09559	0.04758	-0.00855	0.06282	1.00000	0.11871	0.09723	-0.12602	-0.22183
POEC Other External Causes	0.09328	0.09641	0.03852	0.15140	0.06109	0.10469	0.11557	0.11871	1.00000	0.17669	-0.04908	-0.12282
PDFOC Other Causes	0.18362	0.39501	0.30889	0.43613	0.26178	0.20910	0.04608	0.09723	0.17669	1.00000	-0.10228	-0.13060
POP90 1990 Population	0.11343	-0.09918	-0.11201	-0.14364	-0.09101	-0.08822	0.04068	-0.12602	-0.04908	-0.10228	1.00000	0.29257
INC90 1990 Per Capita Income	0.01335	-0.03721	-0.08158	-0.15011	-0.02550	-0.05300	0.04223	-0.22183	-0.12282	-0.13060	0.29257	1.00000
POV 1990 Percent in Poverty	0.10724	0.07221	0.06688	0.20805	0.04197	0.04157	0.06849	0.21053	0.23458	0.23783	-0.13516	-0.62442
ED90 1990 Educational Level	-0.08798	-0.25163	-0.30103	-0.31698	-0.14272	-0.10684	-0.03543	-0.25598	-0.17544	-0.26777	0.25111	0.63785
POV65 1990 % Over 65	0.10389	0.64844	0.62802	0.60889	0.44099	0.34293	0.05632	0.04328	0.07384	0.47061	-0.16415	-0.02929
DENS 1990 Population Density	0.26761	-0.01778	-0.01664	-0.05656	-0.01355	-0.04951	0.05698	-0.07657	0.00405	-0.00535	0.34450	0.22809
LCOAST Log of Miles of Coast	0.09570	-0.01126	-0.10800	-0.10488	-0.11769	-0.05064	0.06589	-0.06129	-0.00891	-0.08266	0.23626	0.20347
BLACK 1990 % Black	0.16305	0.00097	-0.09939	0.13173	-0.13979	-0.14358	0.05274	0.10967	0.16291	0.08222	0.06718	-0.20520
OTHER 1990 % Other Nonwhite	0.03002	-0.22618	-0.17644	-0.18155	-0.08547	-0.09108	0.16624	0.08965	0.12319	-0.02260	0.13294	-0.04336
VEH Motor Vehicles per household	-0.24244	-0.11803	-0.08955	-0.11503	0.04296	0.04660	-0.10147	-0.05866	-0.08305	-0.14978	-0.18855	0.26083
D1 northeast dummy	0.06049	0.01525	0.02068	-0.07533	-0.04963	-0.02001	0.04170	-0.10245	-0.11676	-0.05844	0.16085	0.23707
D2 south dummy	0.15772	-0.00132	-0.06215	0.07818	-0.10295	-0.09887	0.02003	0.15753	0.15969	0.07738	-0.06845	-0.26363
D3 midwest dummy	-0.13240	0.13906	0.24425	0.12468	0.18157	0.06871	-0.10907	-0.13851	-0.15847	0.04738	-0.06005	0.13081
BEALE Code measures contiguity	-0.04462	0.26615	0.27613	0.33262	0.24681	0.21204	0.01663	0.20036	0.17891	0.24462	-0.42060	-0.34932

	POV	ED90	POV65	DENS	LCOAST	BLACK	OTHER	VEH	D1	D2	D3	BEALE
PIPD	0.10724	-0.08798	0.10389	0.26761	0.09570	0.16305	0.03002	-0.24244	0.06049	0.15772	-0.13240	-0.04462
PNEO	0.07221	-0.25163	0.64844	-0.01778	-0.01126	0.00097	-0.22618	-0.11803	0.01525	-0.00132	0.13906	0.26615
PIHD	0.06688	-0.30103	0.62802	-0.01664	-0.10800	-0.09939	-0.17644	-0.08955	0.02068	-0.06215	0.24425	0.27613
POCD	0.20805	-0.31698	0.60889	-0.05656	-0.10488	0.13173	-0.18155	-0.11503	-0.07533	0.07818	0.12468	0.33262
PIPN	0.04197	-0.14272	0.44099	-0.01355	-0.11769	-0.13979	-0.08547	0.04296	-0.04963	-0.10295	0.18157	0.24681
PBEA	0.04157	-0.10684	0.34293	-0.04951	-0.05064	-0.14358	-0.09108	0.04660	-0.02001	-0.09887	0.06871	0.21204
PCLI	0.06849	-0.03543	0.05632	0.05698	0.06589	0.05274	0.16624	-0.10147	0.04170	0.02003	-0.10907	0.01663
PMVA	0.21053	-0.25598	0.04328	-0.07657	-0.06129	0.10967	0.08965	-0.05866	-0.10245	0.15753	-0.13851	0.20036
POEC	0.23458	-0.17544	0.07384	0.00405	-0.00891	0.16291	0.12319	-0.08305	-0.11676	0.15969	-0.15847	0.17891
PDFOC	0.23783	-0.26777	0.47061	-0.00535	-0.08266	0.08222	-0.02260	-0.14978	-0.05844	0.07738	0.04738	0.24462
POP90	-0.13516	0.25111	-0.16415	0.34450	0.23626	0.06718	0.13294	-0.18855	0.16085	-0.06845	-0.06005	-0.42060
INC90	-0.62442	0.63785	-0.02929	0.22809	0.20347	-0.20520	-0.04336	0.26083	0.23707	-0.26363	0.13081	-0.34932
POV	1.00000	-0.62144	0.06511	-0.03428	-0.10904	0.39867	0.29464	-0.47748	-0.21670	0.38649	-0.24255	0.36448
ED90	-0.62144	1.00000	-0.26497	0.12607	0.17267	-0.22872	-0.02962	0.26331	0.20758	-0.43031	0.12038	-0.44560
POV65	0.06511	-0.26497	1.00000	-0.06273	-0.05724	-0.17422	-0.20261	0.00713	-0.05313	-0.12915	0.26674	0.45790
DENS	-0.03428	0.12607	-0.06273	1.00000	0.15745	0.09629	0.08459	-0.31095	0.17560	-0.02828	-0.05067	-0.20832
LCOAST	-0.10904	0.17267	-0.05724	0.15745	1.00000	0.12345	0.04083	-0.15678	0.13250	0.09401	-0.20033	-0.19520
BLACK	0.39867	-0.22872	-0.17422	0.09629	0.12345	1.00000	-0.14467	-0.46356	-0.08830	0.51129	-0.34707	-0.07538
OTHER	0.29464	0.02962	-0.20261	0.08459	0.04083	-0.14467	1.00000	-0.09761	-0.05079	-0.05156	-0.12398	-0.02770
VEH	-0.47748	0.26331	0.00713	-0.31095	-0.15678	-0.46356	-0.09761	1.00000	-0.19746	-0.32785	0.25527	0.17952
D1	-0.21670	0.20758	-0.05313	0.17560	0.13250	-0.08830	-0.05079	-0.19746	1.00000	-0.24985	-0.18735	-0.23640
D2	0.38649	-0.43031	-0.12915	-0.02828	0.09401	0.51129	-0.05156	-0.32785	-0.24985	1.00000	-0.64427	-0.01630
D3	-0.24255	0.12038	0.26674	-0.05067	-0.20033	-0.34707	-0.12398	0.25527	-0.18735	-0.64427	1.00000	0.10785
BEALE	0.36448	-0.44560	0.45790	-0.20832	-0.19520	-0.07538	-0.02770	0.17952	-0.23640	-0.01630	0.10785	1.00000

Table 3. Regression Estimates

Model: MODEL1
Dependent Variable: PIPD Infectious and Para. Disease

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	13	6.97356	0.53643	38.406	0.0001
Error	3126	43.66200	0.01397		
C Total	3139	50.63557			

Root MSE	0.11818	R-square	0.1377
Dep Mean	0.14353	Adj R-sq	0.1341
C.V.	82.33867		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	0.083396	0.05907203	1.412	0.1581
POP90	1	0.000010441	0.00000957	1.091	0.2752
INC90	1	0.000514	0.00090997	0.565	0.5721
POV	1	0.000335	0.00047229	0.710	0.4776
ED90	1	-0.004634	0.00451288	-1.027	0.3046
POV65	1	0.005826	0.00060865	9.572	0.0001
DENS	1	0.018597	0.00146610	12.685	0.0001
LCOAST	1	0.002210	0.00198569	1.113	0.2658
BLACK	1	0.083434	0.01958230	4.261	0.0001
OTHER	1	0.105083	0.03517275	2.988	0.0028
D1	1	0.029164	0.01071642	2.721	0.0065
D2	1	0.035327	0.00830775	4.252	0.0001
D3	1	-0.003054	0.00763656	-0.400	0.6893
BEALE	1	-0.003294	0.00117439	-2.805	0.0051

Model: MODEL2
Dependent Variable: PNEO Malignant Neoplasms

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	13	692.22785	53.24830	197.823	0.0000
Error	3126	841.43048	0.26917		
C Total	3139	1533.65833			

Root MSE	0.51882	R-square	0.4514
Dep Mean	2.18462	Adj R-sq	0.4491
C.V.	23.74864		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	1.635709	0.25932190	6.308	0.0001
POP90	1	-0.000000221	0.00004200	-0.005	0.9958
INC90	1	0.006809	0.00399471	1.704	0.0884
POV	1	-0.000149	0.00207334	-0.072	0.9427
ED90	1	-0.093492	0.01981120	-4.719	0.0001
POV65	1	0.102967	0.00267193	38.536	0.0001
DENS	1	0.001957	0.00643609	0.304	0.7612
LCOAST	1	0.008954	0.00871704	1.027	0.3044
BLACK	1	0.383549	0.08596488	4.462	0.0001
OTHER	1	-0.655568	0.15440580	-4.246	0.0001
D1	1	0.212171	0.04704431	4.510	0.0001
D2	1	0.075822	0.03647040	2.079	0.0377
D3	1	0.076986	0.03352396	2.296	0.0217
BEALE	1	-0.011155	0.00515548	-2.164	0.0306

Model: MODEL3
Dependent Variable: PIHD Ischemic Heart Disease

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	13	1474.39694	113.41515	195.475	0.0000
Error	3126	1813.71820	0.58020		
C Total	3139	3288.11514			

Root MSE	0.76171	R-square	0.4484
Dep Mean	2.44102	Adj R-sq	0.4461
C.V.	31.20457		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	3.382563	0.38072814	8.884	0.0001
POP90	1	0.000049094	0.00006166	0.796	0.4260
INC90	1	-0.003189	0.00586491	-0.544	0.5867
POV	1	-0.006511	0.00304400	-2.139	0.0325
ED90	1	-0.251347	0.02908617	-8.641	0.0001
POV65	1	0.133766	0.00392285	34.099	0.0001
DENS	1	0.016611	0.00944926	1.758	0.0789
LCOAST	1	-0.044611	0.01279808	-3.486	0.0005
BLACK	1	-0.011089	0.12621089	-0.088	0.9300
OTHER	1	-0.012867	0.22669368	-0.057	0.9547
D1	1	0.584876	0.06906895	8.468	0.0001
D2	1	0.255123	0.05354468	4.765	0.0001
D3	1	0.454278	0.04921880	9.230	0.0001
BEALE	1	-0.016548	0.00756912	-2.186	0.0289

Model: MODEL4
Dependent Variable: POCD Other Cardiovascular Disease

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	13	1351.27720	103.94440	198.602	0.0000
Error	3126	1636.08376	0.52338		
C Total	3139	2987.36096			

Root MSE	0.72345	R-square	0.4523
Dep Mean	2.31937	Adj R-sq	0.4501
C.V.	31.19165		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	0.183694	0.36160368	0.508	0.6115
POP90	1	-0.000003296	0.00005857	-0.056	0.9551
INC90	1	-0.004917	0.00557031	-0.883	0.3775
POV	1	0.005085	0.00289110	1.759	0.0787
ED90	1	-0.023860	0.02762513	-0.864	0.3878
POV65	1	0.136137	0.00372580	36.539	0.0001
DENS	1	-0.007517	0.00897461	-0.838	0.4024
LCOAST	1	-0.061580	0.01215522	-5.066	0.0001
BLACK	1	1.407277	0.11987115	11.740	0.0001
OTHER	1	-0.158628	0.21530656	-0.737	0.4613
D1	1	0.257243	0.06559953	3.921	0.0001
D2	1	0.245581	0.05085506	4.829	0.0001
D3	1	0.259779	0.04674648	5.557	0.0001
BEALE	1	0.010518	0.00718891	1.463	0.1436

Model: MODEL5
Dependent Variable: PIPN Influenza and Pneumonia

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	13	55.90510	4.30039	64.270	0.0001
Error	3126	209.16495	0.06691		
C Total	3139	265.07005			

Root MSE	0.25867	R-square	0.2109
Dep Mean	0.40001	Adj R-sq	0.2076
C.V.	64.66625		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	0.115306	0.12929286	0.892	0.3726
POP90	1	0.000009979	0.00002094	0.477	0.6337
INC90	1	0.002537	0.00199169	1.274	0.2029
POV	1	0.001333	0.00103372	1.289	0.1973
ED90	1	-0.014077	0.00987748	-1.425	0.1542
POV65	1	0.025874	0.00133217	19.422	0.0001
DENS	1	0.006135	0.00320891	1.912	0.0560
LCOAST	1	-0.019032	0.00434615	-4.379	0.0001
BLACK	1	-0.128897	0.04286042	-3.007	0.0027
OTHER	1	-0.075434	0.07698373	-0.980	0.3272
D1	1	-0.017154	0.02345538	-0.731	0.4646
D2	1	-0.009565	0.01818343	-0.526	0.5989
D3	1	0.019175	0.01671439	1.147	0.2514
BEALE	1	0.003913	0.00257042	1.522	0.1280

Model: MODEL6
Dependent Variable: PBEA Bronchitis, Emphysema, Asthma

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	13	27.75880	2.13529	41.435	0.0001
Error	3126	161.09253	0.05153		
C Total	3139	188.85133			

Root MSE	0.22701	R-square	0.1470
Dep Mean	0.40592	Adj R-sq	0.1434
C.V.	55.92461		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	0.364862	0.11346653	3.216	0.0013
POP90	1	0.000001319	0.00001838	0.072	0.9428
INC90	1	-0.000728	0.00174789	-0.417	0.6770
POV	1	0.002452	0.00090719	2.703	0.0069
ED90	1	-0.011350	0.00866841	-1.309	0.1905
POV65	1	0.016935	0.00116911	14.485	0.0001
DENS	1	-0.000463	0.00281612	-0.164	0.8695
LCOAST	1	-0.001300	0.00381415	-0.341	0.7332
BLACK	1	-0.193690	0.03761401	-5.149	0.0001
OTHER	1	-0.332335	0.06756040	-4.919	0.0001
D1	1	-0.072653	0.02058428	-3.530	0.0004
D2	1	-0.098435	0.01595766	-6.168	0.0001
D3	1	-0.098785	0.01466844	-6.735	0.0001
BEALE	1	0.001291	0.00225579	0.572	0.5670

Model: MODEL7
Dependent Variable: PCLI Cirrosis of the Liver

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	13	2.37599	0.18277	18.100	0.0001
Error	3126	31.56532	0.01010		
C Total	3139	33.94131			

Root MSE	0.10049	R-square	0.0700
Dep Mean	0.09191	Adj R-sq	0.0661
C.V.	109.33585		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	0.226764	0.05022676	4.515	0.0001
POP90	1	-0.000005915	0.00000813	-0.727	0.4672
INC90	1	0.003007	0.00077372	3.886	0.0001
POV	1	-0.000816	0.00040157	-2.032	0.0422
ED90	1	-0.016800	0.00383713	-4.378	0.0001
POV65	1	0.003159	0.00051751	6.104	0.0001
DENS	1	0.000778	0.00124657	0.624	0.5324
LCOAST	1	0.002035	0.00168836	1.206	0.2281
BLACK	1	0.091571	0.01665011	5.500	0.0001
OTHER	1	0.280017	0.02990609	9.363	0.0001
D1	1	-0.010188	0.00911178	-1.118	0.2636
D2	1	-0.032582	0.00706377	-4.613	0.0001
D3	1	-0.042024	0.00649309	-6.472	0.0001
BEALE	1	-0.000631	0.00099854	-0.632	0.5276

Model: MODEL8
Dependent Variable: PMVA Motor Vehicle Accidents

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	14	14.19128	1.01366	28.802	0.0001
Error	3125	109.98128	0.03519		
C Total	3139	124.17256			

Root MSE	0.18760	R-square	0.1143
Dep Mean	0.28306	Adj R-sq	0.1103
C.V.	66.27557		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	1.004573	0.10829094	9.277	0.0001
POP90	1	-0.000032884	0.00001525	-2.156	0.0312
INC90	1	-0.003187	0.00147521	-2.161	0.0308
POV	1	-0.003502	0.00081031	-4.322	0.0001
ED90	1	-0.048627	0.00717177	-6.780	0.0001
POV65	1	0.000400	0.00098666	0.405	0.6854
DENS	1	-0.003089	0.00240612	-1.284	0.1993
LCOAST	1	-0.005712	0.00318173	-1.795	0.0727
BLACK	1	0.145279	0.03177139	4.573	0.0001
OTHER	1	0.342937	0.05585499	6.140	0.0001
VEH	1	-0.040593	0.02559392	-1.586	0.1128
D1	1	-0.066774	0.01851172	-3.607	0.0003
D2	1	-0.038505	0.01348101	-2.856	0.0043
D3	1	-0.078979	0.01235911	-6.390	0.0001
BEALE	1	0.010153	0.00196628	5.163	0.0001

Model: MODEL9
Dependent Variable: POEC Other External Causes

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	13	27.41196	2.10861	30.810	0.0001
Error	3126	213.94251	0.06844		
C Total	3139	241.35447			

Root MSE	0.26161	R-square	0.1136
Dep Mean	0.46063	Adj R-sq	0.1099
C.V.	56.79369		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	0.531538	0.13076112	4.065	0.0001
POP90	1	-0.000009124	0.00002118	-0.431	0.6666
INC90	1	0.003667	0.00201430	1.820	0.0688
POV	1	0.000559	0.00104546	0.535	0.5930
ED90	1	-0.023106	0.00998965	-2.313	0.0208
POV65	1	0.005907	0.00134730	4.384	0.0001
DENS	1	0.003920	0.00324535	1.208	0.2271
LCOAST	1	-0.004549	0.00439550	-1.035	0.3008
BLACK	1	0.300792	0.04334714	6.939	0.0001
OTHER	1	0.484901	0.07785796	6.228	0.0001
D1	1	-0.129357	0.02372174	-5.453	0.0001
D2	1	-0.048050	0.01838992	-2.613	0.0090
D3	1	-0.119830	0.01690420	-7.089	0.0001
BEALE	1	0.013414	0.00259961	5.160	0.0001

Model: MODEL10
Dependent Variable: PDFOC All Other Causes

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	13	381.32123	29.33240	94.729	0.0001
Error	3126	967.94871	0.30964		
C Total	3139	1349.26995			

Root MSE	0.55646	R-square	0.2826
Dep Mean	1.53437	Adj R-sq	0.2796
C.V.	36.26611		

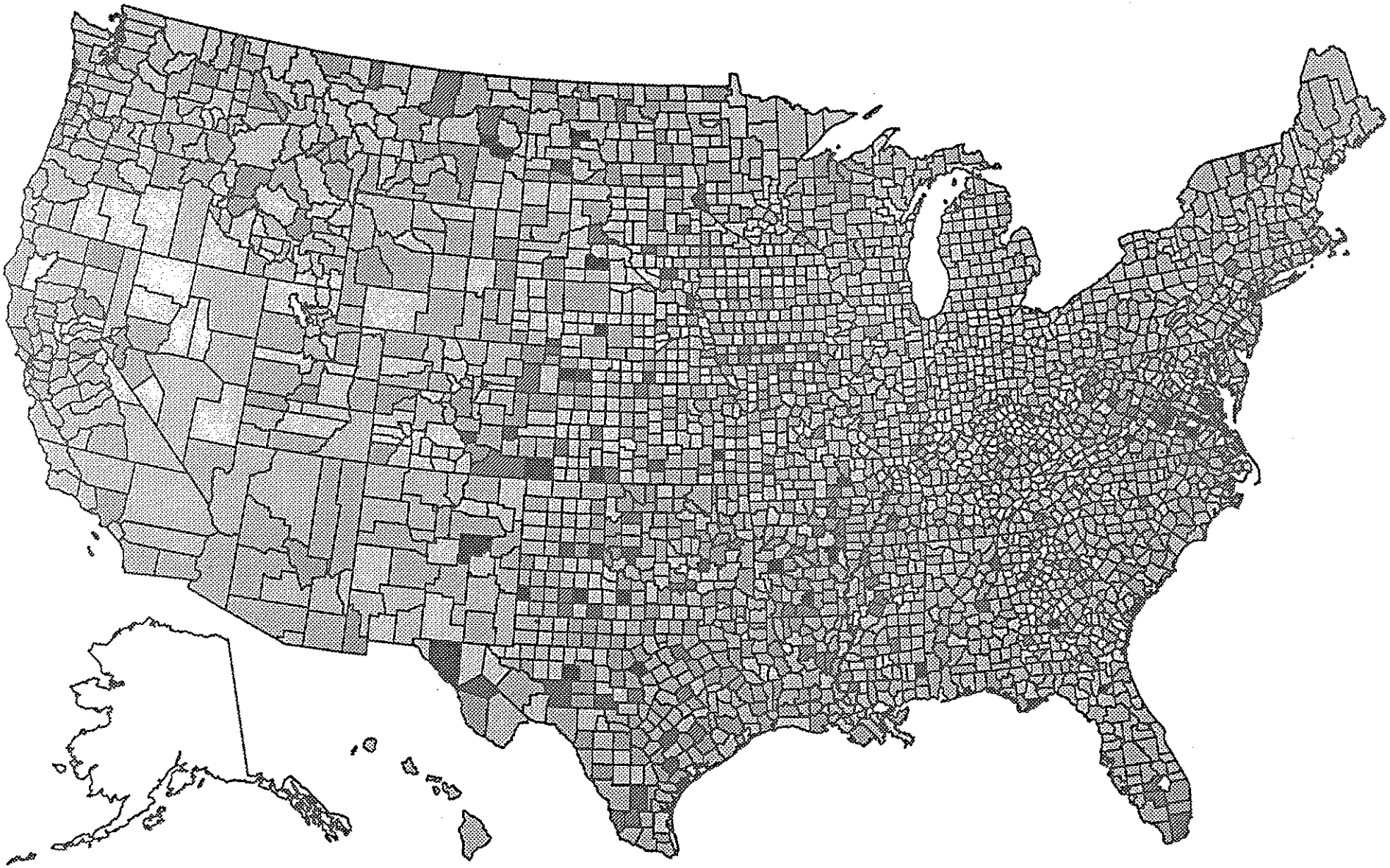
Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	0.452883	0.27813539	1.628	0.1036
POP90	1	-0.000064481	0.00004505	-1.431	0.1524
INC90	1	0.002765	0.00428453	0.645	0.5188
POV	1	0.009576	0.00222375	4.306	0.0001
ED90	1	-0.027269	0.02124847	-1.283	0.1995
POV65	1	0.076634	0.00286578	26.741	0.0001
DENS	1	0.007967	0.00690302	1.154	0.2485
LCOAST	1	-0.037752	0.00934945	-4.038	0.0001
BLACK	1	0.532794	0.09220152	5.779	0.0001
OTHER	1	0.720556	0.16560776	4.351	0.0001
D1	1	0.091616	0.05045731	1.816	0.0695
D2	1	0.089760	0.03911628	2.295	0.0218
D3	1	0.050993	0.03595608	1.418	0.1562
BEALE	1	-0.011190	0.00552951	-2.024	0.0431

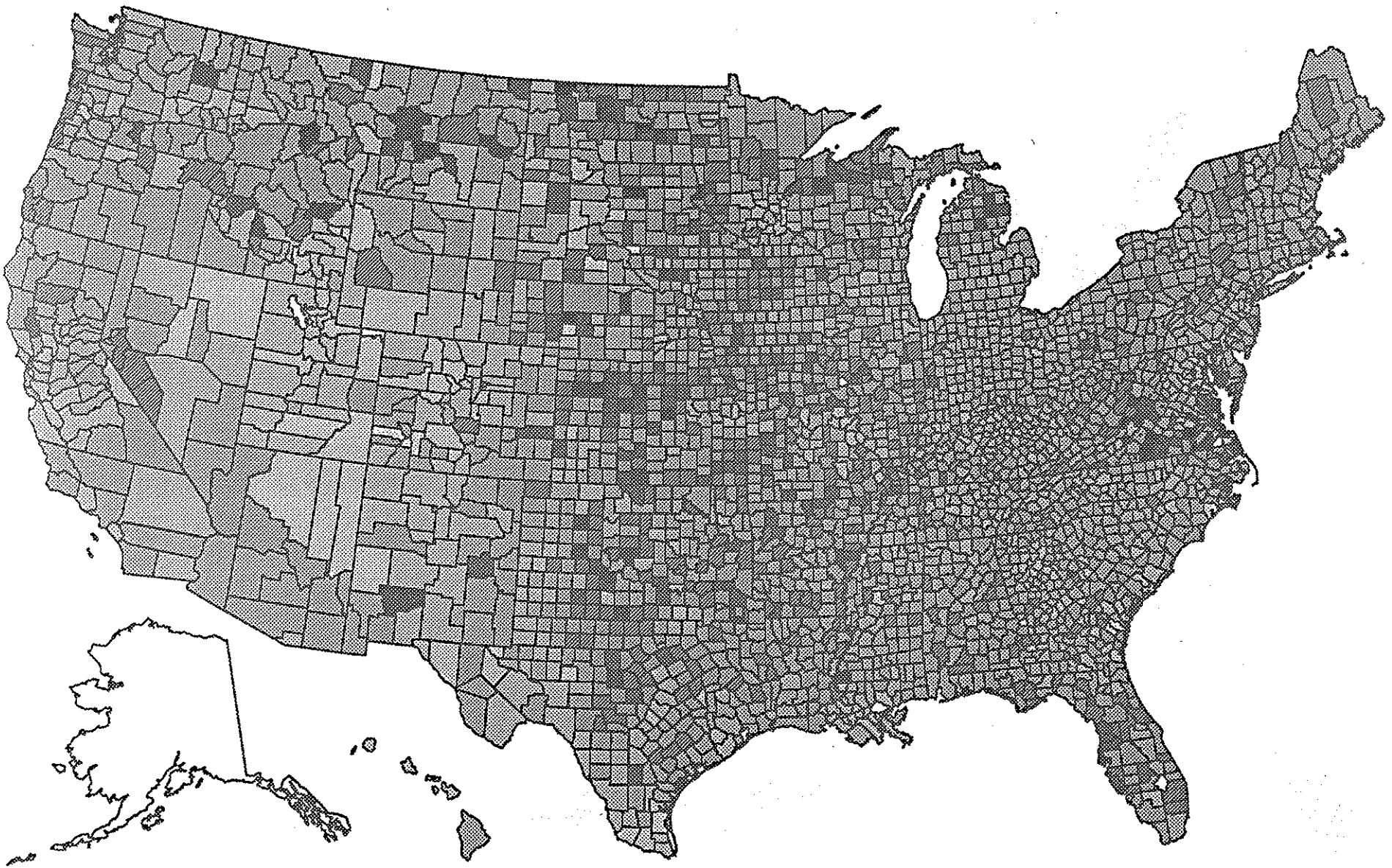
Table 4. Important Factors for Each Cause of Death

Infectious and Para. Disease	DENS, POV65, BLACK, D2, BEALE, OTHER
Malignant Neoplasms	POV65, ED90, BLACK, OTHER, D1, D3, BEALE D2
Ischemic Heart Disease	POV65, D3, ED90, D1, D2. BEALE POV
Other Cardiovascular Disease	POV65, BLACK LCOAST D3, D2, D1
Influenza and Pneumonia	POV65, LCOAST, BLACK
Bronchitis, Emphysema, Asthma	POV65, D3, D2, BLACK, OTHER
Cirrhosis of the Liver	OTHER, D3, POV65, BLACK, ED90, D2, ED90, INC90, POV(-)
Motor Vehicle Accidents	ED90, D3 OTHER BLACK, POV, D1, D2, INC90 POP90(-)
Other External Causes	D3, BLACK, OTHER, BEALE, D1 POV65, D2, ED90
All Other Causes	POV65, BLACK OTHER, POV, BEALE

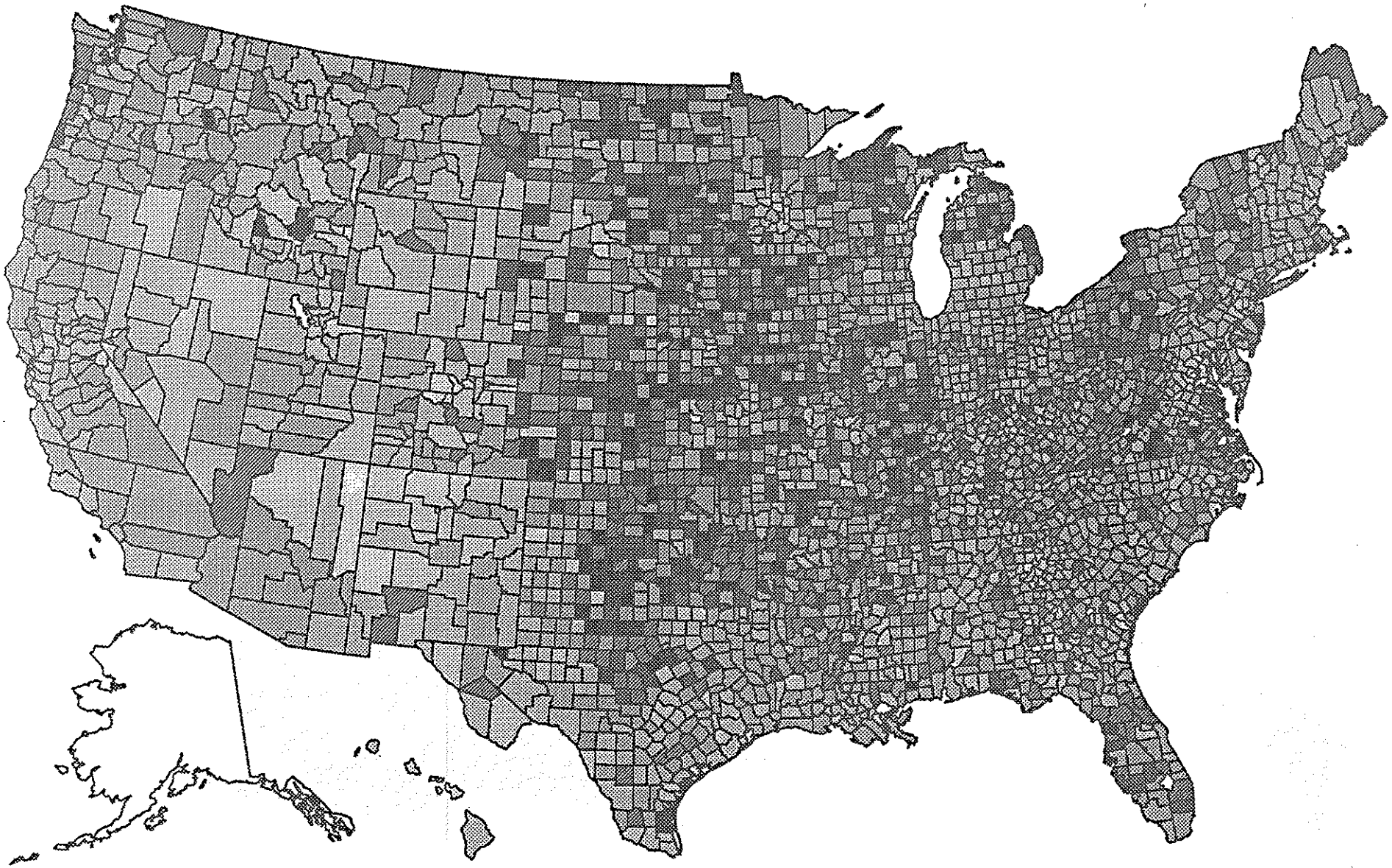
Death rates from Infectious and Para Disease, 1988



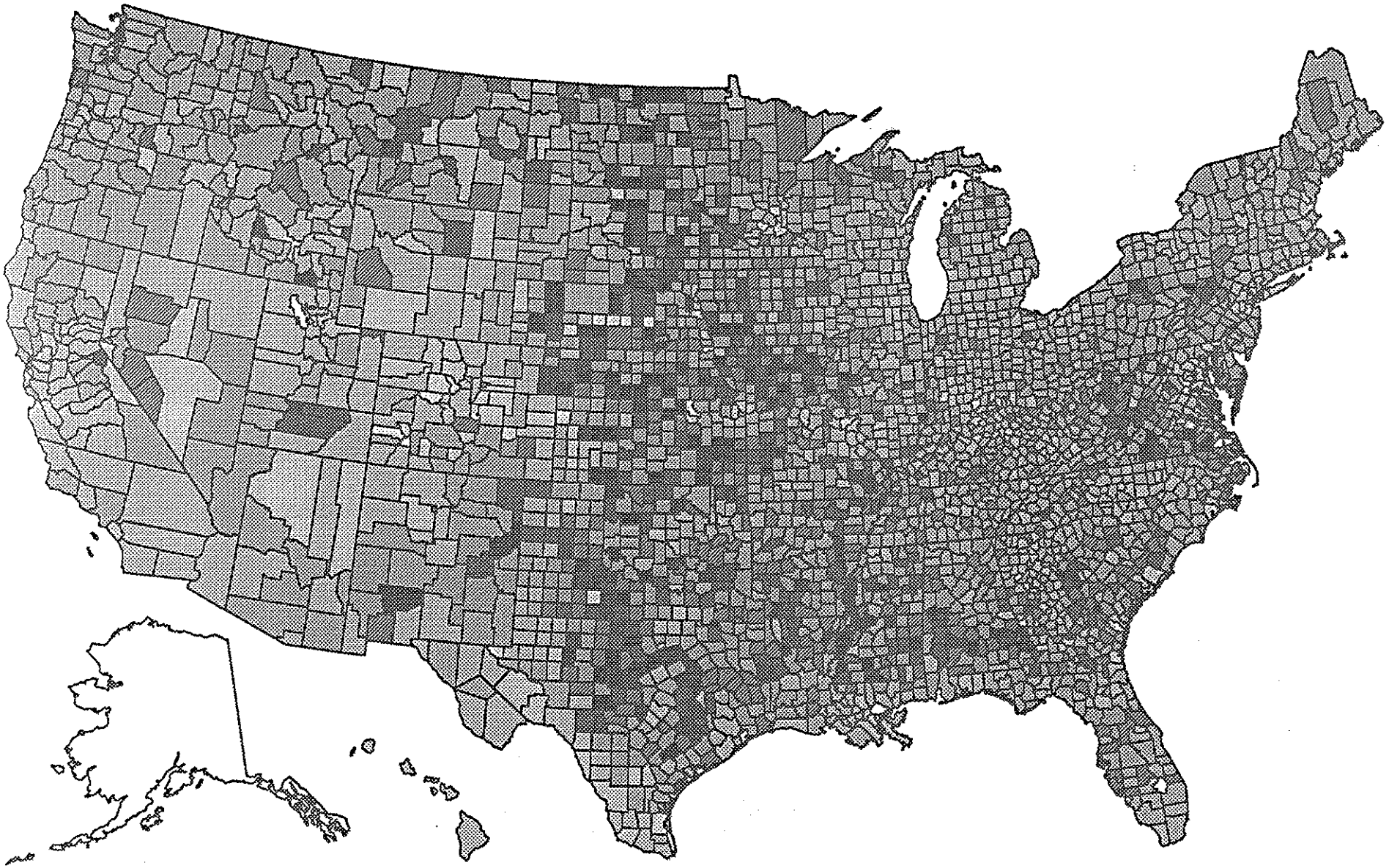
Death rates from Malignant Neoplasms, 1988



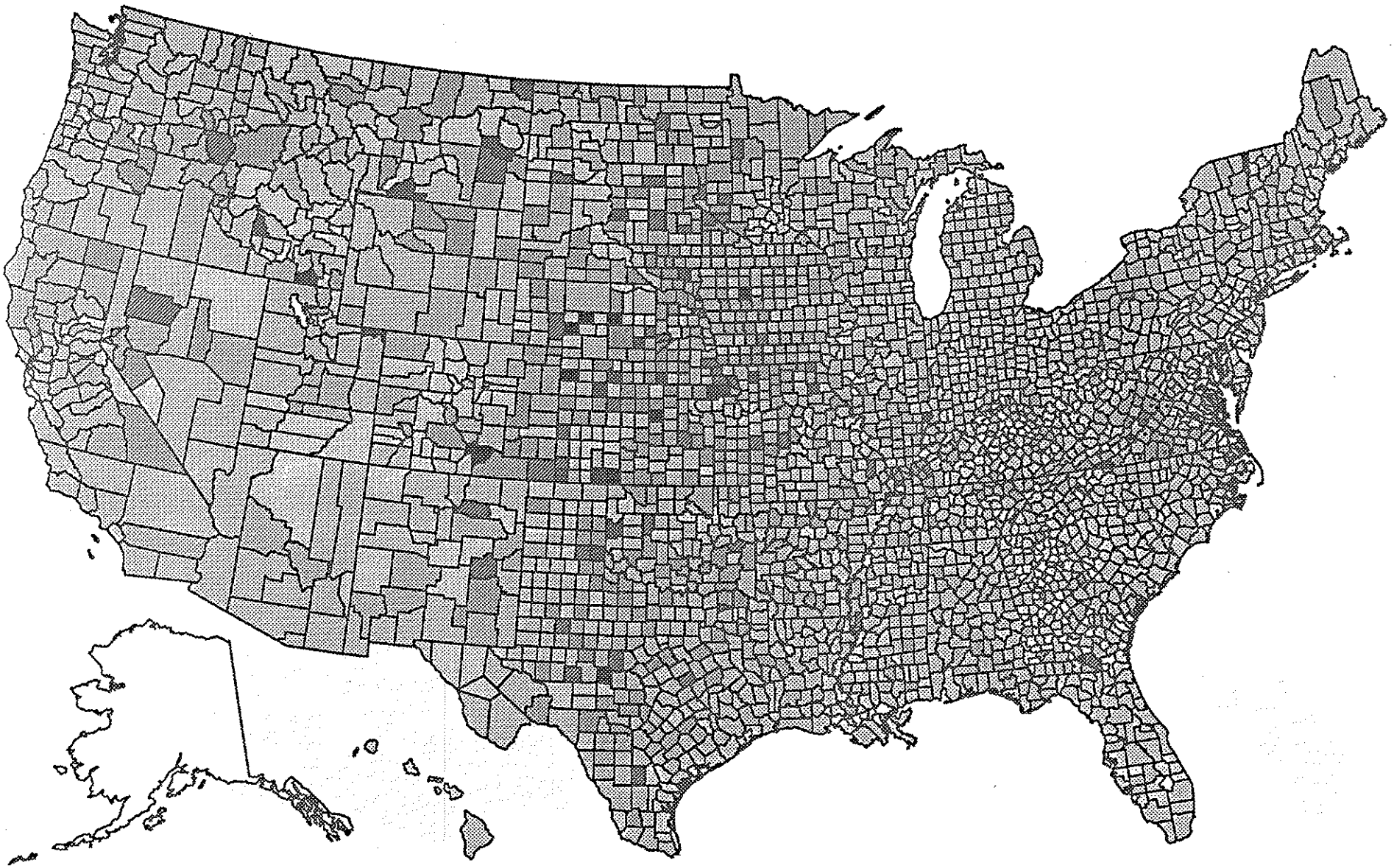
Death rates from Ischemic Heart Disease, 1988



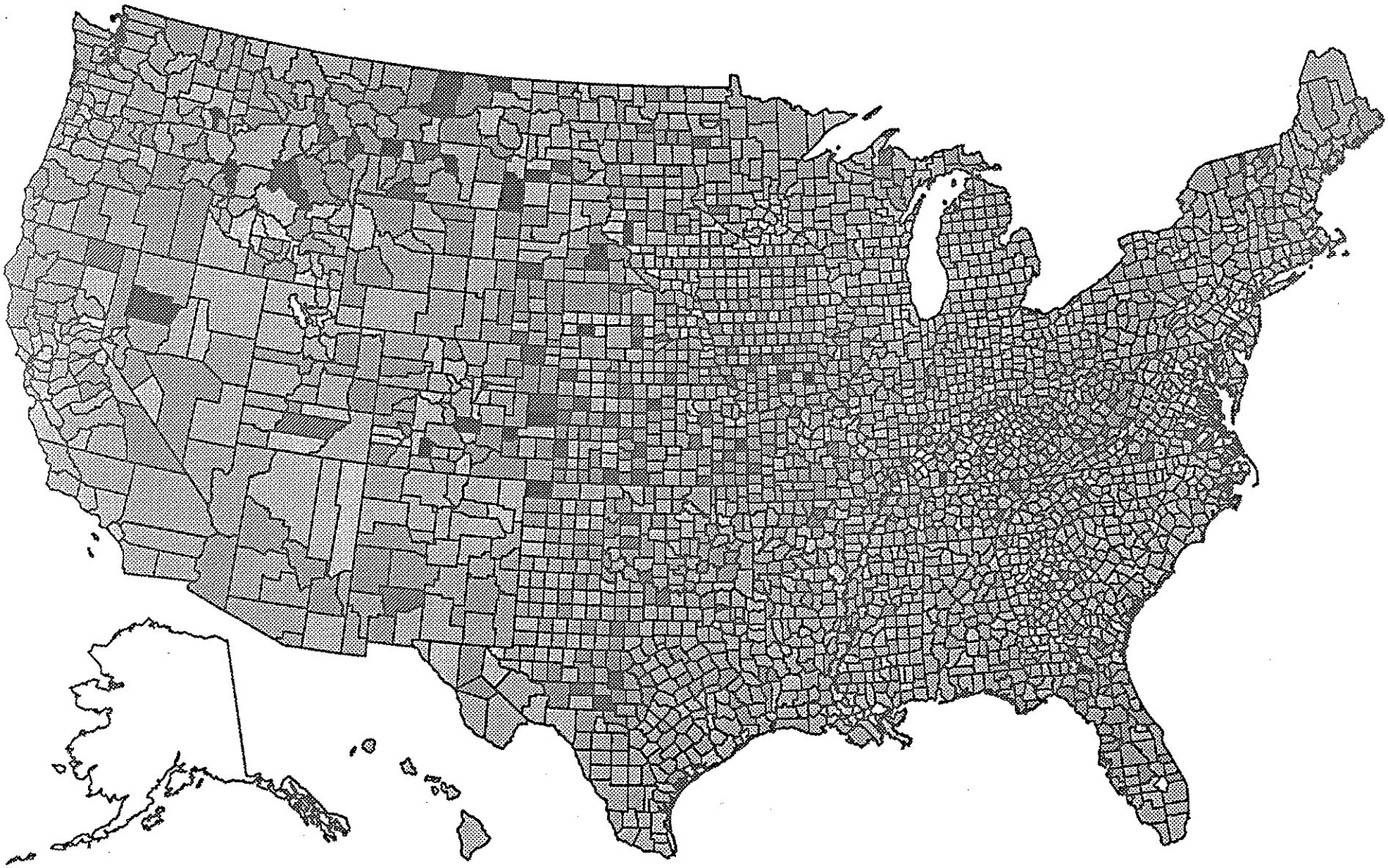
Death rates from Other Cariovascular Disease, 1988



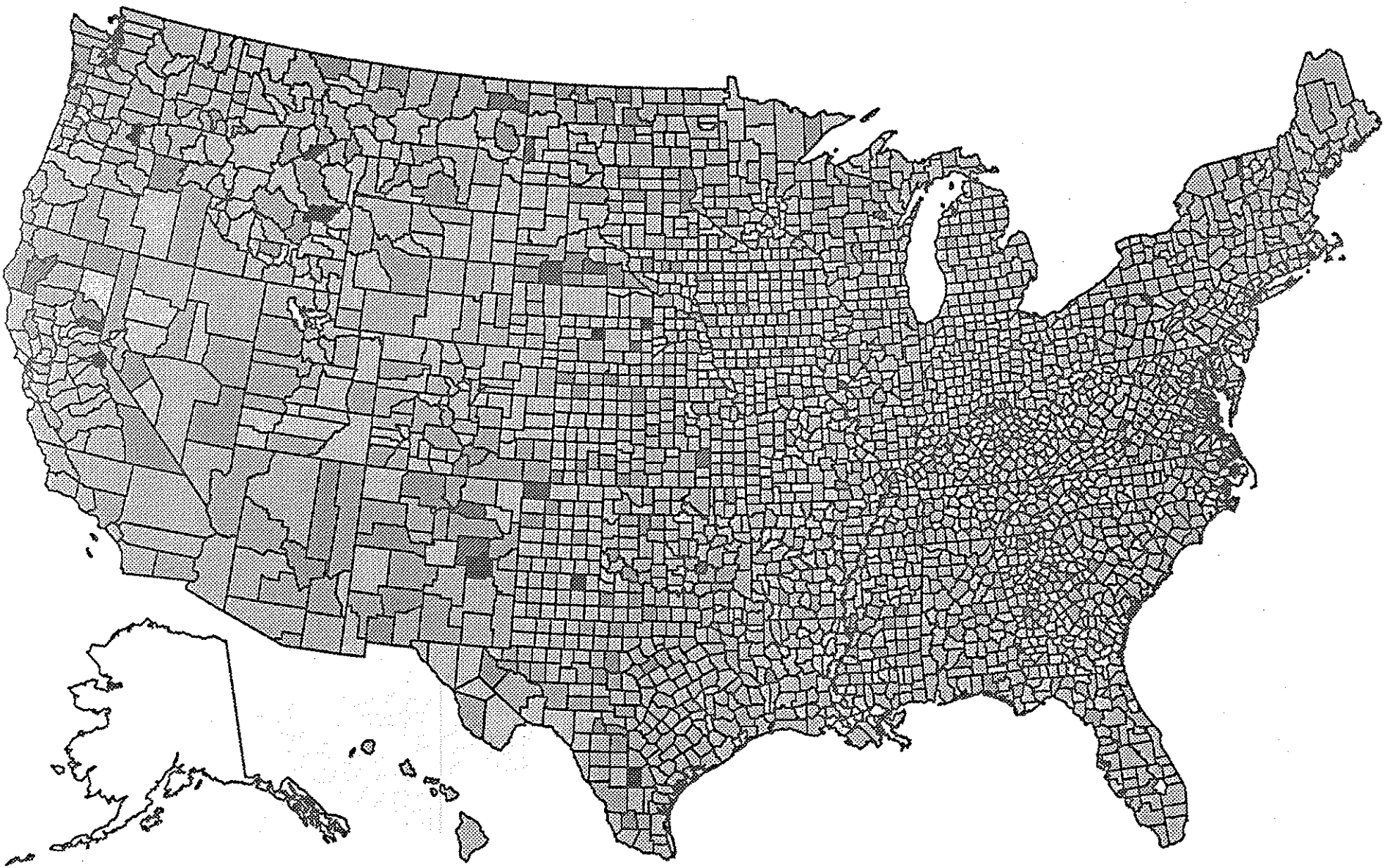
Death rates from Influenza and Pneumonia, 1988



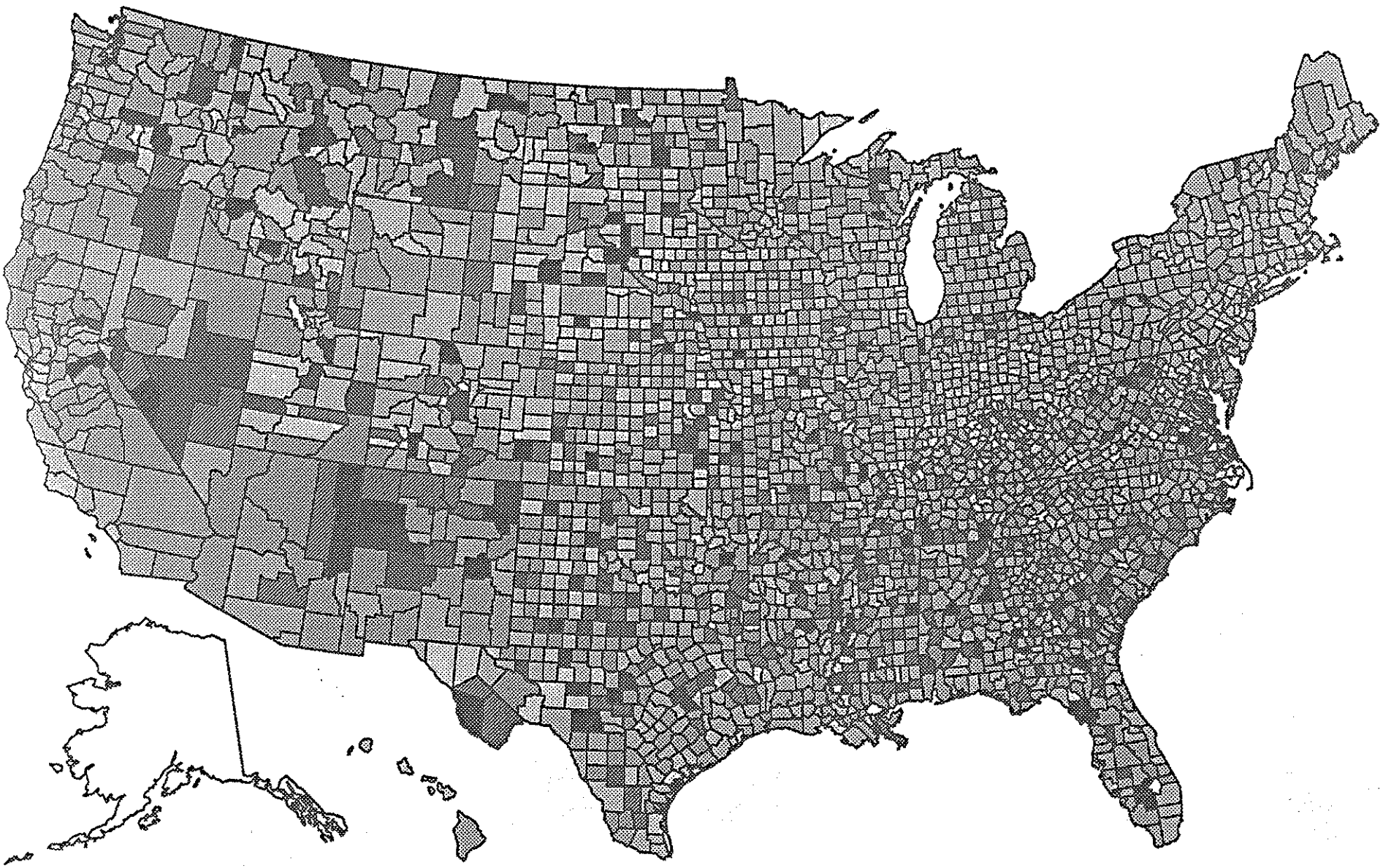
Death rates from Bronchitis, Emphysema, Asthma, 1988



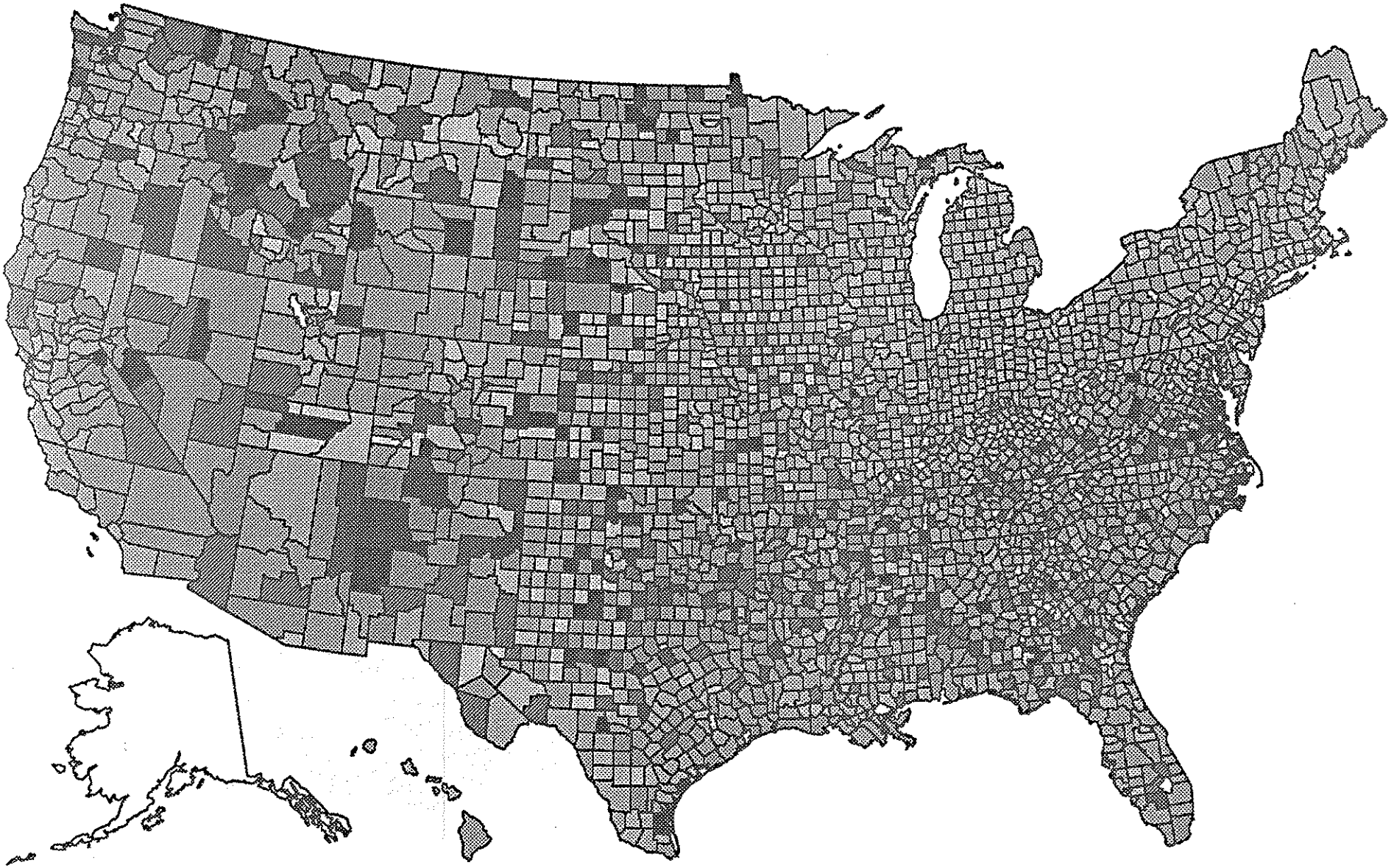
Death rates from Cirrosis of the Liver, 1988



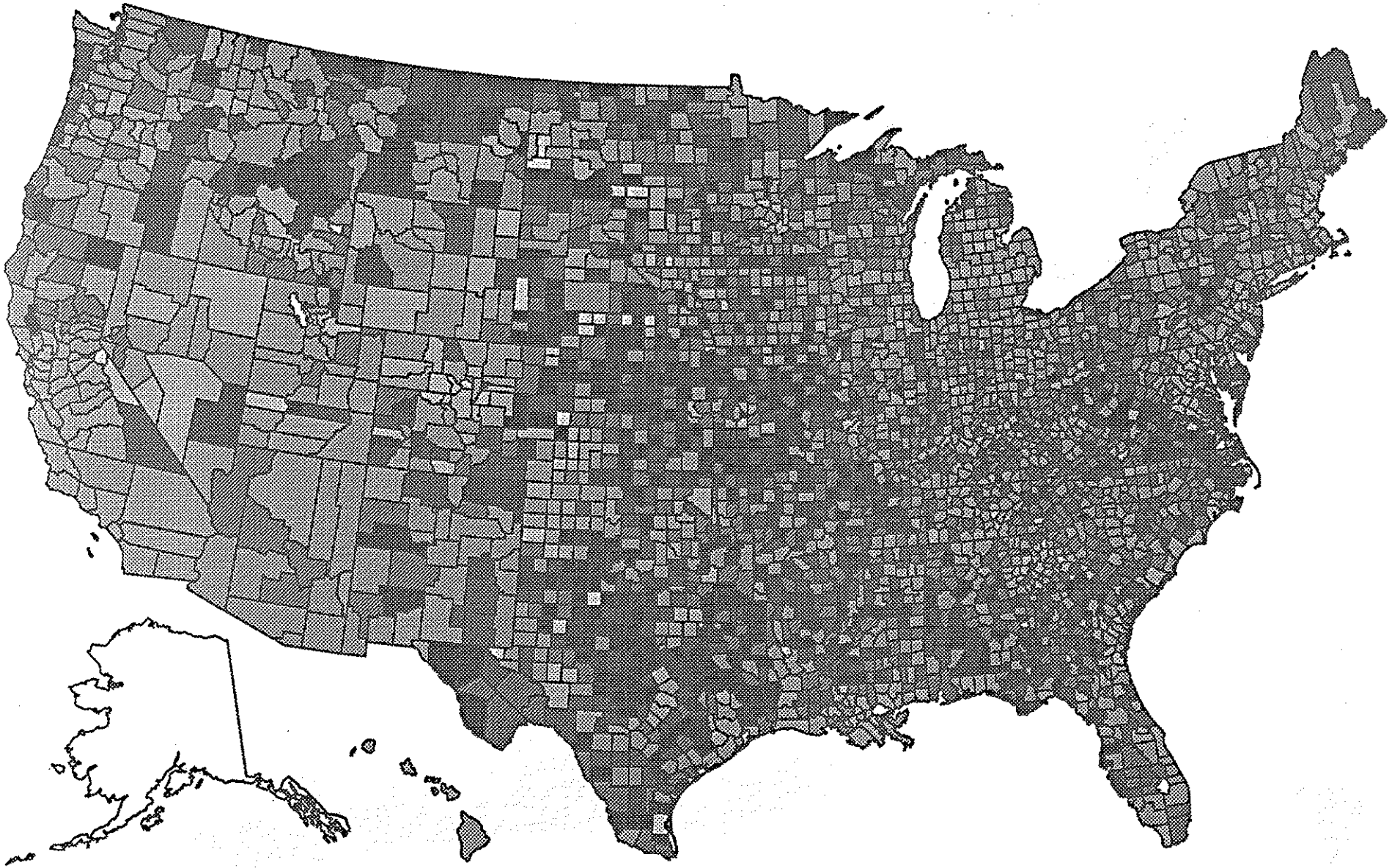
Death rates from Motor Vehicle Accidents, 1988



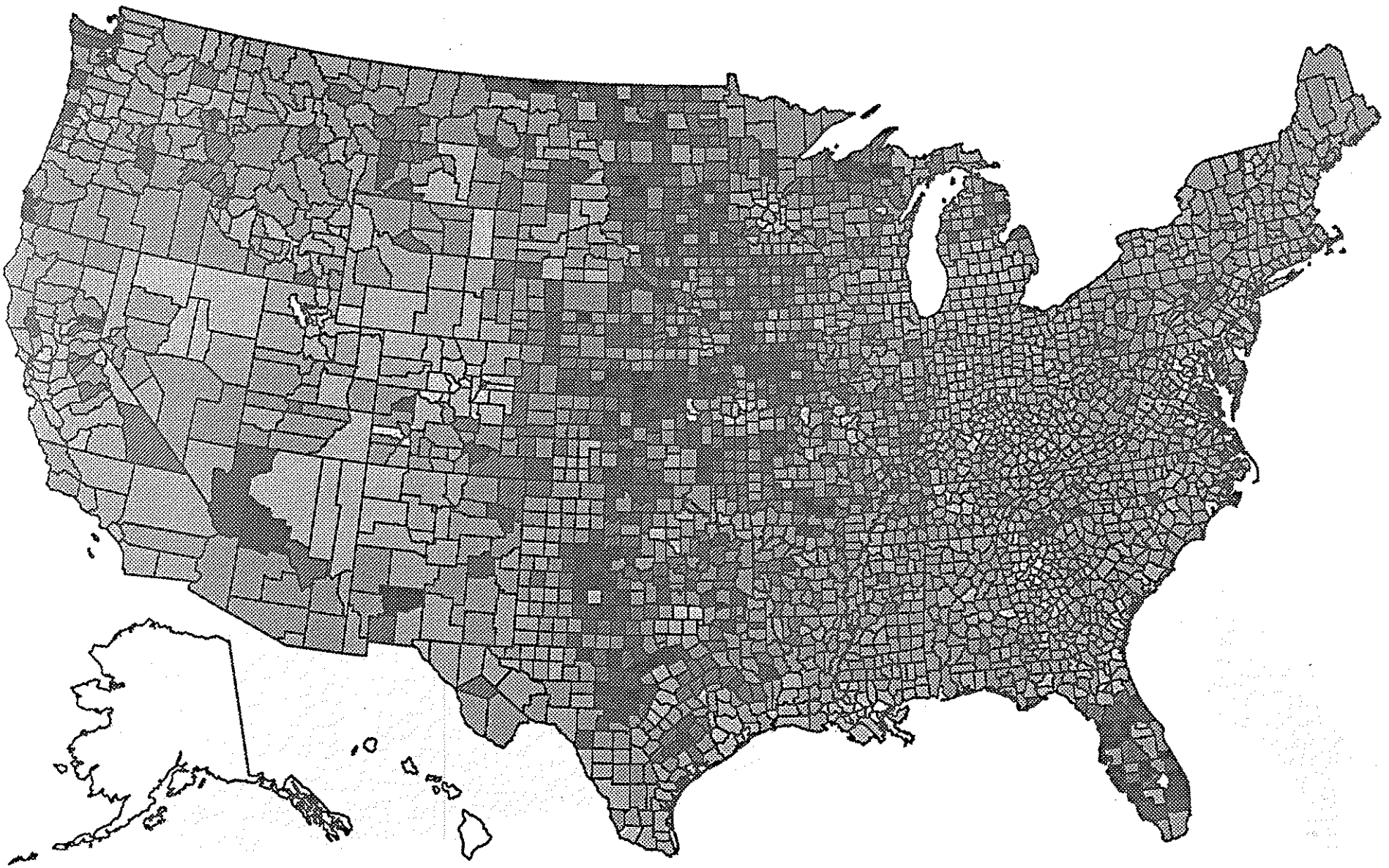
Death rates from Other External Causes, 1988



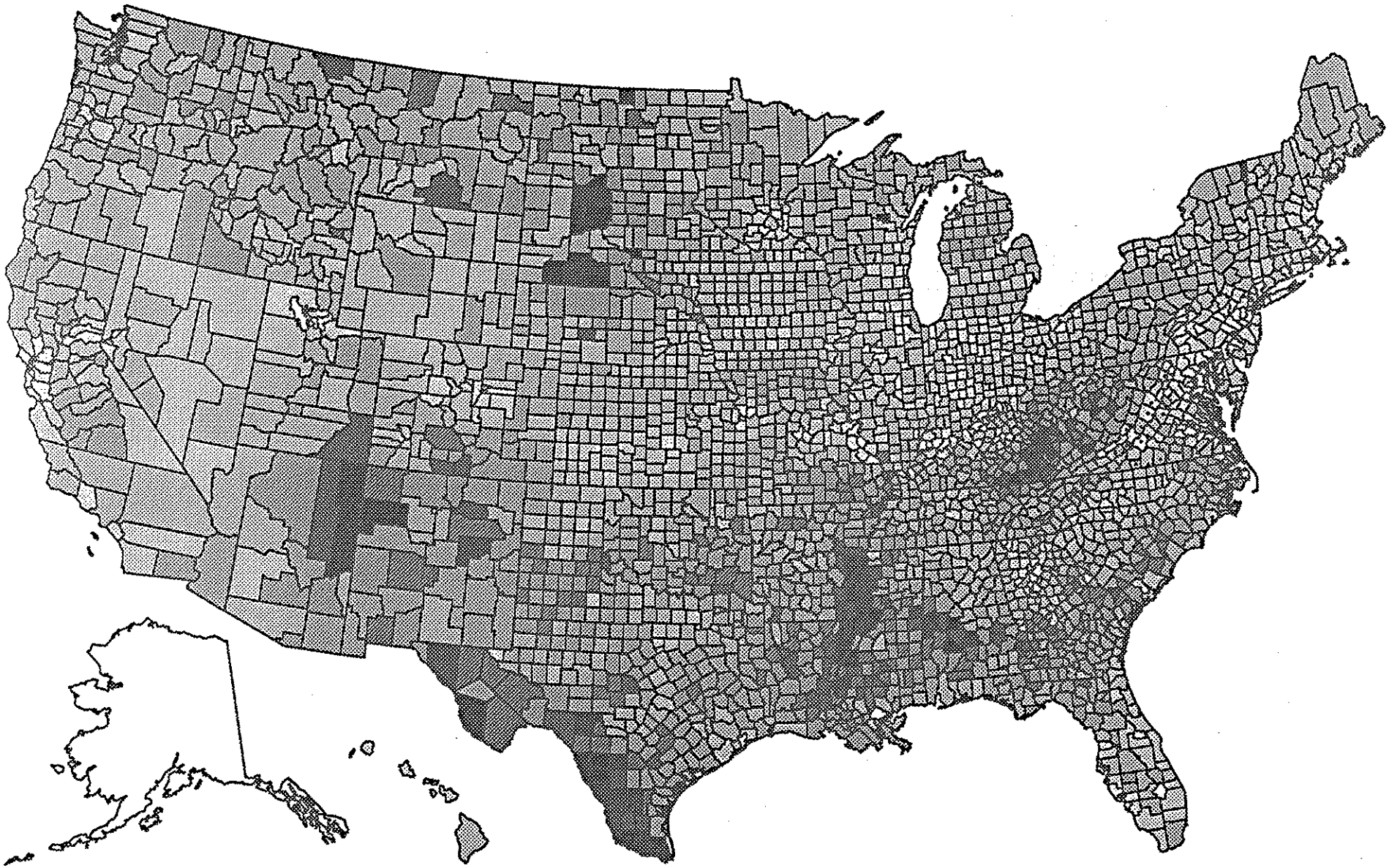
Deaths From All Other Causes, 1988



Percent Over 65, 1990

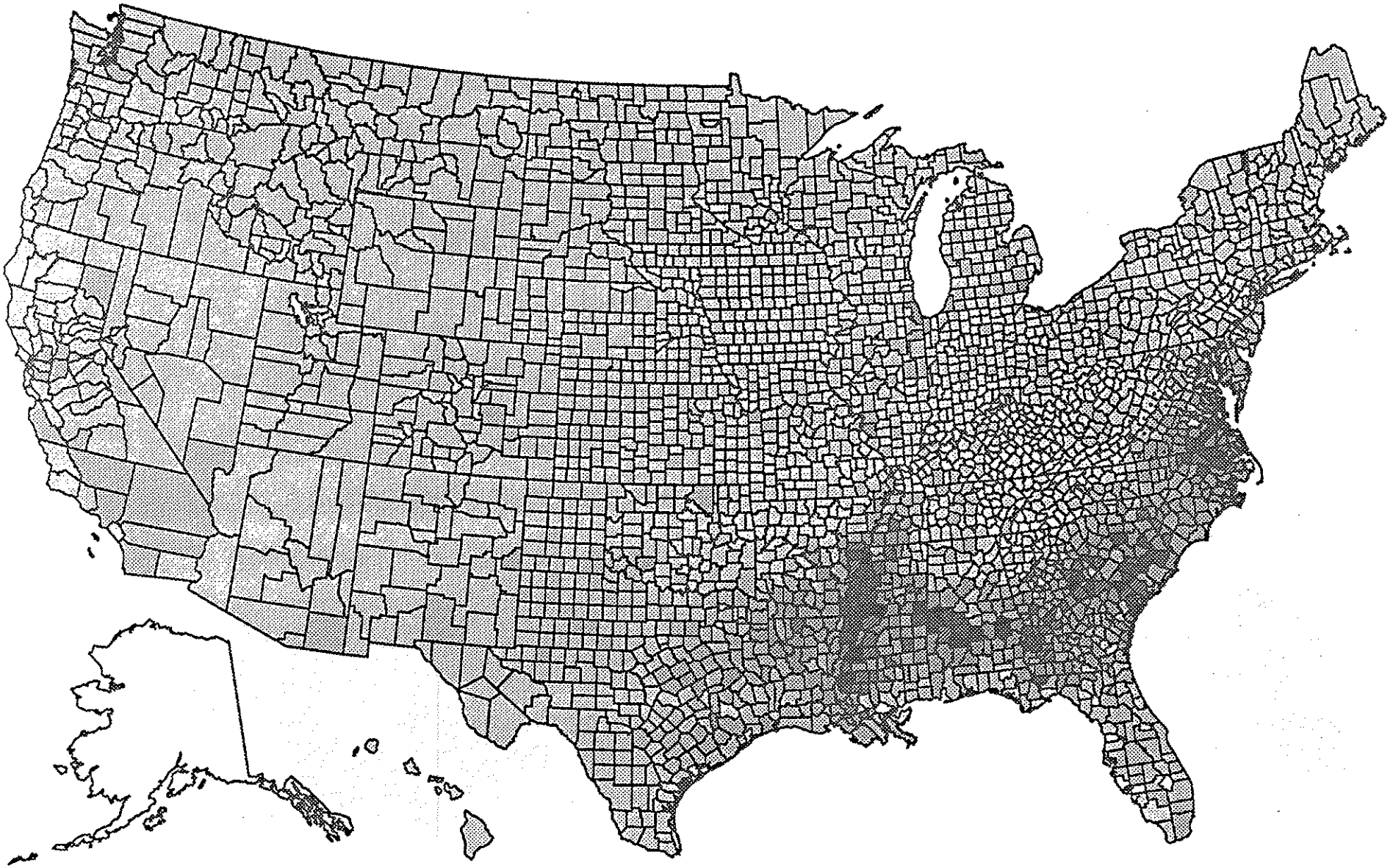


Percent in Poverty, 1990

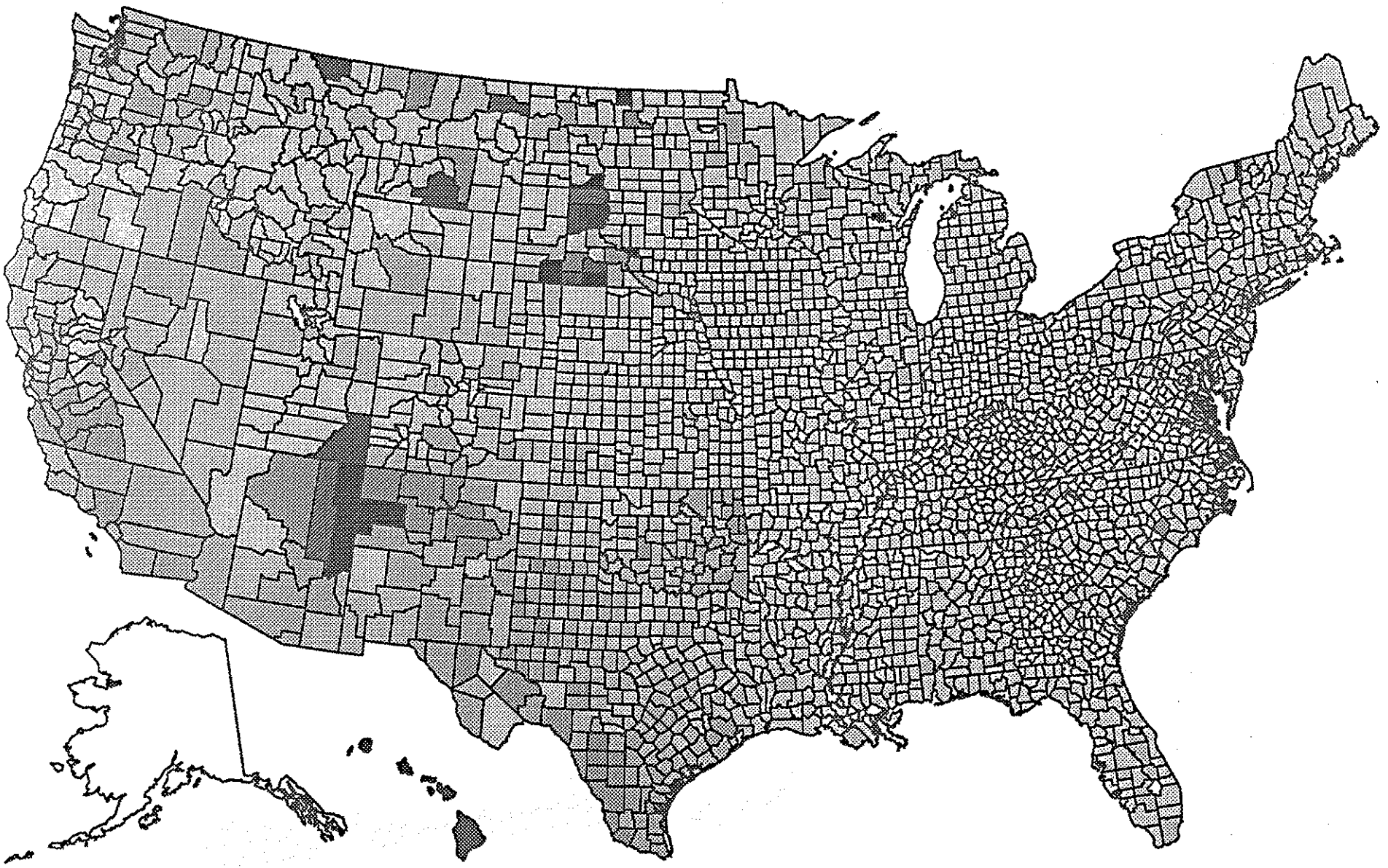


Legend values are midpoints within the range

Percent Black Population, 1990

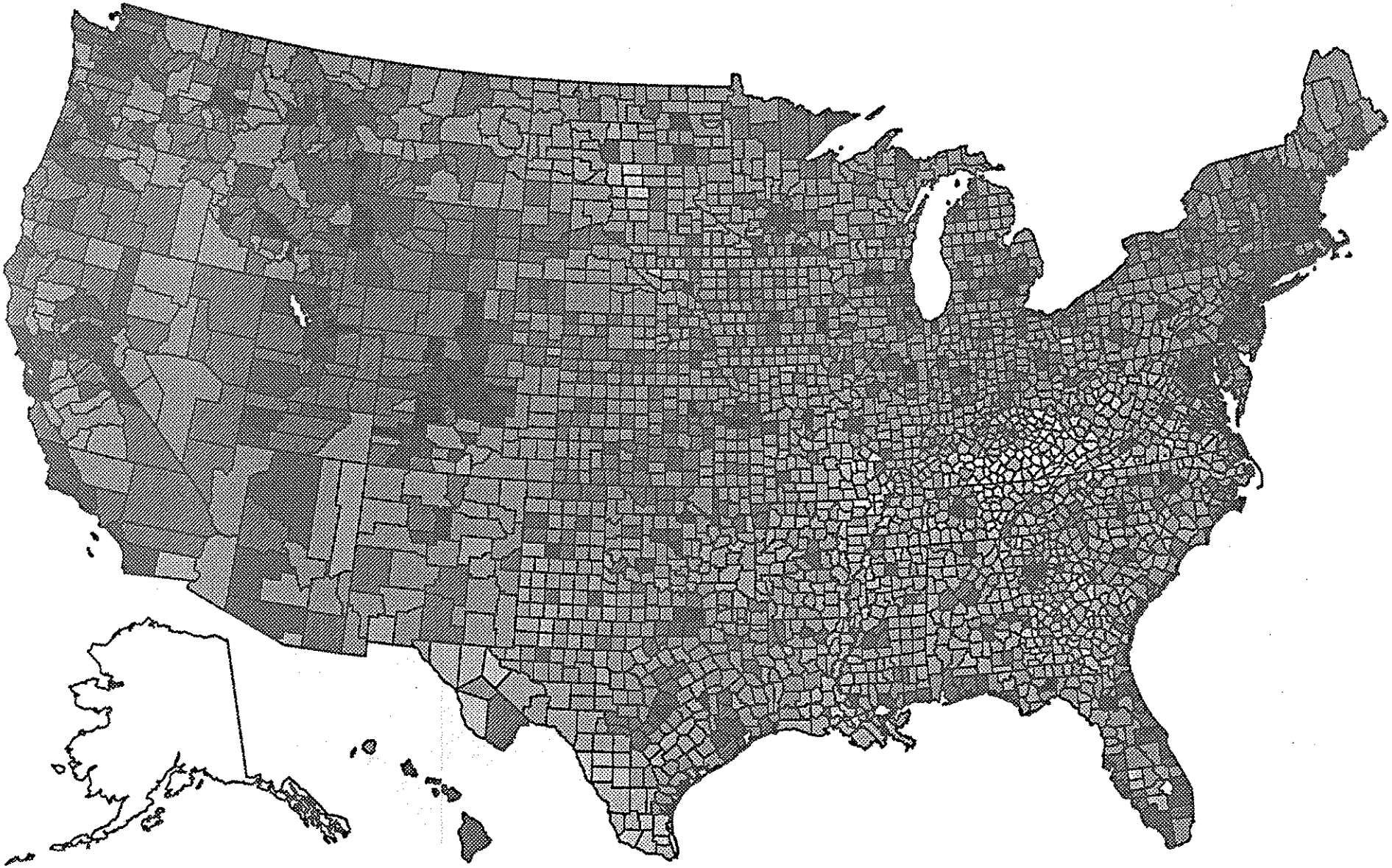


Percent Other Non-White, 1990

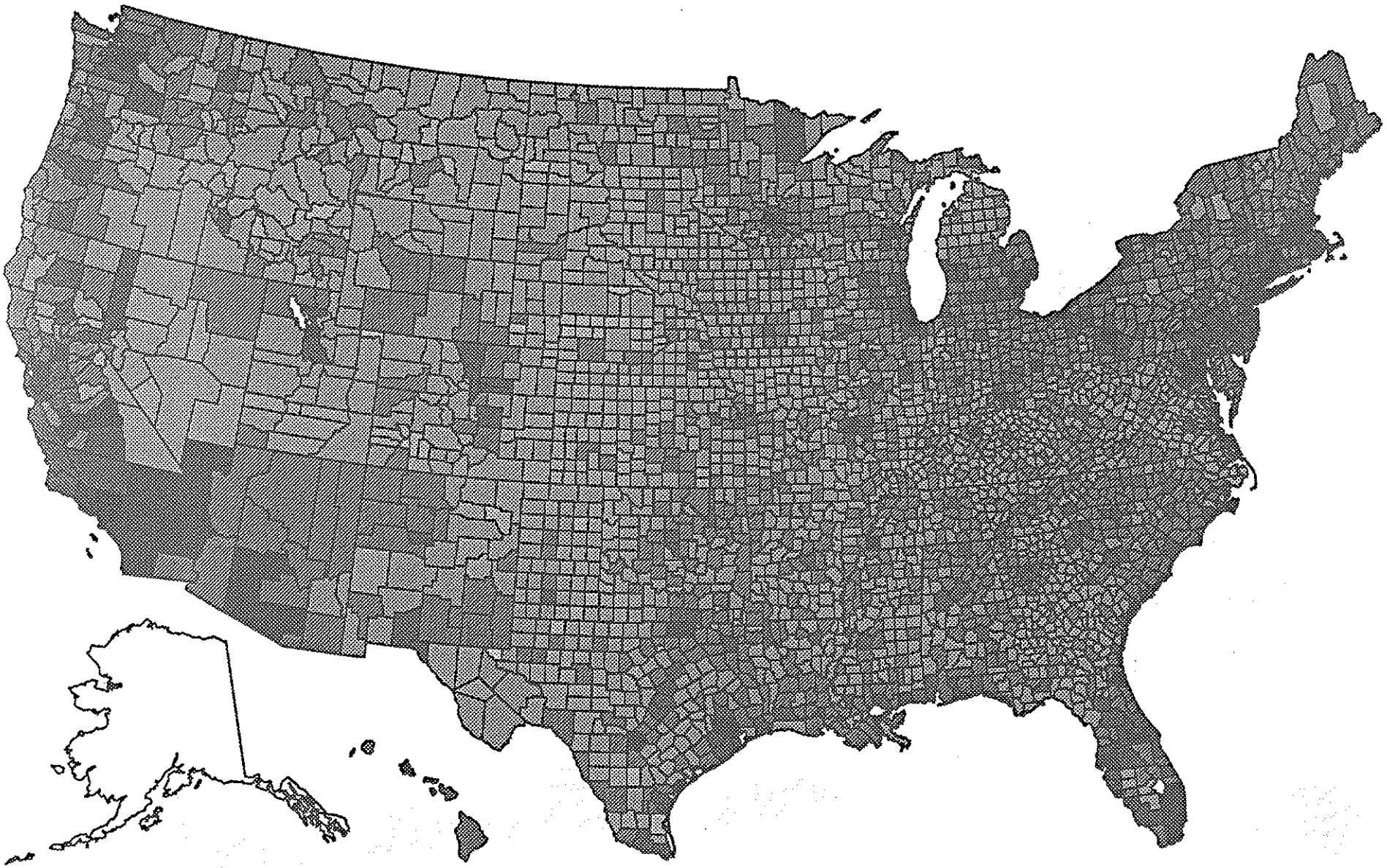
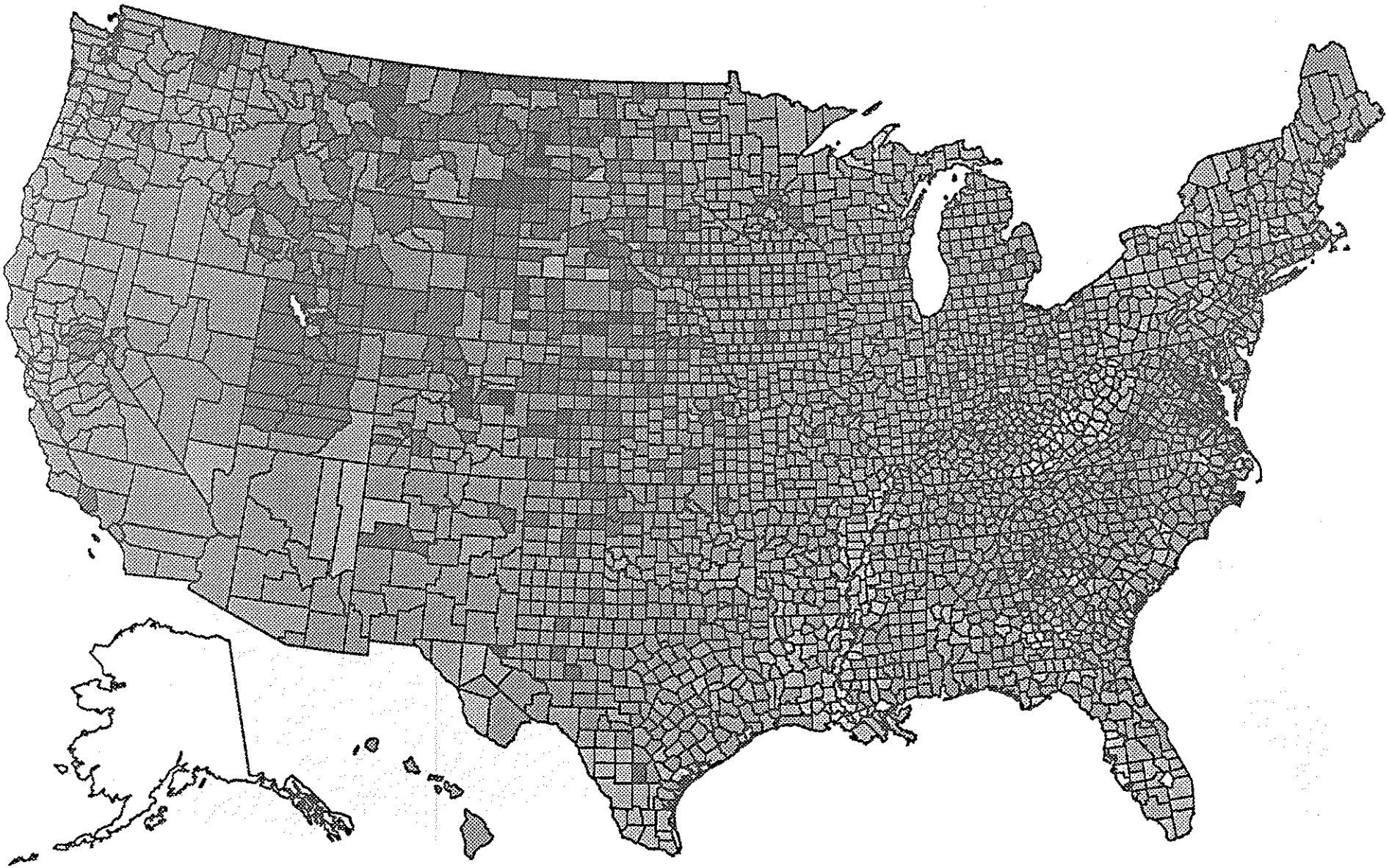


Legend values are midpoints within the range

Calculated County–Level Educational Attainment



Log of County-Level Population, 1990



Vehicles Per Household