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HURRICANE EXPERIENCE LEVELS OF COASTAL COUNTY POPULATIONS
FROM TEXAS TO MAINE

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ABSTRACT

Population graphs for the period 1900-1970 have been prepared for coastal counties from Texas to Maine which could be affected significantly by hurricane winds and/or tides. The Saffir/Simpson Hurricane Scale¹ (range 1-5) has been used to develop a hurricane climatology for each county for the period 1900-1974. The combined statistics graphically illustrate that over 75 percent of all Atlantic and Gulf coastal residents of the United States have never experienced the effects of a direct hit by a major² hurricane.

INTRODUCTION

A series of hurricane workshops was conducted during the Spring of 1974 by Dr. Neil Frank, Director, National Hurricane Center (NHC), and his staff. The basic purpose of these workshops was to exchange ideas and information with National Weather Service officials representing all Gulf and Atlantic coastal stations and to discuss operational hurricane problems. Some of the materials prepared for the workshops are the basis for this paper.

Population statistics indicate a trend in recent years of rapid population increases along Atlantic and Gulf coastal areas. This trend, along with the relatively low frequency of hurricanes and low hurricane experience level of several million coastal residents, has become an item of major concern at the National Hurricane Center.

¹ See Table 1 and Appendix A .

² A major hurricane is in category 3, 4 or 5 on the Saffir/Simpson Hurricane Scale, and is comparable to a Great Hurricane in several other referenced publications.

Table 1. Saffir/Simpson Hurricane Scale Ranges

Scale Number (Category)	Central Pressure		Winds (Mph)	Surge (Ft.)	Damage
	Millibars	Inches			
1	≥ 980	≥ 28.94	74 - 95	4 - 5	Minimal
2	965 - 979	28.50 - 28.91	96 - 110	6 - 8	Moderate
3	945 - 964	27.91 - 28.47	111 - 130	9 - 12	Extensive
4	920 - 944	27.17 - 27.88	131 - 155	13 - 18	Extreme
5	< 920	< 27.17	> 155	> 18	Catastrophic

DATA SOURCES

Population statistics were obtained from the U. S. Department of Commerce, Bureau of the Census, publications. Hurricane information was obtained by checking conventional data sources plus available materials in NHC files and some material from local station files.

PURPOSE

The primary purpose of this study is to illustrate the increase in Gulf and Atlantic coastal populations in recent years and to indicate the low hurricane experience level of a large majority of these coastal residents. While many people have experienced fringe conditions of a major hurricane or the direct effects of a weaker hurricane, it will be pointed out that a relatively small percentage of the coastal population have experienced a direct hit by a major hurricane.

It is hoped that the information in this paper will help coastal residents and disaster groups to substitute education for hurricane experience. A simple comparison of numbers (Saffir/Simpson Hurricane Scale Numbers 1-5) relating hurricanes of recent experience to major or historical hurricanes of the past has been found to be most effective by NHC personnel in addressing various groups concerning hurricane disaster potential.

PROCEDURE

Population statistics for each coastal county from Texas to Maine were obtained from the U. S. Bureau of the Census publications for the period 1900-1970. This information was plotted on individual graphs for each county, 175 in all. A hurricane climatology, described below, was entered along the bottom of each graph indicating the year and severity of each hurricane affecting the county from 1900 through 1974. The complete collection of county graphs is included as Appendix B.

A tabulation was made for each Gulf and Atlantic coastal state listing coastal county populations in 1970 and at the time of the last major hurricane (Scale numbers 3-5) since 1900. This is illustrated in Table 2. The population differences were listed for each state and percentages calculated giving an indication of hurricane experience levels for Gulf and Atlantic coastal residents.

Table 2. Coastal county population by state showing percentage of residents who have never experienced a direct hit by a major hurricane (>3 on Saffir/Simpson Hurricane Scale).

STATE	1970	AT LAST ^{1,2} MAJOR HURRICANE	INCREASE	% OF 1970 TOTAL
TEXAS	2,899,895	1,365,430	1,534,465	52.9
LOUISIANA	1,385,438	1,145,440	239,998	17.3
MISSISSIPPI	239,944	167,463	72,481	30.2
ALABAMA	376,690	136,330	240,360	63.8
FLORIDA	5,414,868	1,144,571	4,270,297	78.8
GEORGIA	281,108		281,108	100.0
S. CAROLINA	429,900	344,700	85,200	19.8
N. CAROLINA	414,850	356,327	58,523	14.1
VIRGINIA	1,170,349	28,901	1,151,448	98.5
MARYLAND	2,263,152		2,263,152	100.0
DELAWARE	548,104		548,104	100.0
NEW JERSEY	3,498,389		3,498,389	100.0
NEW YORK	11,341,996	666,784	10,675,212	94.1
CONNECTICUT	1,882,926	1,108,374	774,552	41.1
RHODE ISLAND	946,725	818,933	127,792	13.5
MASSACHUSETTS	2,862,290	926,619	1,935,671	67.6
NEW HAMPSHIRE	138,951		138,951	100.0
MAINE	464,883		464,883	100.0
ALL	36,560,458		28,360,586	77.5

¹State totals are based on individual county populations at time of last major hurricane since 1900 (different years).

²Significant changes in Texas, Florida, New York, and Massachusetts from a preliminary version of this table are a result of a more detailed study of individual counties.

A hurricane climatology, based upon the Saffir/Simpson Hurricane Scale (with atmospheric pressure ranges adapted), was prepared for the 75-year period 1900-1974 based on the following guidelines:

1. Scale numbers (1-5), as indicated in Table 1, were assigned to hurricanes primarily based on estimated central pressure values at the time of landfall. A certain amount of subjectivity is inherent in this type of classification, particularly with hurricanes during earlier years and with those moving inland in sparsely-settled areas. In view of this, some hurricanes near the borderline between two scale numbers might be classified one way or the other based on various considerations, such as storm surge.

It should be pointed out that flooding from excessive rainfall during the life of a hurricane was not a criterion in selecting scale numbers. Hurricanes DIANE 1955 and AGNES 1972 for example, relatively weak hurricanes, were disastrous flood-makers and resulted in widespread flood damage in several states; however, based on central pressures at the time of landfall, both hurricanes were in category 1.

In some cases, hurricanes traversing a long path across many states may change scale numbers one or more times before dissipating. A good example of this is Hurricane DONNA of 1960, which changed from category 4 all the way down to category 1 during its journey between Florida and Maine (see Table 3).

Examples of hurricanes in each category of the Saffir/Simpson Hurricane Scale are listed in Table 3. The five most recent hurricanes are listed for categories 1-3 for Florida and the remainder of the Atlantic and Gulf coasts. Three additional dates are indicated for category 3 on the Atlantic coast in order to include the hurricanes of 1938 and 1944, memorable storms for that region. The hurricanes listed for scale numbers 4 and 5 are totals for the 75-year period 1900-1974, inclusive. (NOTE: Prior to 1950, names were not used in connection with hurricanes. For three years, 1950-1952, the phonetic alphabet was used for naming hurricanes, e.g., ABLE, BAKER, CHARLIE, etc... Girls' names have been used for naming hurricanes from 1953 to the present.)

2. After each hurricane had been assigned a scale number, all coastal counties from Texas to Maine were examined to determine which counties received direct hits and which received indirect hits by hurricanes near to, or crossing the coast since 1900.

Table 3. - Examples of Hurricane Classifications
on the Saffir/Simpson Hurricane Scale

Category	Gulf Coast	Florida	Atlantic Coast
1	FERN 1971 (TX) CINDY 1963 (TX) ETHEL 1960 (MS) DEBRA 1959 (TX) ABLE 1950 (AL)	AGNES 1972 (NW) INEZ 1966 (Keys) FLOSSY 1956 (NW) FLORENCE 1953 (NW) 1947 (Keys, SE)	AGNES 1972 (NY, CT) GINGER 1971 (NC) GERDA 1969 (ME) DONNA 1960 (MA, NH, ME) CINDY 1959 (SC)
2	EDITH 1971 (LA) FLOSSY 1956 (LA) 1949 (TX) 1947 (LA) 1945 (TX)	GLADYS 1968 (NW) ALMA 1966 (NW) ISBELL 1964 (SW) CLEO 1964 (SE) DORA 1964 (NE)	DONNA 1960 (CT, RI) CAROL 1954 (NC) HAZEL 1954 (MD) 1947 (GA, SC) 1944 (MA)
3	CARMEN 1974 (LA) CELIA 1970 (TX) BEULAH 1967 (TX) BETSY 1965 (LA) HILDA 1964 (LA)	BETSY 1965 (Keys) EASY 1950 (W-CNTRL) KING 1950 (SE) 1949 (SE) 1948 (SW, Keys)	DONNA 1960 (NC, NY) GRACIE 1959 (SC) CONNIE 1955 (NC) IONE 1955 (NC) CAROL 1954 (NY, CT, RI) EDNA 1954 (MA) 1944 (NC, VA, NY, CT, RI) 1938 (NY, CT, RI, MA)
4	CARLA 1961 (TX) AUDREY 1957 (LA) 1932 (TX) 1919 (TX) 1915 (TX) 1915 (LA) 1909 (LA) 1900 (TX)	DONNA 1960 (Keys, SW) 1947 (SE) 1928 (SE, Lake Okeechobee) 1926 (SE) 1919 (Keys)	HAZEL 1954 (SC, NC)
5	CAMILLE 1969 (MS)	1935 (Keys - "Labor Day Storm")	NONE

As with the assignment of scale numbers, a certain amount of subjectivity was inescapable at times in determining which counties received direct or indirect hits during the various hurricane situations. However, certain arbitrary guidelines for these classifications were used as indicated below:

Direct Hit - When the innermost core region, or "eye", moved over a county, it was counted as a direct hit. Using "R" as the radius of maximum winds in a hurricane (the distance in miles from the storm's center to the circle of maximum winds around the center), all or parts of counties falling within approximately $2R$ to the right and R to the left of a storm's landfall point were considered to have received direct hits. (This assumes an observer at sea looking toward shore.) On the average, this direct hit zone extended about 50 miles along the coastline ($R \approx 15$ miles). Of course, some hurricanes were smaller than this and some, particularly in higher latitudes, were much larger. Cases were judged individually, and many borderline situations had to be resolved.

Indirect Hit - These were based primarily on a hurricane's strength and size and on the configuration of the individual county coastline. Here again, much subjectivity was necessary in many cases which were complicated by storm paths and geography. Generally, those areas on either side of the direct hit zone which received hurricane force winds and/or tides of 4 to 5 feet or more above normal were considered to be indirect hits.

The complete hurricane climatology, 1900-1974, for all coastal counties from Texas to Maine is included in tabular form as Appendix C. It is comprised of a series of five fold-outs with counties listed in approximate geographical order from the lower Texas coast to the upper coast of Maine.

The procedures described above comprise the main thrust of this paper. Several other graphs and tables were prepared, using the same basic information, as follows:

1. State Population Graphs (coastal county populations only) were plotted by decades from 1900-1970 for each of the 18 Gulf and Atlantic coastal states. A second set of state graphs was prepared illustrating the percentage of each state population in the coastal counties for the same period. This complete set of graphs is included as Appendix D.

2. Gulf and Atlantic Coastal Population Distribution, 1970:
This set of graphs, included as Appendix E, was designed as a quick reference to indicate approximately how many people are involved in coastal counties along any particular stretch of coastline from Texas to Maine. The graphs were prepared for approximately 300 to 400 mile segments using the same distance scale for all states. Individual county populations were plotted in a position roughly at the mid point of each county along the coast. County names are indicated above the curves, while various coastal locations from Brownsville, Texas, to Eastport, Maine, are listed below the curves.
3. Tables 4a and 4b were prepared in the process of developing the Saffir/Simpson Hurricane Scale climatology. Comments concerning these tables are included in the following section.

DISCUSSION

The purpose of this statistical summary is to graphically demonstrate the low hurricane experience level of most U.S. coastal residents. The 175 county graphs in Appendix B are considered to be the primary data presented. Almost all of the data presented in the other Appendixes and Tables are contained within these graphs. However, while it may appear redundant in some instances, the data have been presented in these forms to allow for an easier statistical interpretation on a county, state and national basis. Some of this interpretation has been included briefly in the sections under Procedures and the forewords of the Appendixes. The remainder of the discussion will attempt to clarify further the data presented in the various tables and appendixes, and to point out some of the more significant facts which can be inferred.

Reference Table 1. An important point here is that the central pressure ranges will agree quite well with the wind ranges, but that the surge is strongly dependent on the slope of the continental shelf (shoaling factor). This can change the height of the surge by a factor of two for any given scale number.

Reference Table 2. This table was designed as a general illustration of population increases in Gulf and Atlantic coastal states since the last direct hit by a major hurricane. It should be emphasized that the population figures refer to coastal sections only for each state and are a summation of individual coastal county population values. Population totals at the time of the last major hurricane in each state since 1900

are for different years. No entry for a particular state indicates that there have been no direct hits by major hurricanes since 1900.

Combined population increases since the last major hurricane for each area indicate that over 28 million people along the Gulf and Atlantic coasts have never experienced a direct hit by a major hurricane. This is over 75% of the Gulf and Atlantic coastal residents of the United States. Six states have not had a single direct hit by a major hurricane in this century, while almost 80% of the coastal population of Florida - the most hurricane prone state - have a low hurricane experience level.

The main point to be made here (and throughout this paper) is that most of the people who go through hurricanes experience either a relatively weak hurricane (categories 1 and 2), or an indirect hit (fringe conditions) by a major hurricane. Generally less than 25% have actually felt the most intense central core region of a major hurricane. This breeds potential disaster by creating a sense of false security for 75% or more of the "experienced" coastal residents during the next major hurricane situation.

Considering the growth rate of most coastal counties, as indicated in the graphs in Appendix B, it is felt that the figures presented are conservative. In the five years since 1970, the only major hurricane to strike the U. S. (Carmen, 1974) hit in an area with one of the highest experience levels.

Reference Table 3. As indicated in Table 1, the terms "Scale Number" and "Category" are used interchangeably. In addition to DONNA 1960, Table 3 also shows several other hurricanes which affected different areas with different scale numbers (e.g., HAZEL 1954, CAROL 1954), or the same scale number (e.g., BETSY 1965, 1919).

It will be noted that only two category 5 hurricanes have affected the U. S. coastline this century - the "Labor Day Storm" of 1935 in the Florida Keys, and Hurricane Camille of 1969 on the Mississippi/Louisiana coast. Of the 13 hurricanes listed in category 4, only one (HAZEL 1954) affected the Atlantic coast north of Florida. (In 1919, the same category 4 hurricane affected the Florida Keys and Texas.)

Reference Table 4a. Many hurricanes affect more than one state (reference Table 3). In addition, Florida and Texas have been sub-divided into sections because of their extensive coastlines. In Florida, the north-south dividing line is roughly from Cape Canaveral to Tarpon Springs. In Texas, south is roughly from

Brownsville to Corpus Christi, central is from north of Corpus Christi to Matagorda Bay, and north is from north of Matagorda Bay to the Louisiana border. As a result, entries in Table 4a may be made more than once for the same hurricane. In other words, Florida and Texas sectional totals may not equal state totals, and state totals cannot be summed to get regional or national totals. However, the first line in the table is an actual count of all hurricanes which have affected the United States, where only the highest category of any state affected has been tabulated. This total indicates that 126 hurricanes have affected the U. S. coast during the period 1900-1974. Of this total, 52, or about 41% were major hurricanes.

While it has been stated that a direct hit by a major hurricane in any one locality is a rare event, the sobering statistics of the top line in Table 4a illustrate that on the average so far this century: 1) two major hurricanes (capable of causing damage in the billions of dollars and killing hundreds) cross the U. S. coast somewhere every three years; 2) a category 4 hurricane crosses the U. S. coastline somewhere once every six years.

This table gives a quick reference to the hurricane climatology of individual states. The table reveals that 39% of all hurricanes hit Florida. A few other noteworthy statistics are that Florida and Texas combined have been hit by 67% of category 4 or higher hurricanes, and that approximately one out of every two hurricanes is a major one along the middle Gulf coast, southern Florida, and New York and southern New England.

Reference Table 4b. This table is a chronological list of all 126 hurricanes including categories by states. Also included in the table is a list of estimated central pressures at the time of landfall for the highest U. S. category. Pressure values are not available for several earlier years and a few hurricanes in recent years which moved inland in sparsely settled areas. By comparing the central pressure of a given hurricane to the range of pressures for each scale number, it is possible to see how close that hurricane came to falling into a higher or lower category. In addition, the effect of extreme forward speed (indicated by an asterisk beside a number), as for most hurricanes north of Cape Hatteras, must be considered.

Reference Appendix A. This scale has been referred to as the Simpson Disaster Potential Scale in some earlier publications.

Table 4a. - Number of Hurricanes (Direct Hits)
Affecting U. S. and Individual States
1900 - 1974 according to Saffir/Simpson
Hurricane Scale.

Area	Category Number					All	Major Hurricanes (≥ 3)
	1	2	3	4	5		
U. S. (Texas to Maine)	45	29	37	13	2	126	52
Texas	9	9	7	6	0	31	13
(North)	4	3	2	4	0	13	6
(Central)	2	2	1	1	0	6	2
(South)	3	4	4	1	0	12	5
Louisiana	3	6	6	3	1	19	10
Mississippi	1	1	2	0	1	5	3
Alabama	3	1	3	0	0	7	3
Florida	18	11	14	5	1	49	20
(Northwest)	9	6	4	0	0	19	4
(Northeast)	1	5	0	0	0	6	0
(Southwest)	5	3	5	2	1	16	8
(Southeast)	4	8	7	3	0	22	10
Georgia	1	3	0	0	0	4	0
South Carolina	4	3	2	1*	0	10	3
North Carolina	9	3	6	1*	0	19	7
Virginia	1	1	1*	0	0	3	1*
Maryland	0	1*	0	0	0	1*	0
Delaware	0	0	0	0	0	0	0
New Jersey	1	0	0	0	0	1	0
New York	2	0	4*	0	0	6	4*
Connecticut	2	1*	3*	0	0	6	3*
Rhode Island	0	1*	3*	0	0	4*	3*
Massachusetts	2	1*	2*	0	0	5	2*
New Hampshire	1*	0	0	0	0	1*	0
Maine	4	0	0	0	0	4	0

* Indicates all hurricanes in this category were moving greater than 30 mph.

Table 4b. - Chronological List of All Hurricanes
Which Affected the U.S. 1900 - 1974
Including Category by States.

Year	Month	States Affected and Category by States	Highest Category U.S.	Minimum Sea Level Pressure (Mb.)
1900	Sept.	Tex. 4N	4	931
1901	July	N.C. 1	1	-
1901	Aug.	La., Miss. 2	2	972
1903	Sept.	Fla. 2SE, 1NW	2	976
1903	Sept.	N.J., N.Y., Conn. 1	1	990
1906	June	Fla. 1SE	1	-
1906	Sept.	S.C., N.C. 3	3	947
1906	Sept.	Miss., Ala. 3	3	958
1906	Oct.	Fla. 2SE	2	967
1908	July	N.C. 1	1	-
1909	July	Tex. 3N	3	958
1909	Aug.	Tex. 2S	2	-
1909	Sept.	La. 4	4	931
1909	Oct.	Fla. 3SE (Keys)	3	957
1910	Sept.	Tex. 2S	2	965
1910	Oct.	Fla. 3SW	3	955
1911	Aug.	Fla. 1NW; Ala. 1	1	-
1911	Aug.	Ga., S.C. 2	2	-
1912	Oct.	Tex. 1S	1	-
1913	June	Tex. 1S	1	-
1913	Sept.	N.C. 1	1	-
1915	Aug.	Tex. 4N	4	945
1915	Sept.	Fla. 1NW	1	988
1915	Sept.	La. 4	4	931
1916	July	Miss., Ala. 3	3	948
1916	July	Mass. 1	1	-
1916	July	S.C. 1	1	980
1916	Aug.	Tex. 3S	3	948
1916	Oct.	Ala. 2; Fla. 2NW	2	972
1916	Nov.	Fla. 1SW (Keys)	1	-
1917	Sept.	Fla. 3NW	3	958
1918	Aug.	La. 3	3	955
1919	Sept.	Fla. 4SW (Keys); Tex. 4S	4	927
1920	Sept.	La. 2	2	975
1920	Sept.	N.C. 1	1	-
1921	June	Tex. 2C	2	979
1921	Oct.	Fla. 3SW, 2NE	3	952

Table 4b. (Cont'd.)

Year	Month	States Affected and Category by States	Highest Category U.S.	Minimum Sea Level Pressure (Mb.)
1923	Oct.	La. 1	1	985
1924	Sept.	Fla. 1NW	1	985
1924	Oct.	Fla. 1SW	1	980
1925	Nov.	Fla. 1SW	1	-
1926	July	Fla. 1NE	1	980
1926	Aug.	La. 3	3	955
1926	Sept.	Fla. 4SE, 3SW, 3NW; Ala. 3	4	935
1928	Sept.	Fla. 4SE, 2NE; Ga., S.C. 1	4	929
1929	June	Tex. 1C	1	982
1929	Sept.	Fla. 3SE, 2NW	3	948
1932	Aug.	Tex. 4N	4	941
1932	Sept.	Ala. 1	1	979
1933	July/ Aug.	Fla. 1SE; Tex. 2S	2	975
1933	Aug.	N.C., Va. 2	2	971
1933	Sept.	Tex. 3S	3	949
1933	Sept.	Fla. 3SE	3	948
1933	Sept.	N.C. 3	3	957
1934	June	La. 3	3	962
1934	July	Tex. 2S	2	975
1935	Sept.	Fla. 5SW (Keys), 2NW	5	892
1935	Nov.	Fla. 2SE	2	973
1936	June	Tex. 1S	1	987
1936	July	Fla. 3NW	3	964
1936	Sept.	N.C. 2	2	-
1938	Aug.	La. 1	1	985
1938	Sept.	N.Y., Conn., R.I., Mass. 3*	3*	946
1939	Aug.	Fla. 1SE, 1NW	1	985
1940	Aug.	Tex. 2N; La. 2	2	972
1940	Aug.	Ga., S.C. 2	2	970
1941	Sept.	Tex. 3N	3	958
1941	Oct.	Fla. 2SE, 2SW, 2NW	2	975
1942	Aug.	Tex. 1N	1	992
1942	Aug.	Tex. 3C	3	950
1943	July	Tex. 2N	2	969
1944	Aug.	N.C. 1	1	990
1944	Sept.	N.C., Va., N.Y., Conn., R.I. 3*; Mass. 2*	3*	947
1944	Oct.	Fla. 3SW, 2NE	3	962

Table 4b. (Cont'd.)

Year	Month	States Affected and Category by States	Highest Category U.S.	Minimum Sea Level Pressure (Mb.)
1945	June	Fla. 1NW	1	985
1945	Aug.	Tex. 2C	2	967
1945	Sept.	Fla. 3SE	3	951
1946	Oct.	Fla. 1SW	1	980
1947	Aug.	Tex. 1N	1	992
1947	Sept.	Fla. 4SE, 2SW; La. 2	4	940
1947	Oct.	Fla. 1SE; Ga., S.C. 2	2	974
1948	Sept.	La. 1	1	987
1948	Sept.	Fla. 3SW, 2SE	3	963
1948	Oct.	Fla. 2SE	2	975
1949	Aug.	N.C. 1	1	980
1949	Aug.	Fla. 3SE	3	954
1949	Oct.	Tex. 2N	2	972
1950	Aug.	Ala. 1	1	980
1950	Sept.	Fla. 3NW	3	958
1950	Oct.	Fla. 3SE	3	955
1952	Aug.	S.C. 1	1	985
1953	Aug.	N.C. 1	1	987
1953	Sept.	Me. 1*	1*	-
1953	Sept.	Fla. 1NW	1	985
1954	Aug.	N.C. 2; N.Y., Conn., R.I. 3*	3*	960
1954	Sept.	Mass. 3*; Me. 1*	3*	954
1954	Oct.	S.C., N.C. 4*; Md. 2*	4*	938
1955	Aug.	N.C. 3; Va. 1	3	962
1955	Aug.	N.C. 1	1	987
1955	Sept.	N.C. 3	3	960
1956	Sept.	La. 2; Fla. 1NW	2	975
1957	June	Tex. 4N; La. 4	4	945
1959	July	Tex. 1N	1	984
1959	July	S.C. 1	1	993
1959	Sept.	S.C. 3	3	950
1960	Sept.	Miss. 1	1	981
1960	Sept.	Fla. 4SW (Keys), 2NE; N.C., N.Y. 3*; Conn., R.I. 2*; Mass., N.H., Me. 1*	4	930
1961	Sept.	Tex. 4C	4	931
1963	Sept.	Tex. 1N	1	996
1964	Aug.	Fla. 2SE	2	968
1964	Sept.	Fla. 2NE	2	966
1964	Oct.	La. 3	3	950

Table 4b. (Cont'd.)

Year	Month	States Affected and Category by States	Highest Category U.S.	Minimum Sea Level Pressure (Mb.)
1964	Oct.	Fla. 2SW, 2SE	2	974
1965	Sept.	Fla. 3SE; La. 3	3	948
1966	June	Fla. 2NW	2	982
1966	Oct.	Fla. 1SW, (Keys)	1	983
1967	Sept.	Tex. 3S	3	950
1968	Oct.	Fla. 2NW	2	977
1969	Aug.	La., Miss. 5	5	909
1969	Sept.	Me. 1	1	980
1970	Aug.	Tex. 3S	3	945
1971	Sept.	La. 2	2	978
1971	Sept.	Tex. 1C	1	979
1971	Sept.	N.C. 1	1	993
1972	June	Fla. 1NW; N.Y., Conn. 1	1	980
1974	Sept.	La. 3	3	952

Reference Appendix B. A note of caution is needed to avoid misinterpretation of these graphs. Because of the different population ranges from graph to graph, the total increase in a county with a large population but relatively slow growth rate may be larger than a more sparsely populated county with a rapid growth rate. One other point - if the core (direct hit) of a major hurricane affected only a sparsely populated section of a heavily populated county (e.g., Dade County, Florida - BETSY 1965), it was considered to be an indirect hit in these graphs, but that portion directly affected was included in Table 2.

While these graphs give a complete hurricane climatology on a county-by-county basis, it would be quite difficult to determine how the individual hurricanes affected larger areas if one had to compare county graphs. Appendix C has been prepared to readily supply this information.

Reference Appendix C. This appendix has been designed so that each foldout is a geographical area likely to be affected solely by a given hurricane. However, foldouts can be combined into a single, continuous display for the entire Gulf and Atlantic coasts.

With the data from the individual graphs of Appendix B combined in this form, many facts can be derived easily on a county, state, or regional basis. For example, an idea of the size of a hurricane can be obtained by the number of counties affected (although tracks relative to geographical configurations can be misleading in a few instances). Also, one can readily count how many direct or indirect hits of any category have occurred, or how long it has been between any hurricanes, or those of a particular category.

Reference Appendix D. See Procedure.

Reference Appendix E. As in Appendix C, these graphs were prepared so that each adjacent section can be combined into a single, continuous graph for the entire Gulf and Atlantic coastline by placing the zero distance scale over the right hand limit of the previous graph. These graphs can be used to estimate the impact (direct and indirect) of future hurricanes on coastal sections affected.

SUMMARY

Populations continue to increase along most sections of the Gulf and Atlantic coasts of the United States. This trend, along with the relatively low frequency of hurricanes in recent years and low hurricane experience levels of some 28 million coastal residents, has become an item of major concern at the National Hurricane Center. It is hoped that this report will help to some degree in substituting education for hurricane experience.

When a hurricane crosses the coast, many persons feel its effects; however, only a small percentage of the coastal residents experience a direct hit by its intense inner core, the major death and damage producer of the hurricane. Most residents experience indirect hits, or fringe effects, during hurricane situations (or direct hits by relatively weak hurricanes - categories 1 and 2) and can be lulled into a false sense of security by feeling that they have experienced the worst part. In view of this, the disaster potential of subsequent hurricane situations might be inaccurately assessed by many coastal residents.

While the increase in coastal populations is alarming, it is felt that the figures presented in this report are conservative. Since 1970, unofficial estimates indicate that most Gulf and Atlantic coastal populations have continued to increase, sharply in some areas. In addition, these population statistics are for permanent residents and do not take into account summer tourism which may increase some county population totals tenfold during weekends or holidays. Another major concern, not discussed in this report, is that many thousands of the coastal county residents live in mobile homes which are extremely vulnerable to hurricanes of any category.

Acknowledgements. Dr. Neil Frank, Director, NHC, conceived the idea of combining population graphs and hurricane climatology and suggested the preparation of this report. Mr. John Hope, Principal Hurricane Specialist, contributed significantly to the preparation of many of the materials used. Ms. Mary Watson did virtually all of the drafting work, and Ms. Liliias Wilson did the typing. Many miscellaneous but important tasks were performed by Ms. Dottie Nixon, Ms. Wanda Lund, Mr. Norman Nixon and Mr. Bill Drybala, all of NHC.

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APPENDIX A

THE SAFFIR/SIMPSON³ HURRICANE SCALE

The Saffir/Simpson Hurricane Scale is used by the National Weather Service to give public safety officials a continuing assessment of the potential for wind and storm-surge damage from a hurricane in progress. Scale numbers are made available to public-safety officials when a hurricane is within 72 hours of landfall.

Scale numbers range from 1 to 5. Scale No. 1 begins with hurricanes in which the maximum sustained winds are at least 74 miles per hour, or will produce a storm surge 4 to 5 feet above normal water level, while Scale No. 5 applies to those in which the maximum sustained winds are 155 miles per hour or more, or has the potential of producing a storm surge more than 18 feet above normal.

Dr. Neil Frank, present NHC Director, has adapted atmospheric pressure ranges to the Saffir/Simpson scale. These pressure ranges, along with a numerical break-down of wind and storm surge ranges, are listed in Table 1.

The Weather Service emphasizes that the scale numbers are not forecasts, but are based on observed conditions at a given time in a hurricane's lifespan. They represent an estimate of what the storm would do to a coastal area if it were to strike without change in size or strength. Scale assessments are revised regularly as new observations are made, and public-safety organizations are kept informed of new estimates of the hurricane's disaster potential.

The Saffir/Simpson Hurricane Scale indicates probable property damage and evacuation recommendations as listed below:

Scale No. 1 - Winds of 74 to 95 miles per hour. Damage primarily to shrubbery, trees, foliage and unanchored mobile homes. No real damage to other structures. Some damage to poorly constructed signs. And/or: storm surge 4 to 5 feet above normal. Low-lying coastal roads inundated, minor pier damage, some small craft in exposed anchorage torn from moorings.

³Developed by Herbert Saffir, Dade County, Florida, Consulting Engineer, and Dr. Robert H. Simpson, former National Hurricane Center Director.

Scale No. 2 - Winds of 96 to 110 miles per hour. Considerable Damage to shrubbery and tree foliage, some trees blown down. Major damage to exposed mobile homes. Extensive damage to poorly constructed signs. Some damage to roofing materials of buildings; some window and door damage. No major damage to buildings. And/or: storm surge 6 to 8 feet above normal. Coastal roads and low-lying escape routes inland cut by rising water 2 to 4 hours before arrival of hurricane center. Considerable damage to piers. Marinas flooded. Small craft in unprotected anchorages torn from moorings. Evacuation of some shoreline residences and low-lying island areas required.

Scale No. 3 - Winds of 111 to 130 miles per hour. Foliage torn from trees, large trees blown down. Practically all poorly constructed signs blown down. Some damage to roofing materials of buildings; some window and door damage. Some structural damage to small buildings. Mobile homes destroyed. And/or: storm surge 9 to 12 feet above normal. Serious flooding at coast and many smaller structures near coast destroyed; larger structures near coast damaged by battering waves and floating debris. Low-lying escape routes inland cut by rising water 3 to 5 hours before hurricane center arrives. Flat terrain 5 feet or less above sea level flooded inland 8 miles or more. Evacuation of low-lying residences within several blocks of shoreline possibly required.

Scale No. 4 - Winds of 131 to 155 miles per hour. Shrubs and trees blown down, all signs down. Extensive damage to roofing materials, windows and doors. Complete failure of roofs on many small residences. Complete destruction of mobile homes. And/or: storm surge 13 to 18 feet above normal. Flat terrain 10 feet or less above sea level flooded inland as far as 6 miles. Major damage to lower floors of structures near shore due to flooding and battering by waves and floating debris. Low-lying escape routes inland cut by rising water 3 to 5 hours before hurricane center arrives. Major erosion of beaches. Massive evacuation of all residences within 500 yards of shore possibly required, and of single-story residences on low ground within 2 miles of shore.

Scale No. 5 - Winds greater than 155 miles per hour. Shrubs and trees blown down, considerable damage to roofs of buildings; all signs down. Very severe and extensive damage to windows and doors. Complete failure of roofs on many residences and industrial buildings. Extensive shattering of glass in windows and doors. Some complete building failures. Small buildings overturned or blown away. Complete destruction of mobile homes. And/or: storm surge greater than 18 feet above normal. Major damage to lower floors of all structures less than 15 feet above sea level within 500 yards of shore. Low-lying escape routes inland cut by rising water 3 to 5 hours before hurricane center arrives. Massive evacuation of residential areas on low ground within 5 to 10 miles of shore possibly required.

APPENDIX B

INDIVIDUAL COASTAL COUNTY HURRICANE CLIMATOLOGY/POPULATION GRAPHS, TEXAS TO MAINE

The set of population graphs in this appendix illustrates population trends along the Gulf and Atlantic coasts of the United States during the period 1900-1970. Indications are that this increasing trend in coastal populations has continued into 1975 in most areas; however, no estimates are included here. Assuming this to be the case, hurricane experience levels and the disaster potential for many areas are even more critical than indicated in the following county climatology/population graphs.

Hurricane climatology along the bottom of each graph is indicated by arrows and Saffir/Simpson scale numbers for the period 1900-1974. Each hurricane is represented by either a solid or a dashed arrow along with the appropriate scale number and is entered at the year of occurrence. Solid arrows indicate direct hits, and dashed arrows denote indirect hits. For direct hits of category 3 hurricanes or higher, a vertical dashed line has been inserted between the arrowhead and the population curve. This gives a convenient, quick reference to the number and frequency of direct hits in each county by major hurricanes (scale numbers 3, 4 and 5) since 1900.

The key to symbols used in connection with hurricane climatology along the bottom of each graph, along with examples, is shown below.

Key for Symbols used in Hurricane Climatology

(NOTE: Dual symbols were needed when using scale numbers in tabular form, without arrows, such as in Appendix C.)

- ↑ - Direct Hit
- () or ↑ - Indirect Hit
- or ○ - Exiting or Inland
- * - Forward Speed 30 mph or Greater (In effect, may increase/decrease Saffir/Simpson scale number by as much as one on strong/weak side, respectively.)

Examples (Symbols used in Hurricane Climatology/Population Graphs)

↑
2

- Direct Hit by a Category 2 Hurricane

↑
2

- Indirect Hit (or fringe hit) by a Category 2 Hurricane

↑
③

- Direct Hit by an inland or exiting (moving from land to water) Category 3 Hurricane

↑
CAROL
*3

- Direct Hit by Hurricane Carol, Category 3, moving 30 mph or greater

↑
3,2

or

↑
3,2

- Two direct or indirect hits in the same year, with the Category 3 hurricane occurring first. (If a direct and indirect hit both occurred in the same year, they were offset slightly and plotted adjacent to one another.)

↑
E4

- Direct Hit by a Category 4 Hurricane in the eastern part of Monroe County, Florida. (Note: W indicates the western part of Monroe County. No letter designation indicates the entire county was affected. This notation is used only in Monroe County - the Florida Keys - because of geographical configurations and hurricane frequencies.)

NOTE: Names of hurricanes are entered beside arrows 1950 - present.

INDEX OF INDIVIDUAL COASTAL COUNTY GRAPHS

(NOTE: The 175 graphs in this appendix are arranged in approximate geographical order from the Lower Texas coast to the upper coast of Maine. Major cities or well-known locations are indicated for some counties.)

1. TEXAS (17)

Cameron (Brownsville), Willacy, Kenedy, Kleberg, Nueces (Corpus Christi), San Patricio, Aransas, Refugio, Calhoun (Port O'Connor), Jackson, Matagorda, Brazoria, Galveston (Galveston), Harris (Houston), Chambers, Jefferson (Port Arthur, Beaumont), Orange.

2. LOUISIANA (11)

Cameron, Vermilion, Iberia, St. Mary (Morgan City), Terrebonne, Lafourche, Jefferson, Plaquemines, St. Bernard, Orleans (New Orleans), St. Tammany.

3. MISSISSIPPI (3)

Hancock (Bay St. Louis), Harrison (Biloxi), Jackson (Pascagoula).

4. ALABAMA (2)

Mobile (Mobile), Baldwin.

5. FLORIDA (38)

Escambia (Pensacola), Santa Rosa, Okaloosa, Walton, Bay (Panama City), Gulf, Franklin (Apalachicola), Wakulla, Jefferson, Taylor, Dixie, Levy (Cedar Key), Citrus (Homosassa), Hernando, Pasco (New Port Richey), Pinellas (St. Petersburg), Hillsborough (Tampa), Manatee (Bradenton), Sarasota (Sarasota), Charlotte (Punta Gorda), Lee (Fort Myers), Collier (Naples), Monroe (Key West), Dade (Miami), Broward (Fort Lauderdale), Palm Beach (West Palm Beach), Hendry (Clewiston), Glades (Moore Haven), Okeechobee, Martin (Stuart), St. Lucie (Fort Pierce), Indian River (Vero Beach), Brevard (Cape Canaveral), Volusia (Daytona Beach), Flagler, St. Johns (St. Augustine), Duval (Jacksonville), Nassau (Fernandina Beach).

6. GEORGIA (6)

Camden, Glynn (Brunswick), McIntosh, Liberty, Bryan, Chatham (Savannah).

7. SOUTH CAROLINA (5)

Beaufort (Hilton Head, Colleton, Charleston (Charleston), Georgetown (Georgetown), Horry (Myrtle Beach).

8. NORTH CAROLINA (17)

Brunswick, New Hanover (Wilmington), Pender, Onslow, Carteret (Moorehead City), Pamlico, Beaufort, Hyde, Dare (Cape Hatteras), Tyrrell, Washington, Bertie, Chowan, Perquimans, Pasquotank (Elizabeth City), Camden, Currituck.

9. VIRGINIA (15)

(NOTE: Several independent cities are listed instead of counties. See notes in Virginia table, Appendix C.)

Virginia Beach, Chesapeake (Chesapeake, Norfolk and Portsmouth Cities), Nansemond (Suffolk City), Isle of Wight, Surry, James City (Williamsburg City), York (Hampton City, Newport News City) Gloucester, Mathews, Middlesex, Lancaster, Northumberland, Westmoreland, Northampton, Accomack.

10. MARYLAND (14)

Worcester (Ocean City), Somerset, St. Marys, Calvert, Anne Arundel (Annapolis), Baltimore (includes Baltimore City), Harford, Cecil, Kent, Queen Annes, Talbot, Caroline, Dorchester, Wicomico.

11. DELAWARE (3)

Sussex (Rehoboth Beach), Kent, New Castle (Wilmington).

12. NEW JERSEY (10)

Salem, Cumberland, Cape May (Ocean City), Atlantic (Atlantic City), Burlington, Ocean, Monmouth (Asbury Park), Middlesex (Perth Amboy), Hudson (Jersey City), Bergen.

13. NEW YORK (8)

Richmond (Staten Island), New York (Manhattan), Kings (Brooklyn), Queens, Nassau (Jones Beach), Suffolk (Westhampton), Bronx (Bronx), Westchester.

14. CONNECTICUT (4)

New London (New London), Middlesex, New Haven, Fairfield
(Bridgeport).

15. RHODE ISLAND (5)

Newport (Newport), Bristol (Bristol), Providence (Providence),
Kent, Washington (Narragansett Point),

16. MASSACHUSETTS (8)

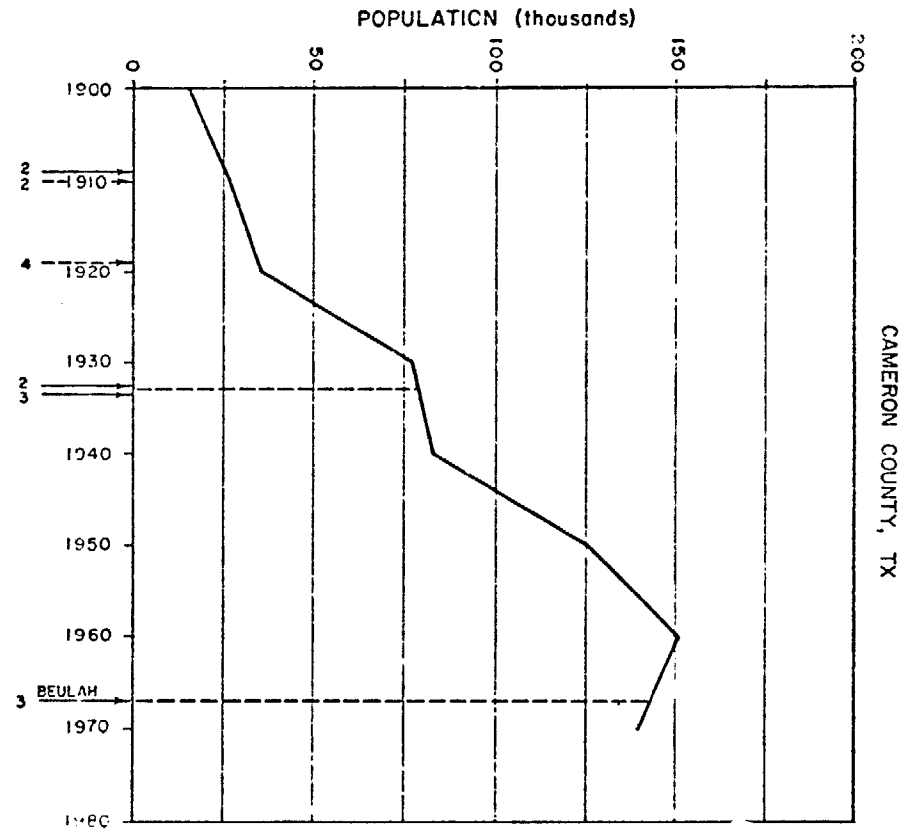
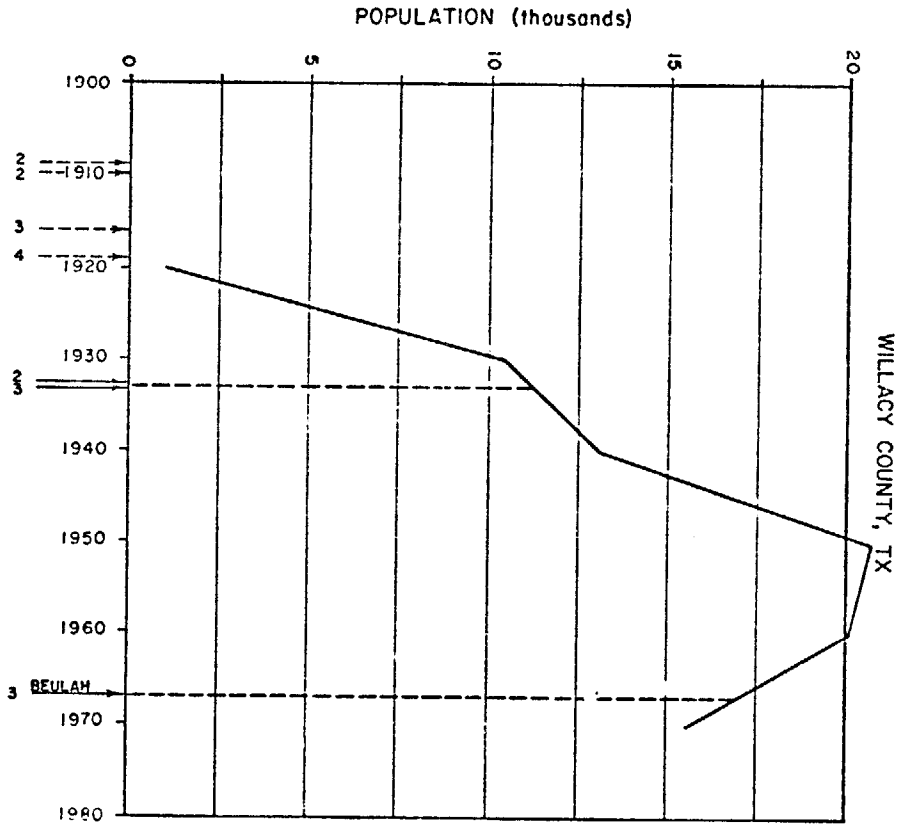
Bristol (New Bedford), Dukes (Martha's Vineyard), Nantucket
(Nantucket), Barnstable (Cape Cod), Plymouth (Plymouth),
Norfolk, Suffolk (Boston), Essex (Gloucester).

17. NEW HAMPSHIRE (1)

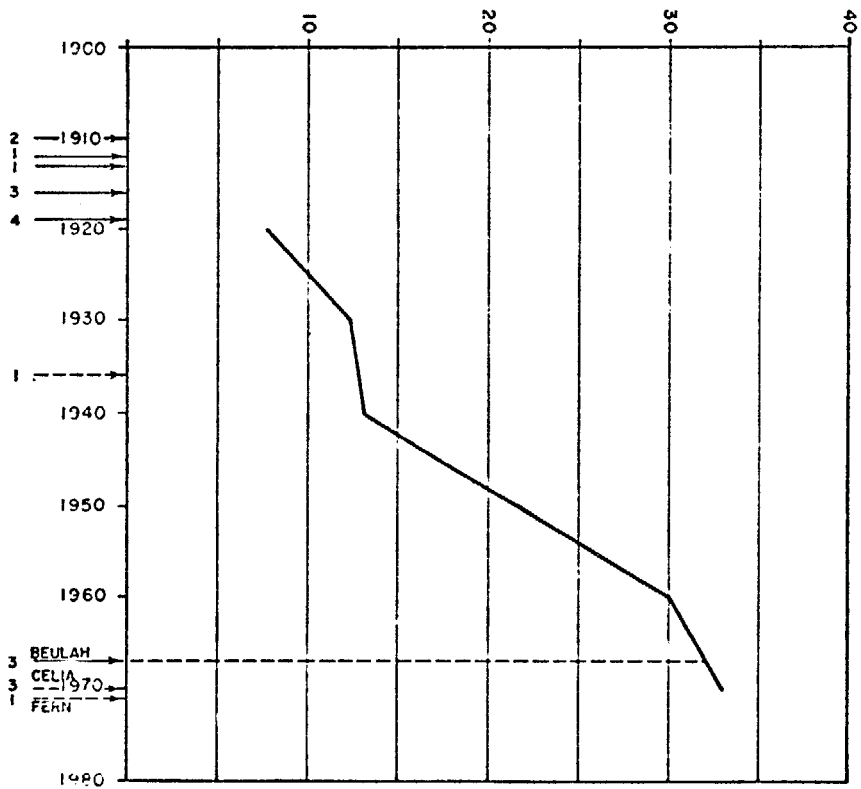
Rockingham (Portsmouth).

18. MAINE (8)

York, Cumberland (Portland), Sagadahoc, Lincoln, Knox, Waldo,
Hancock, Washington (Eastport),

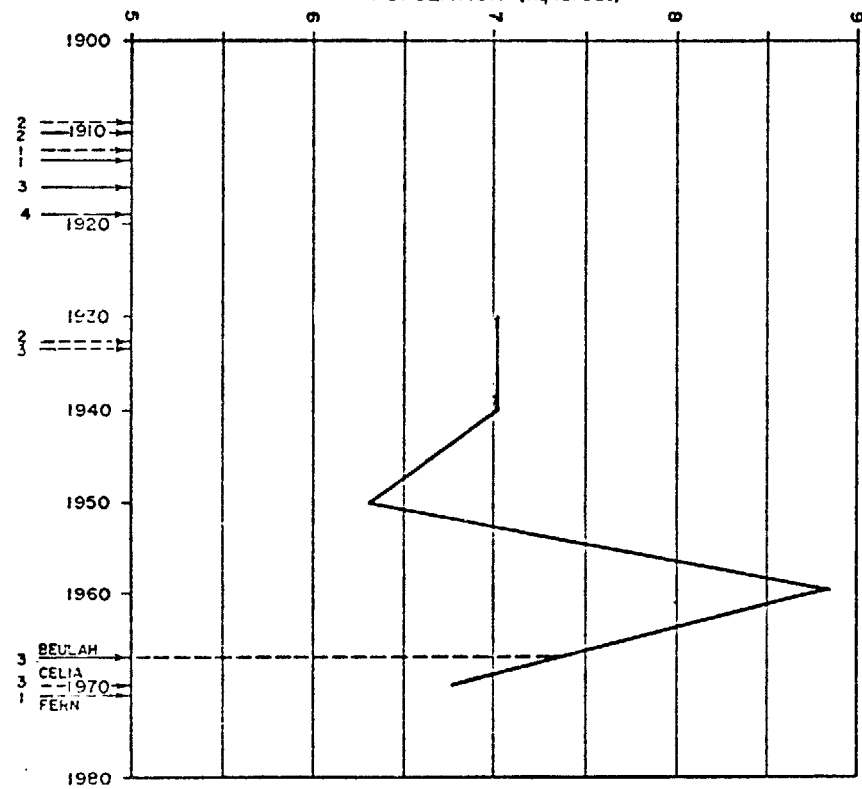


POPULATION (thousands)

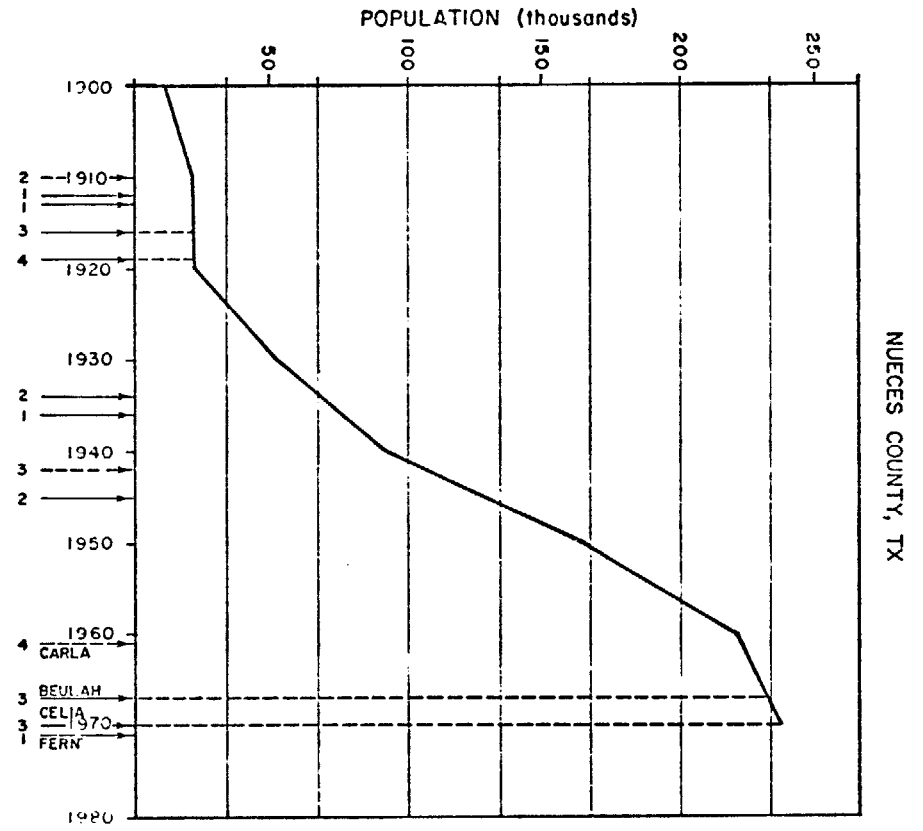
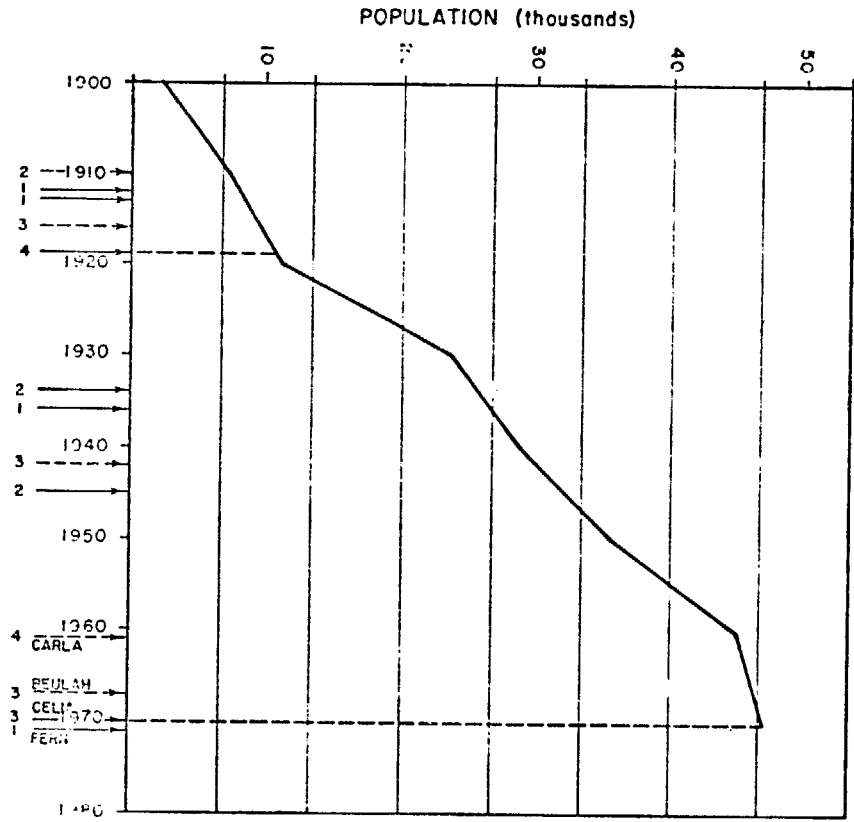


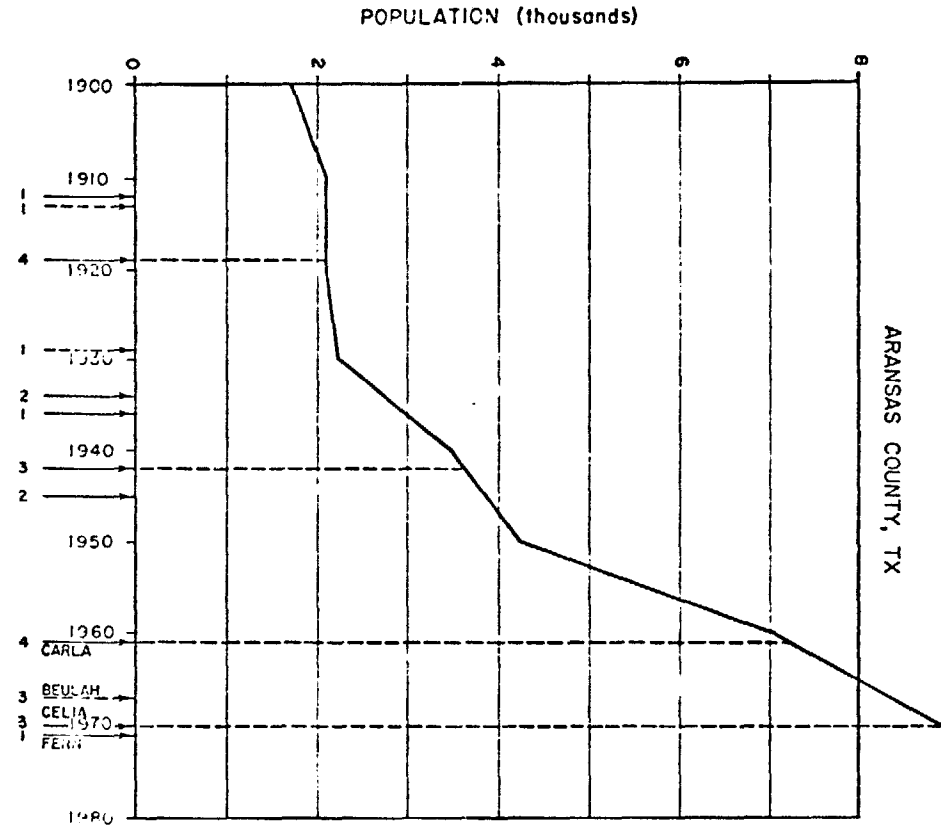
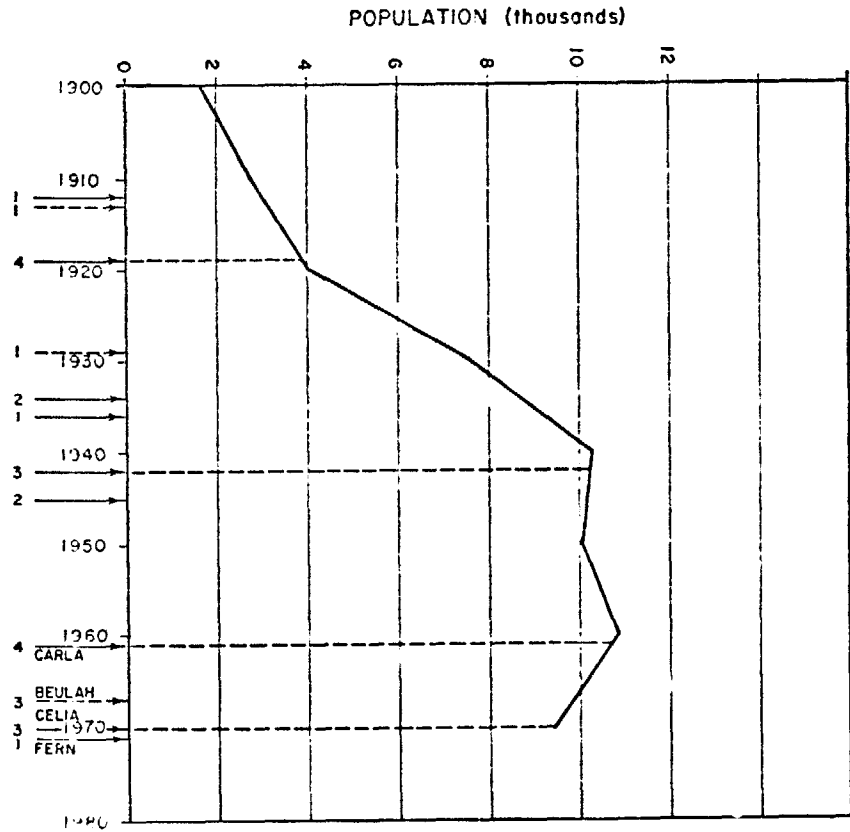
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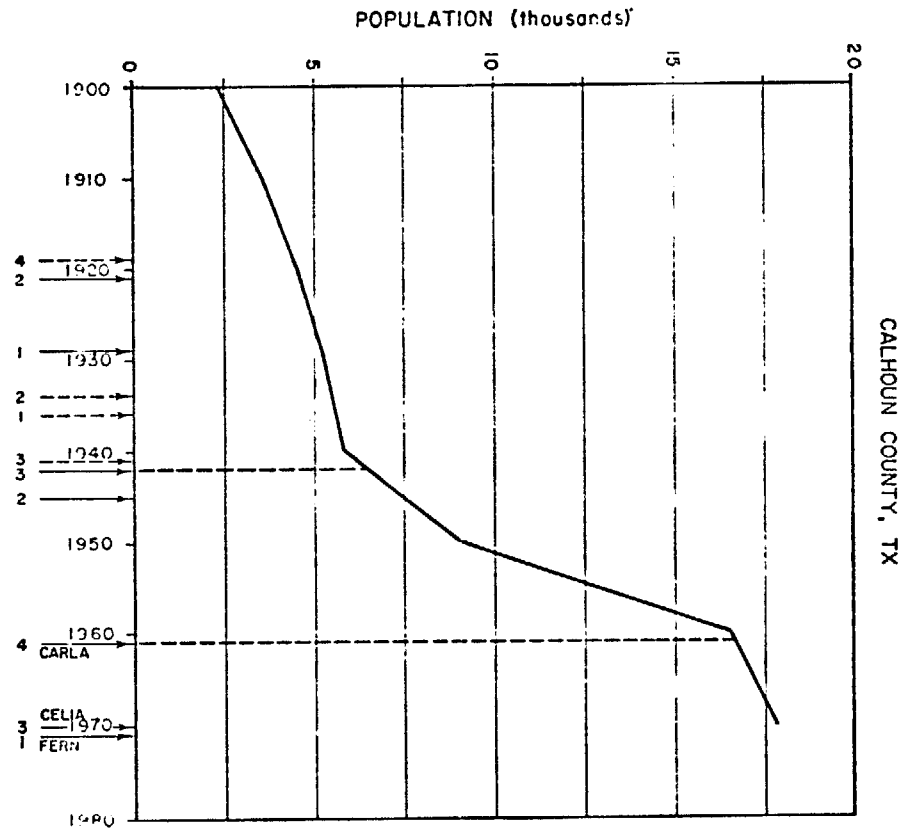
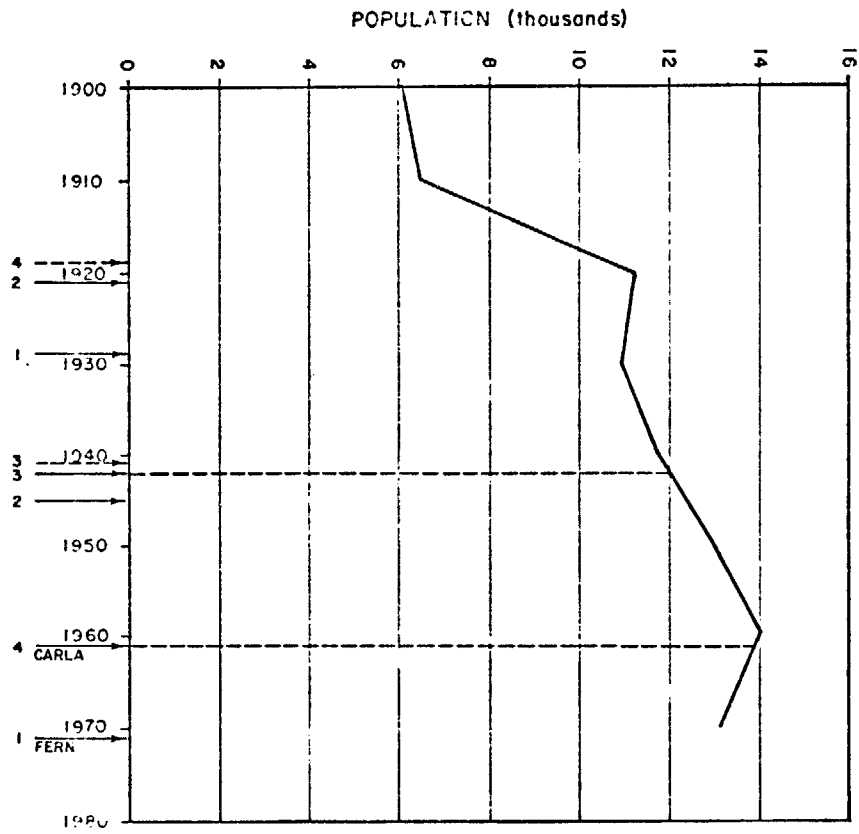
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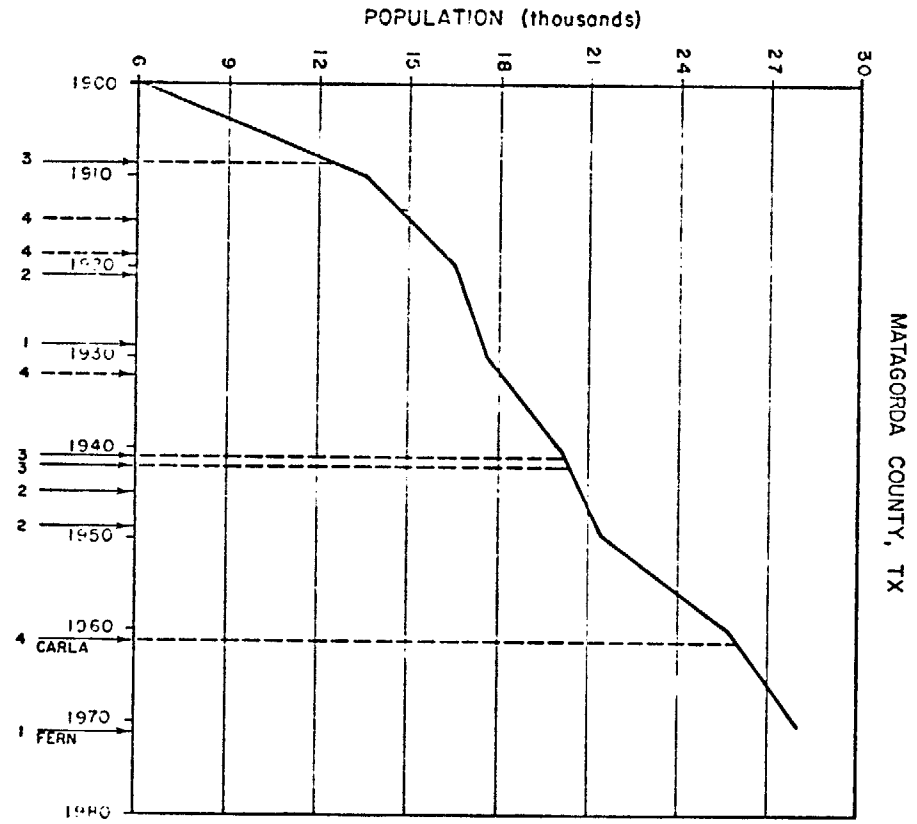
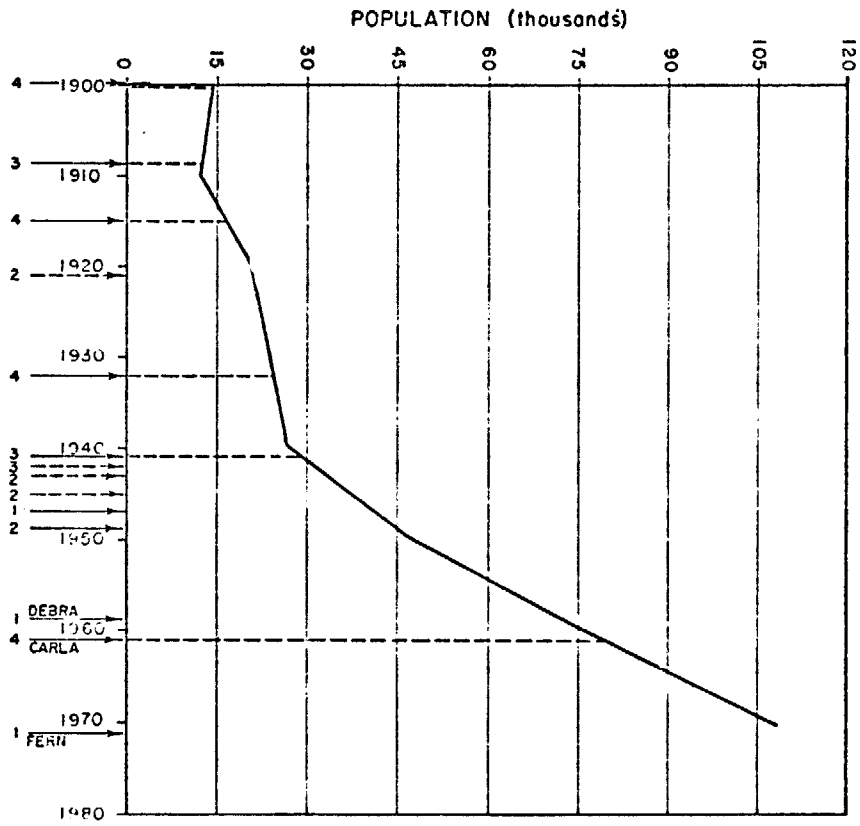


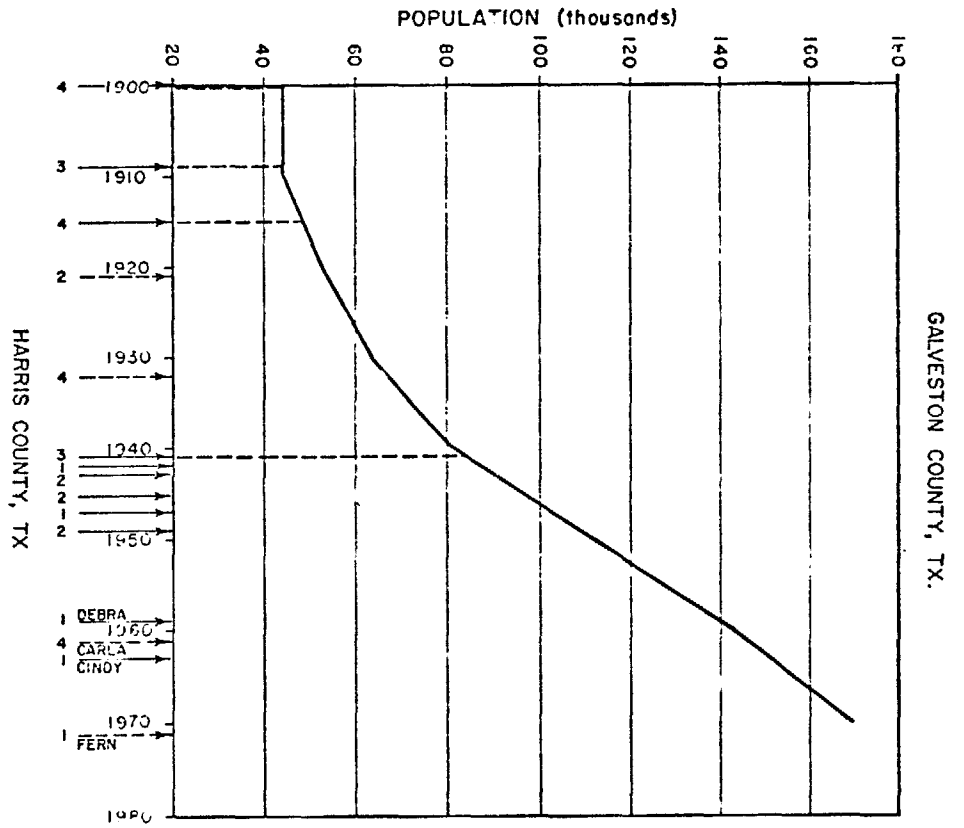
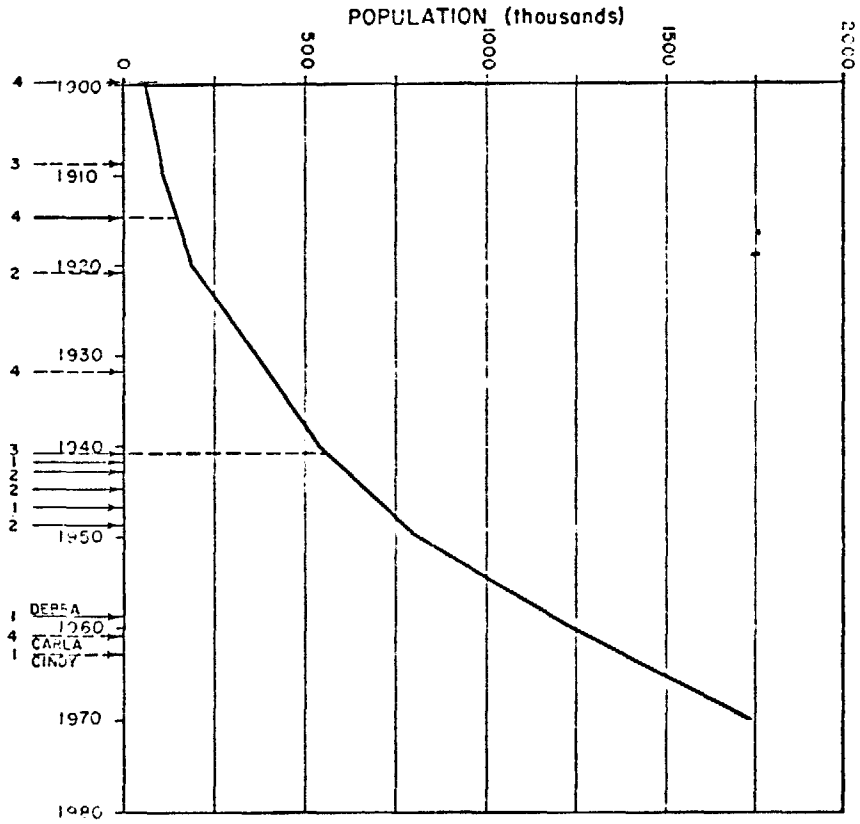
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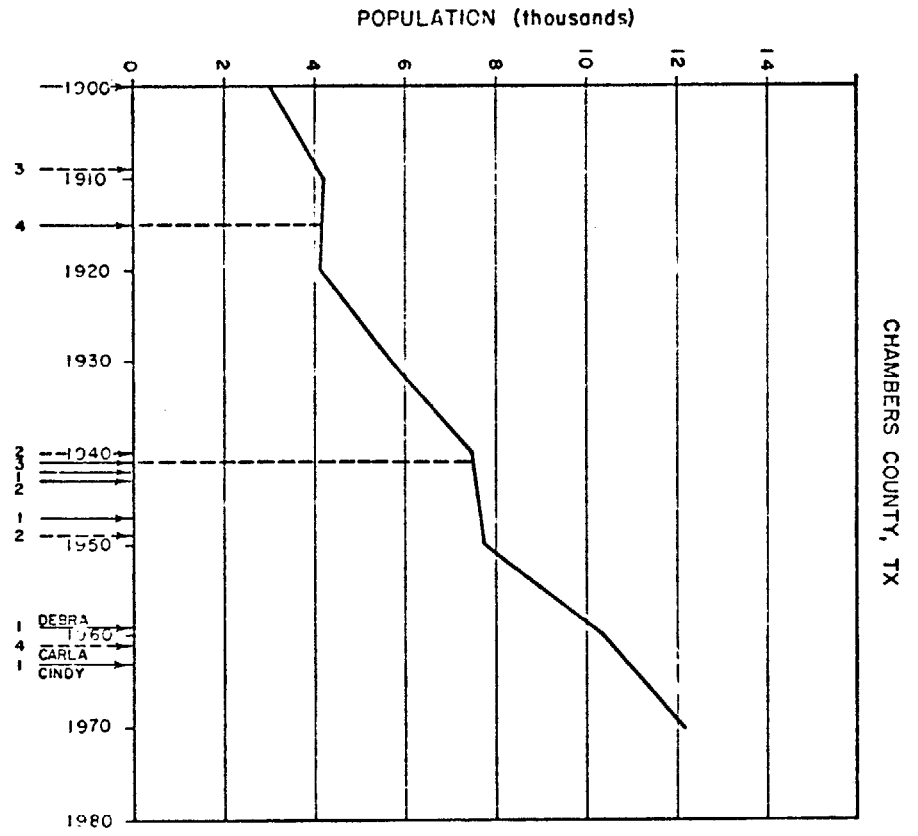
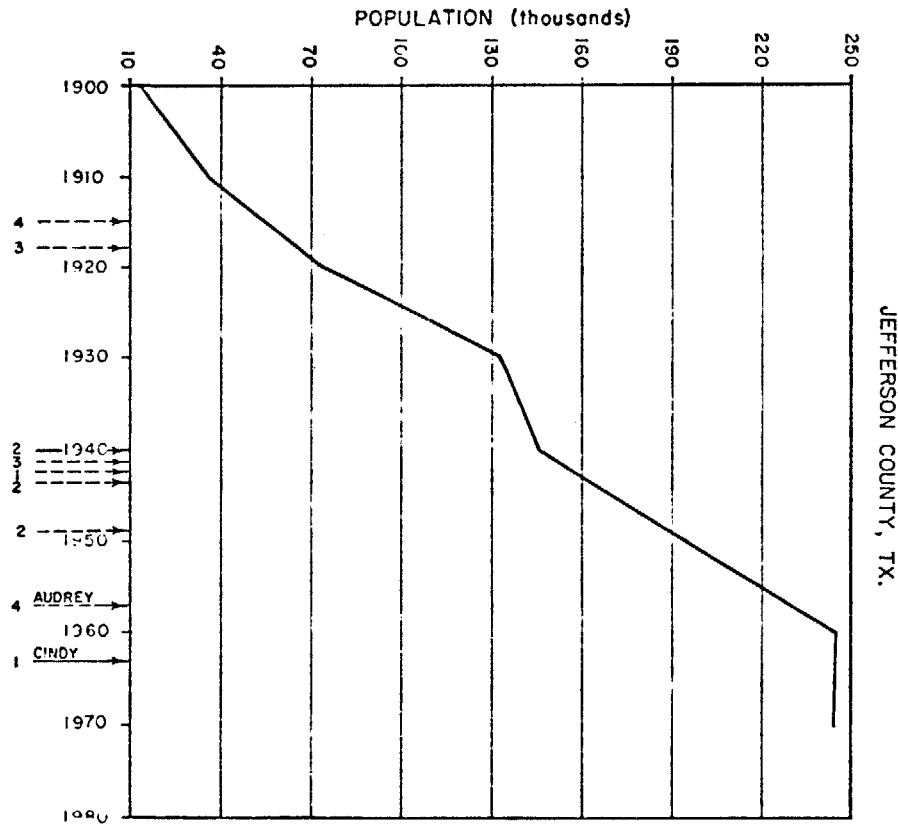




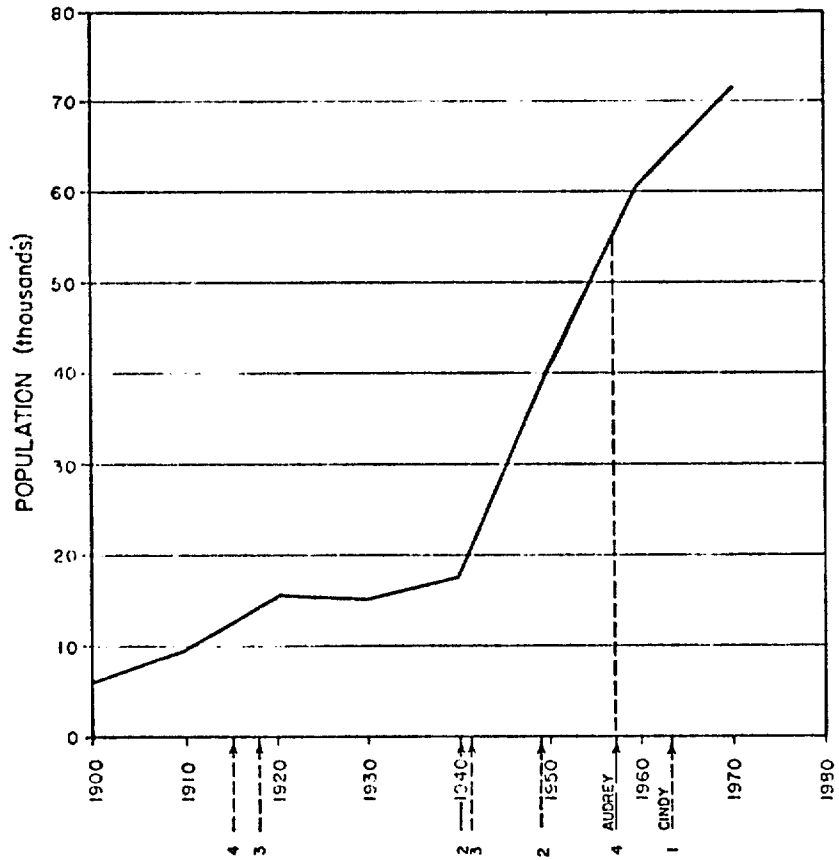




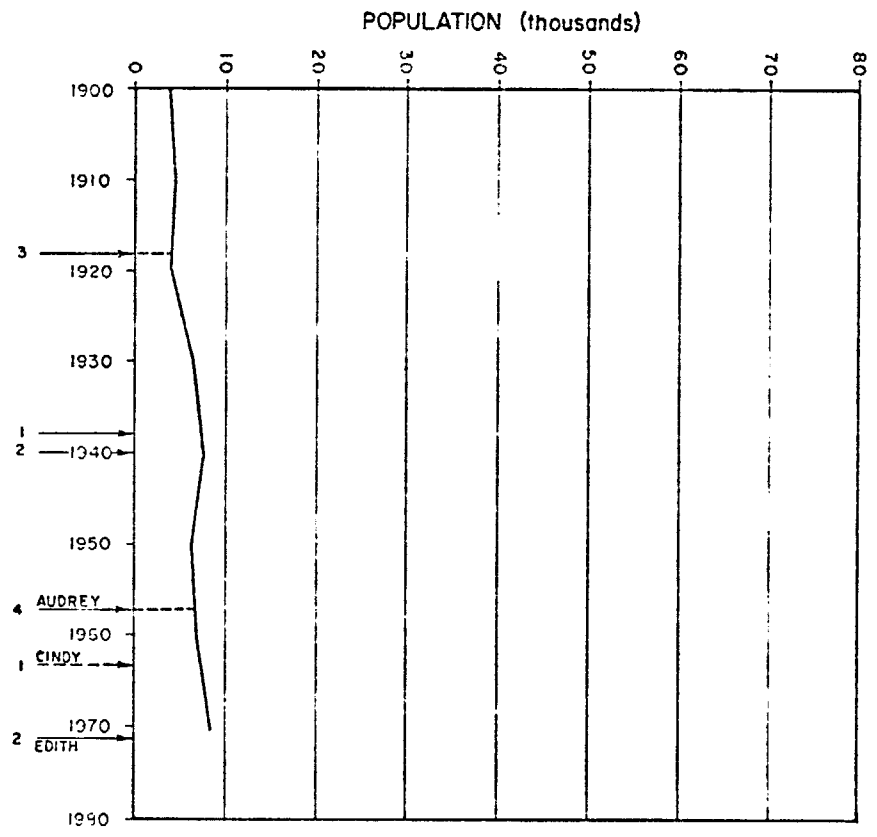
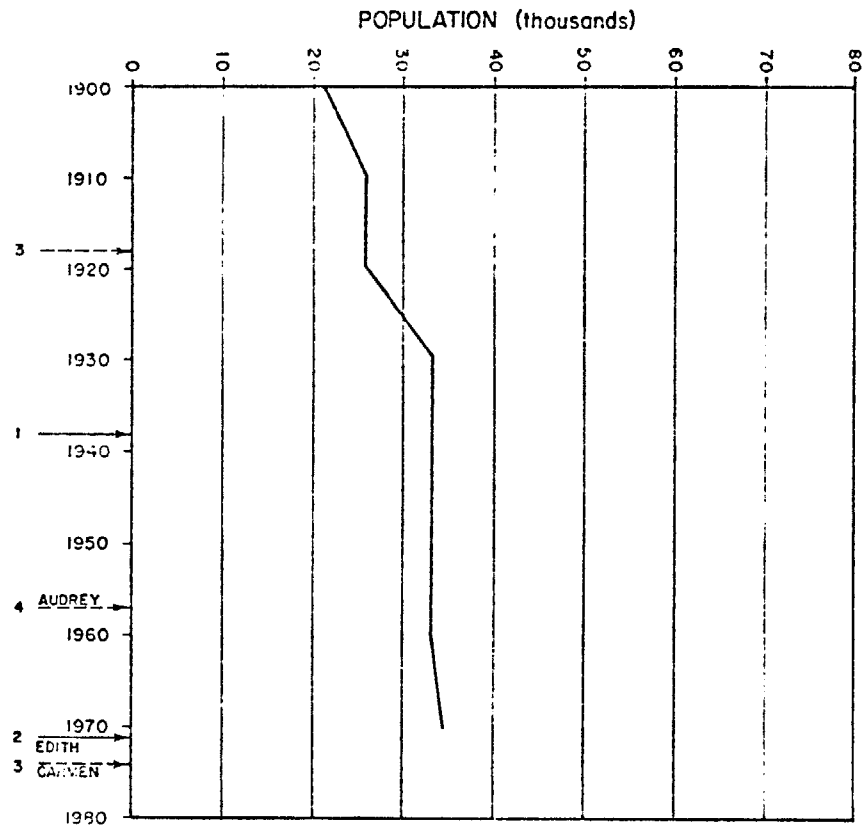


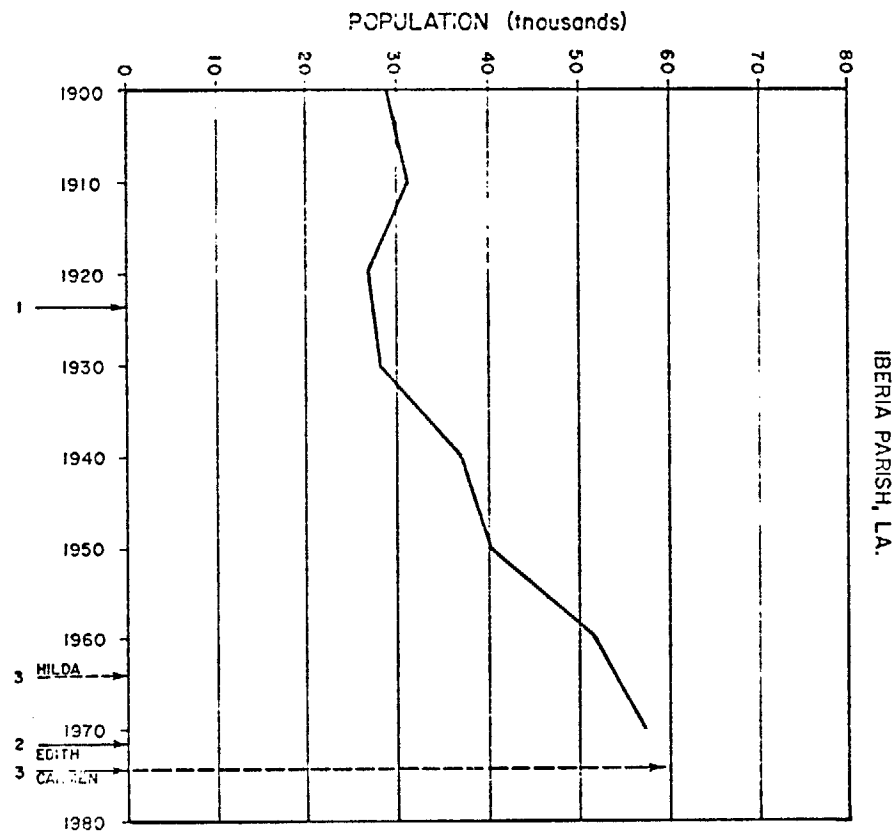
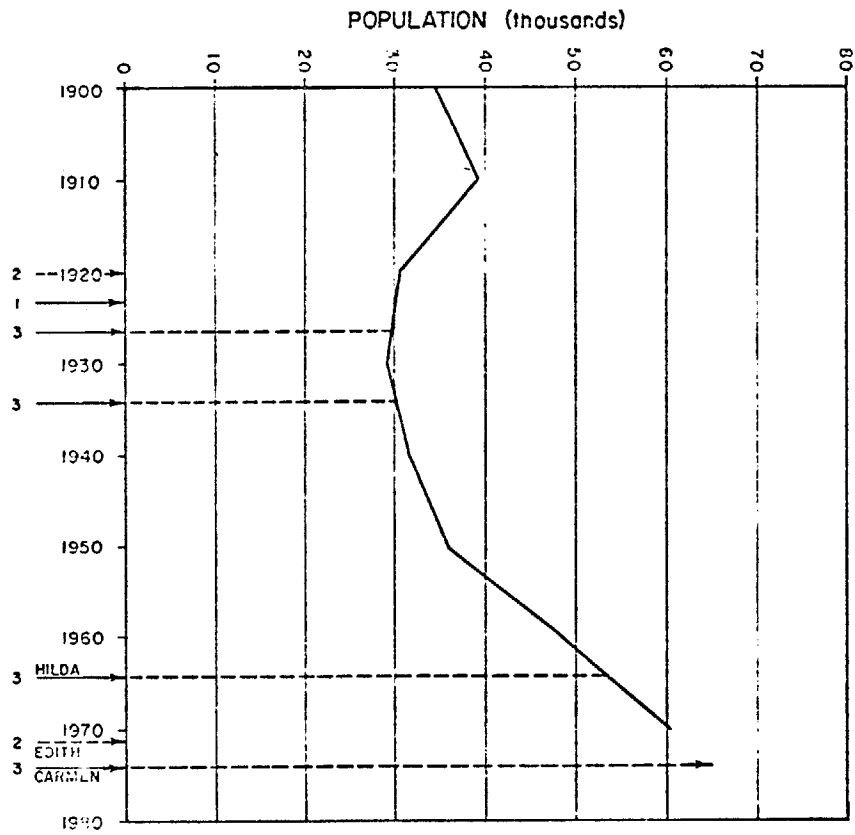


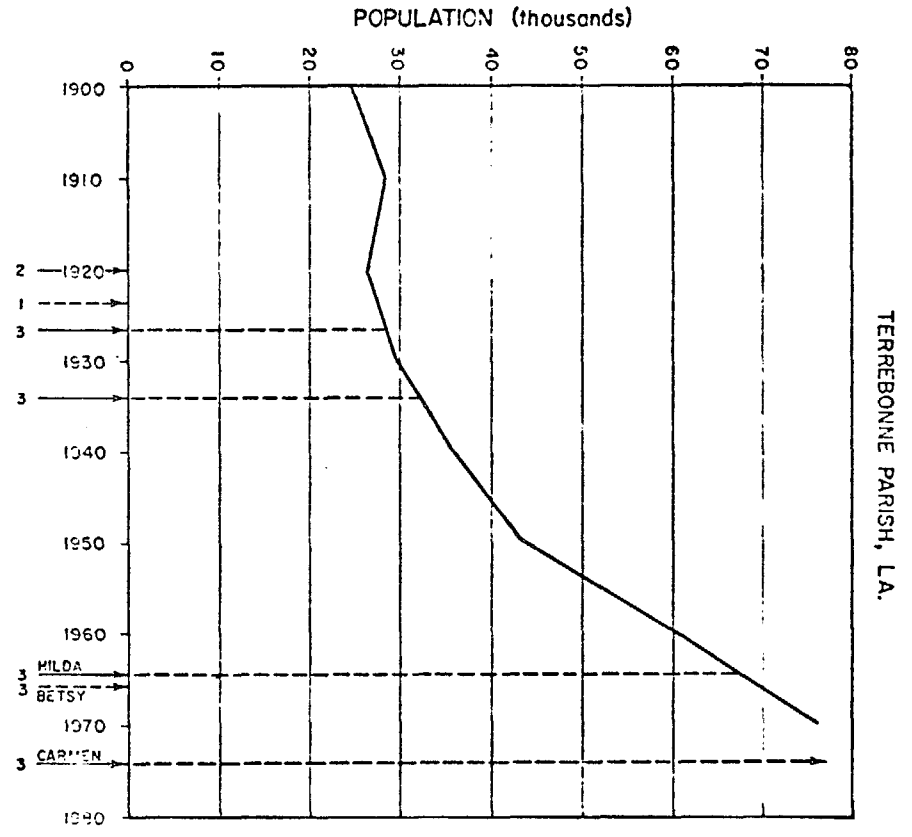
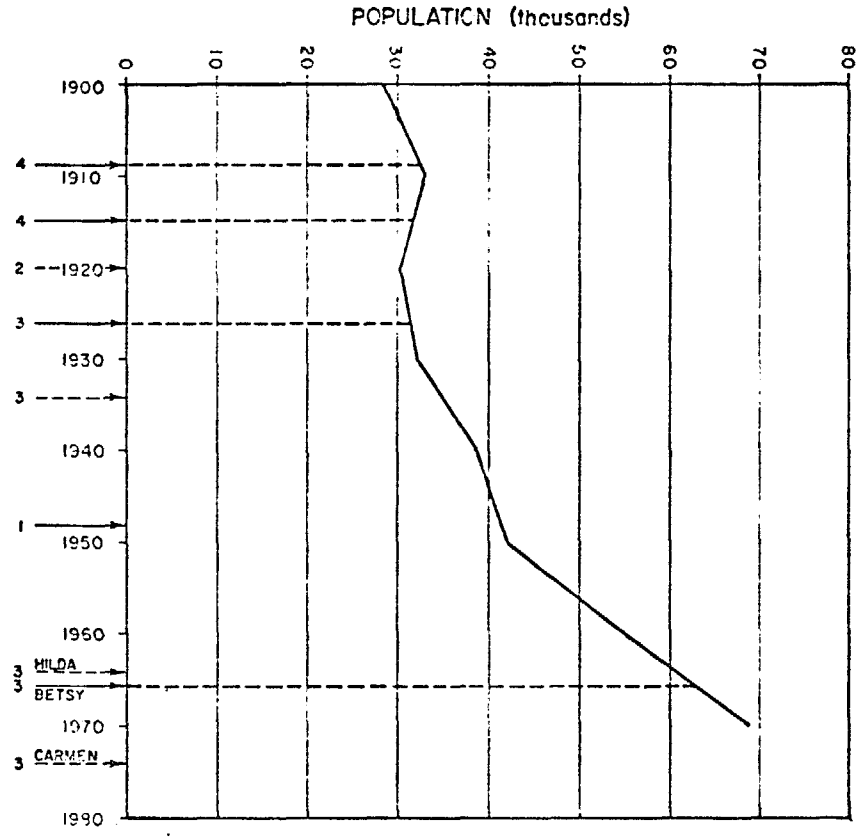
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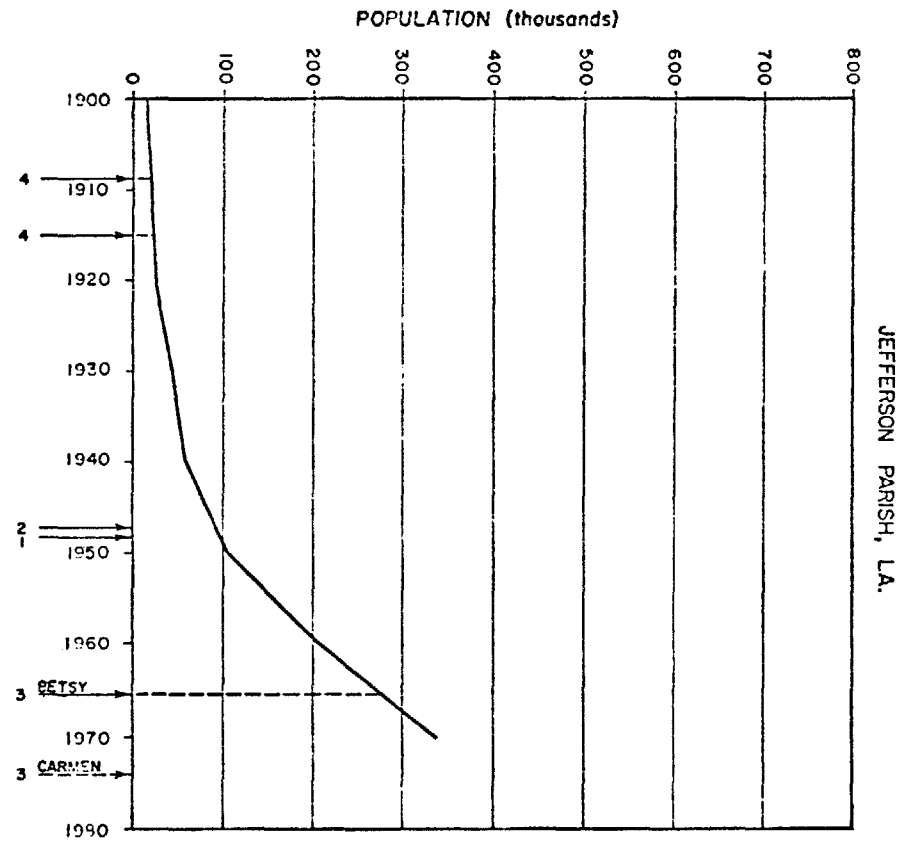
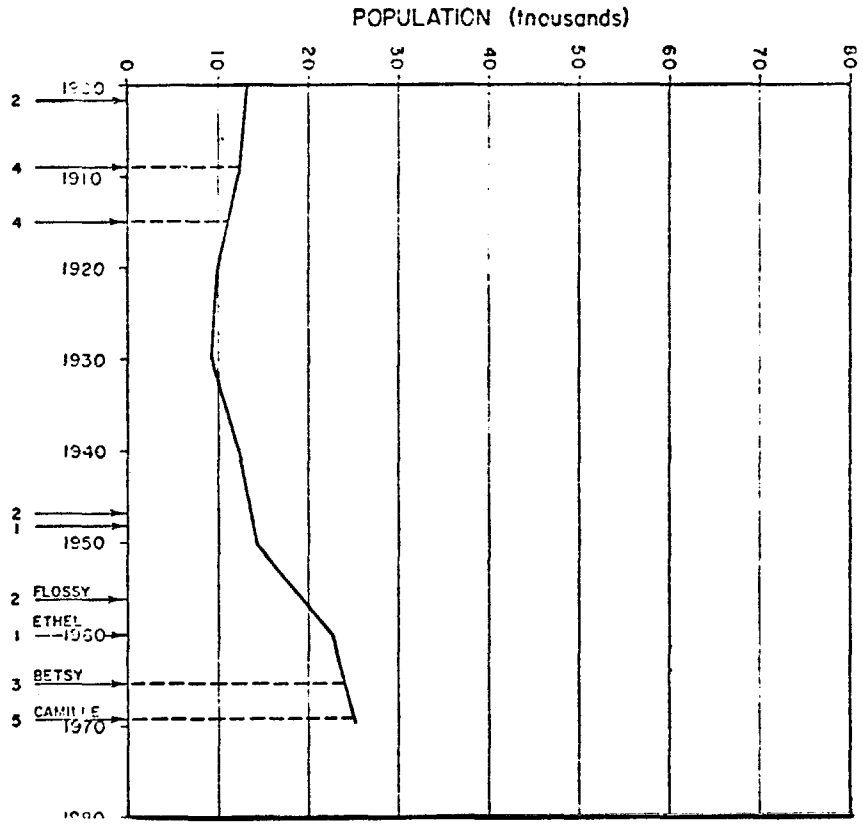


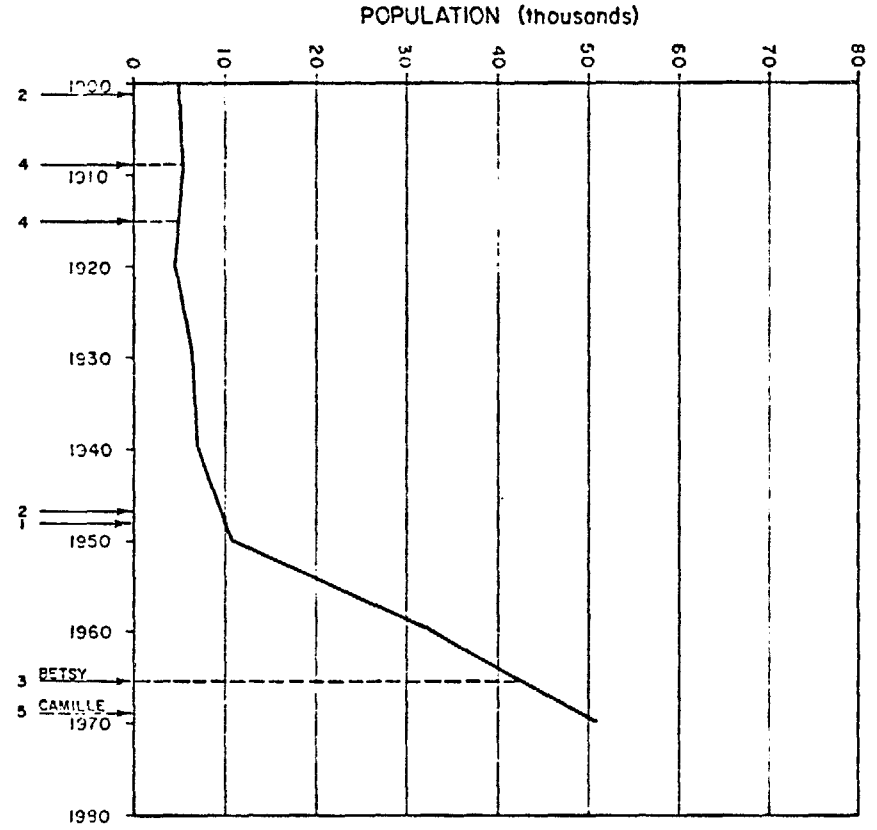
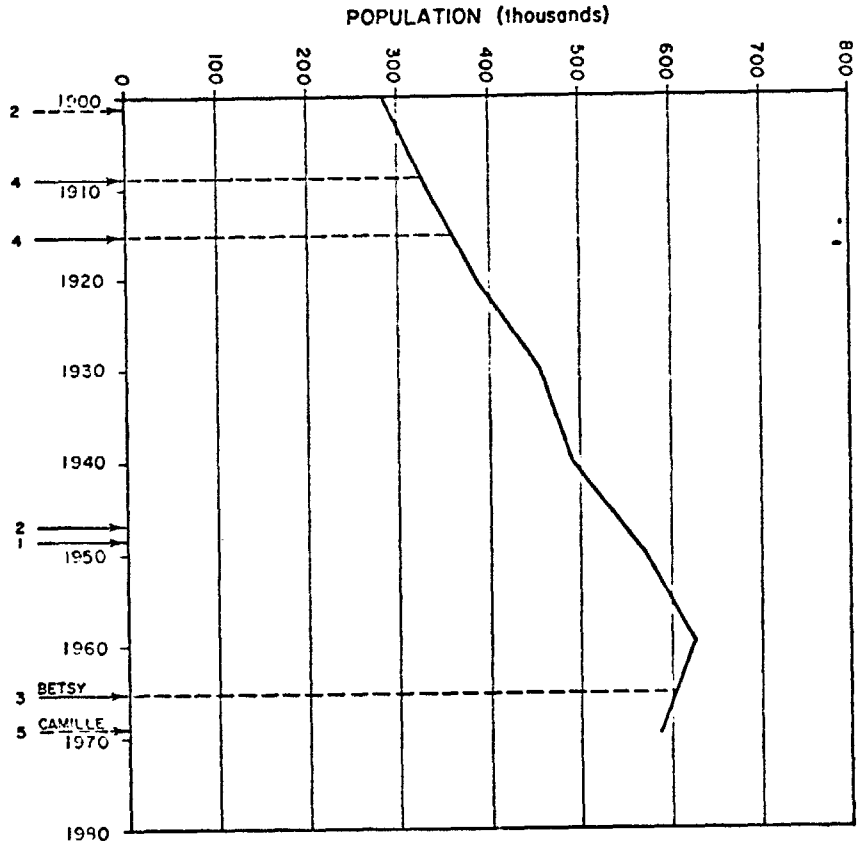
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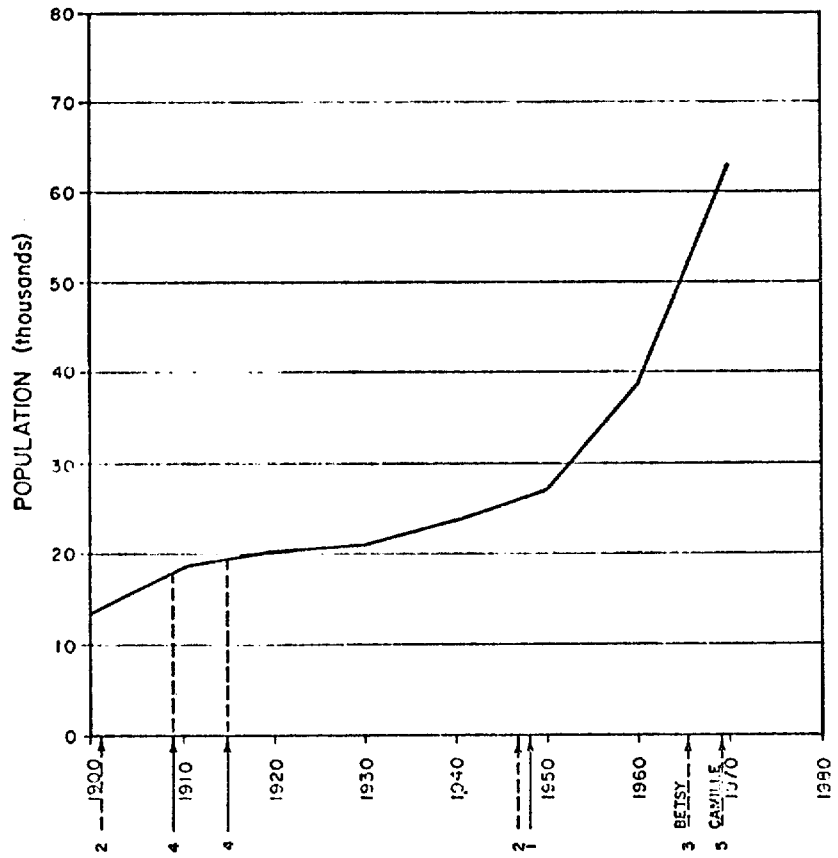




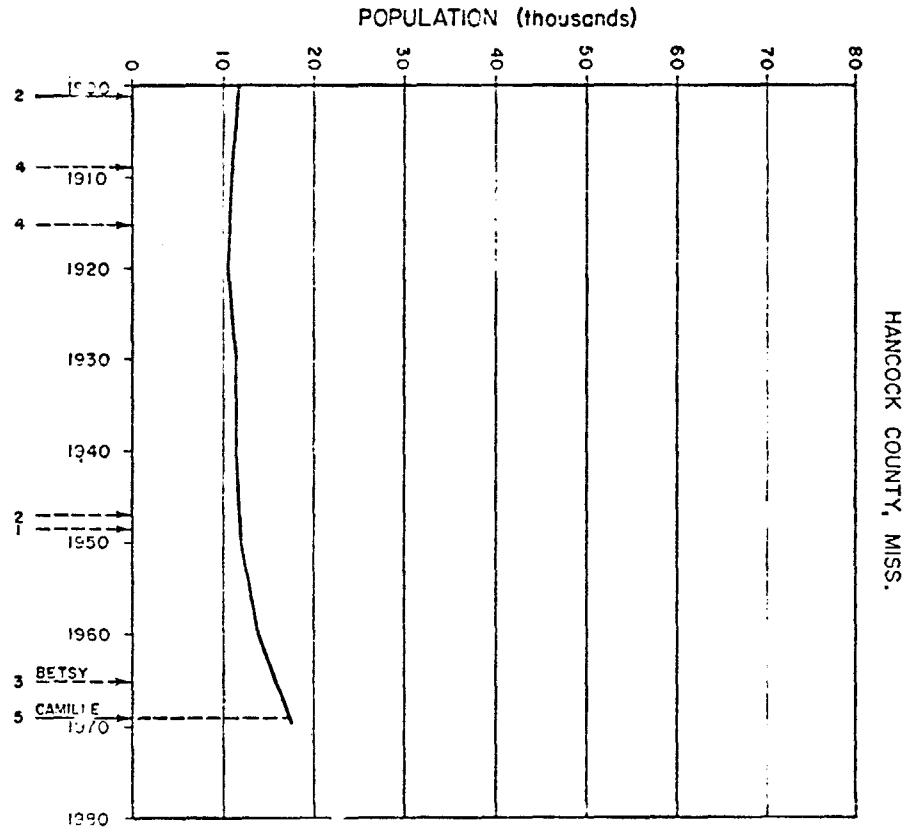
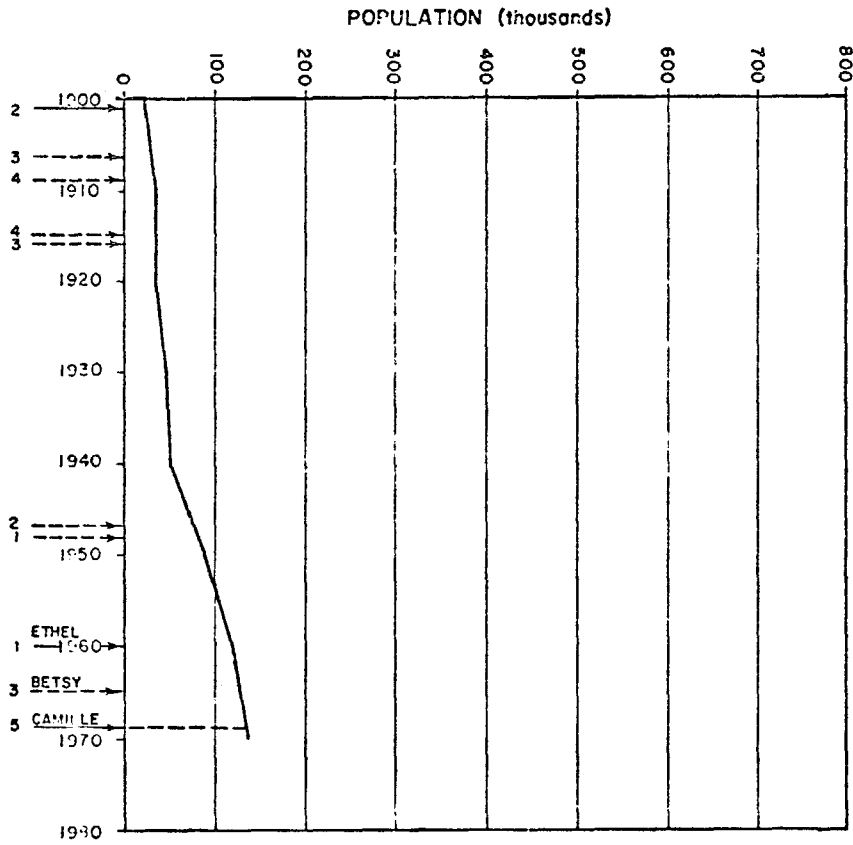




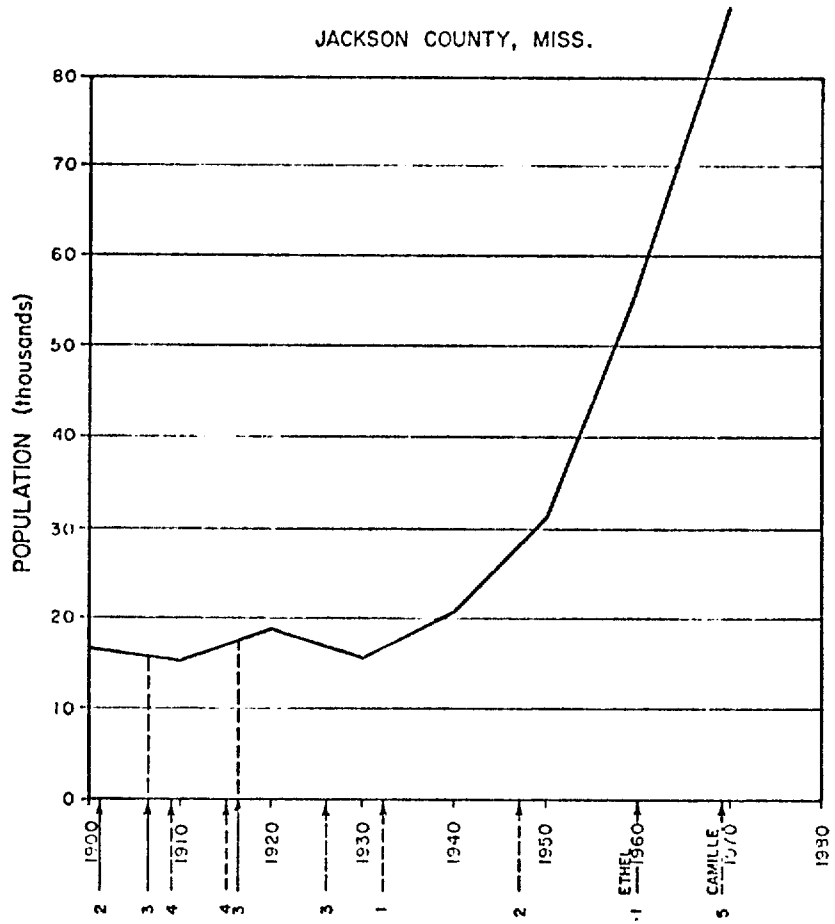
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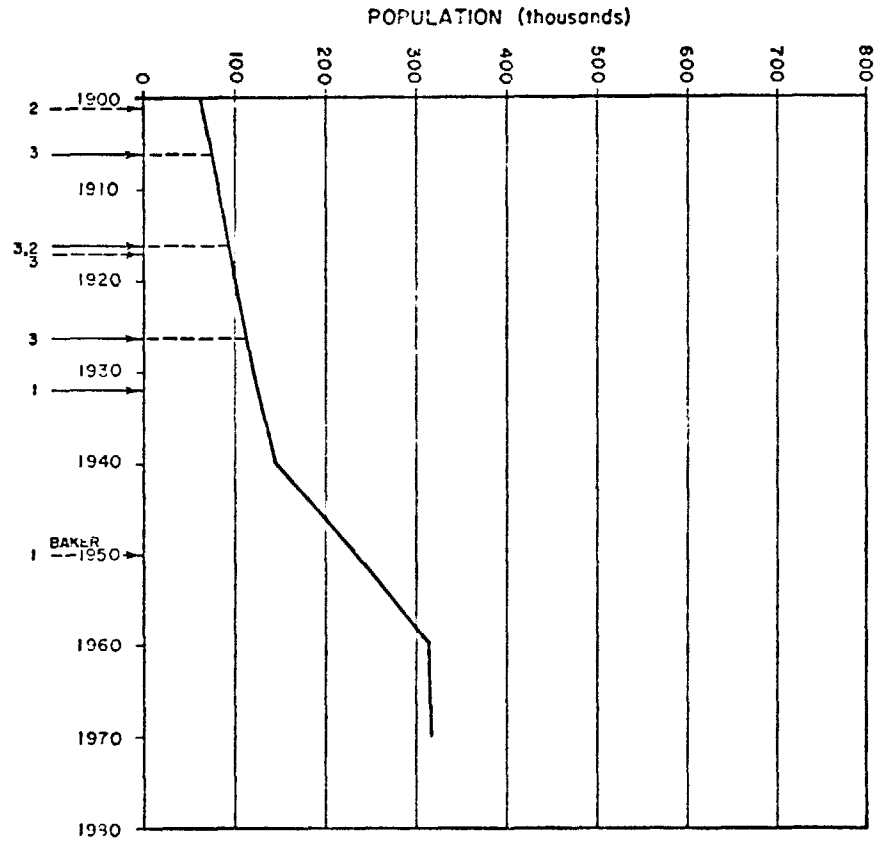
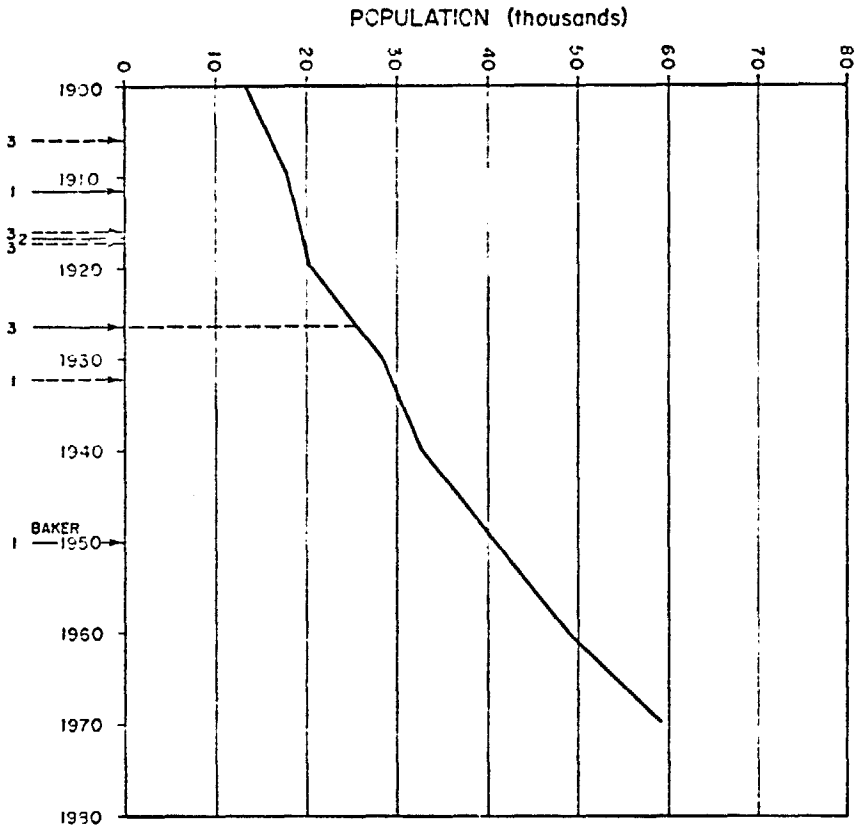
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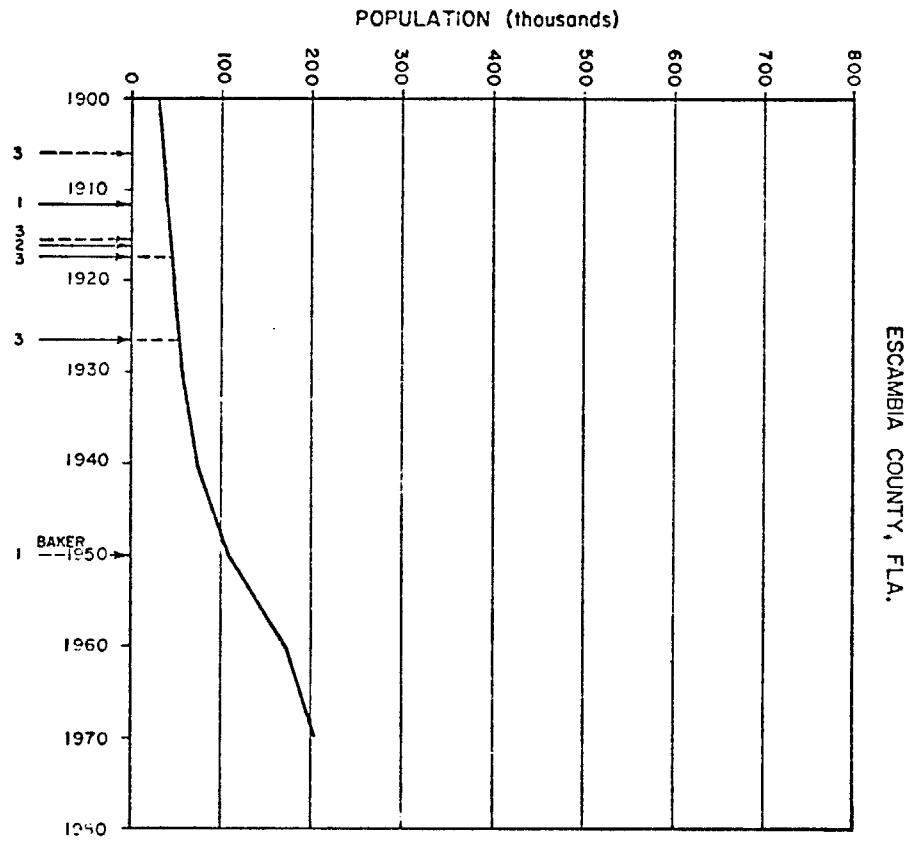
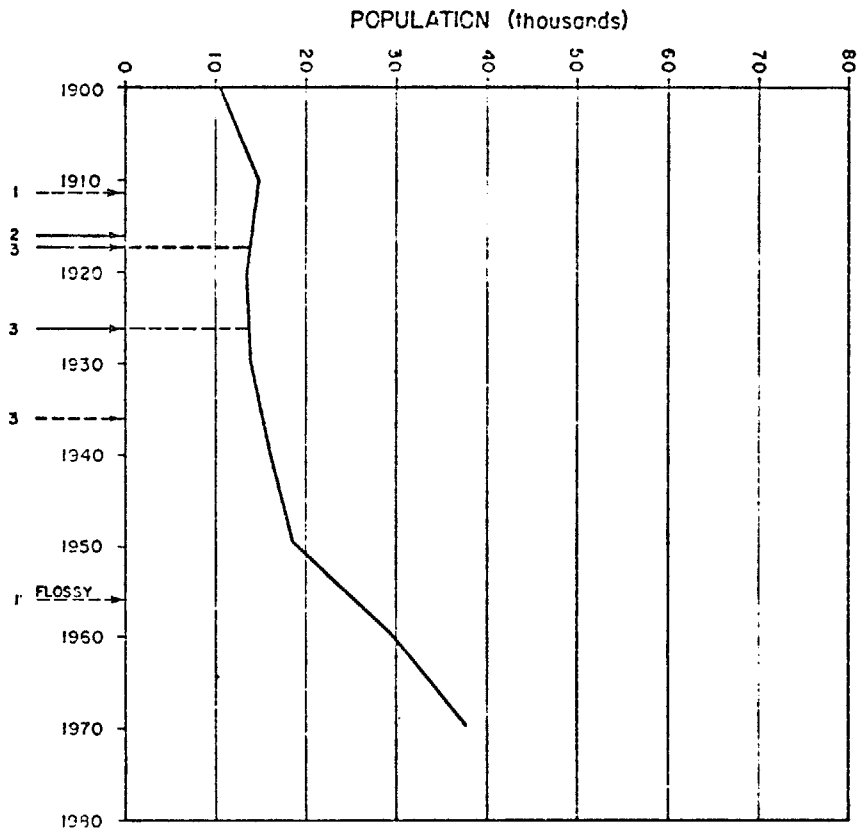


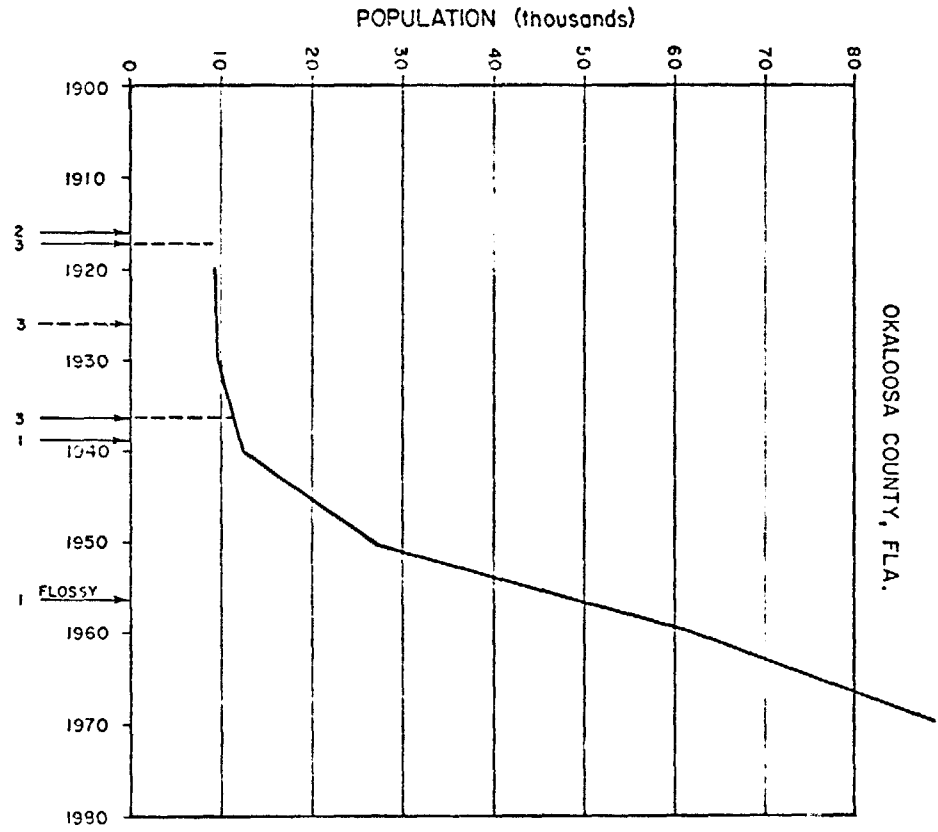
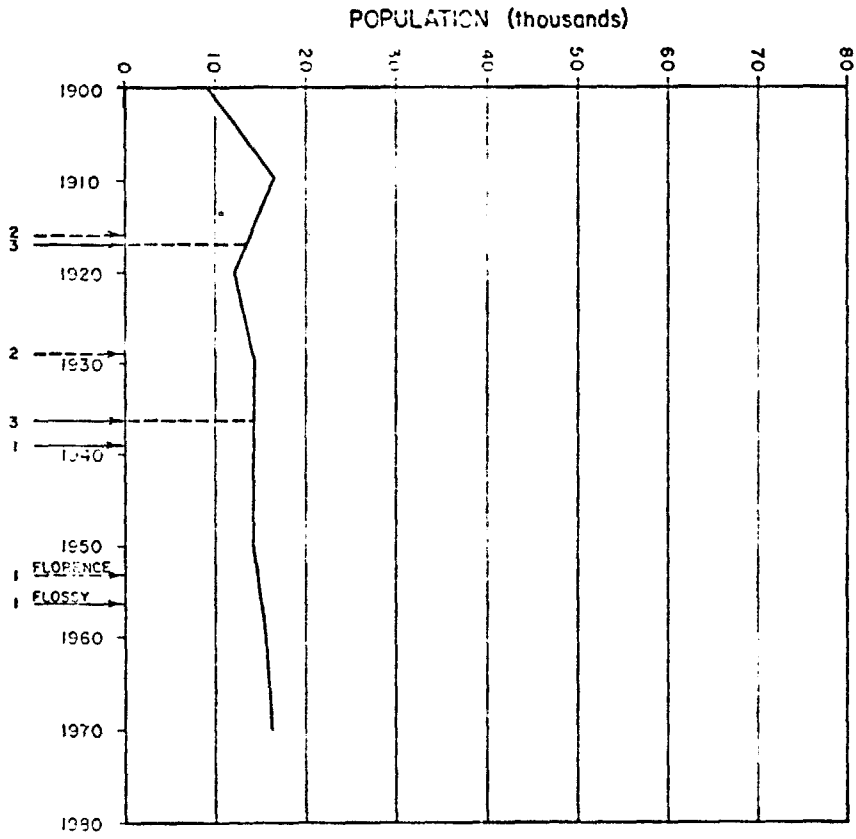
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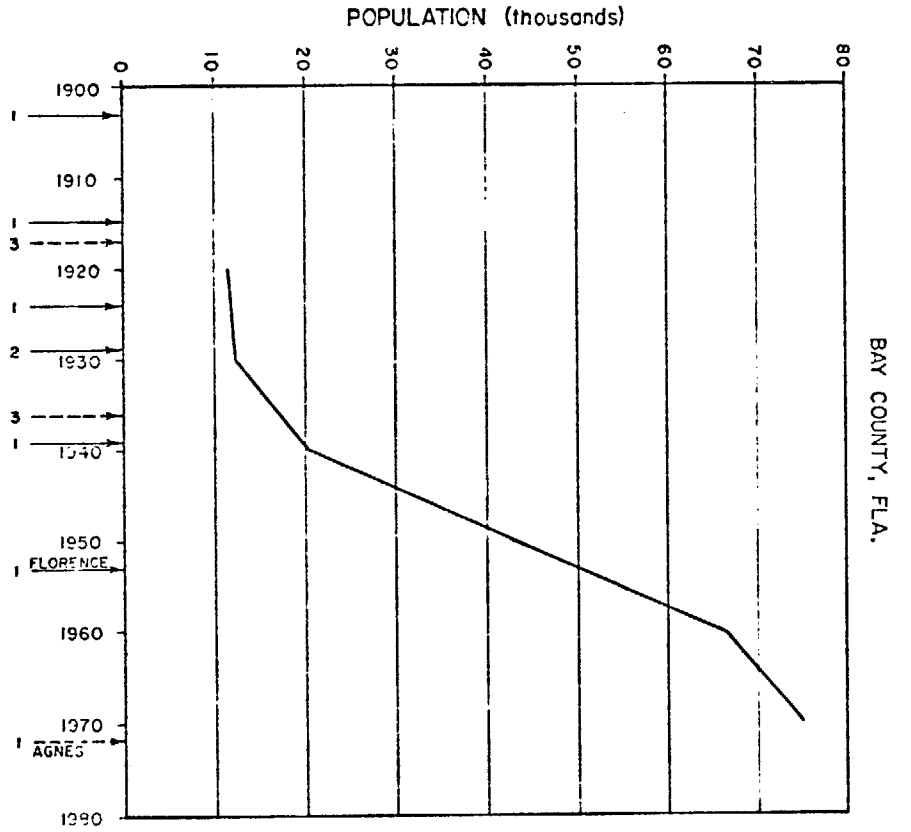
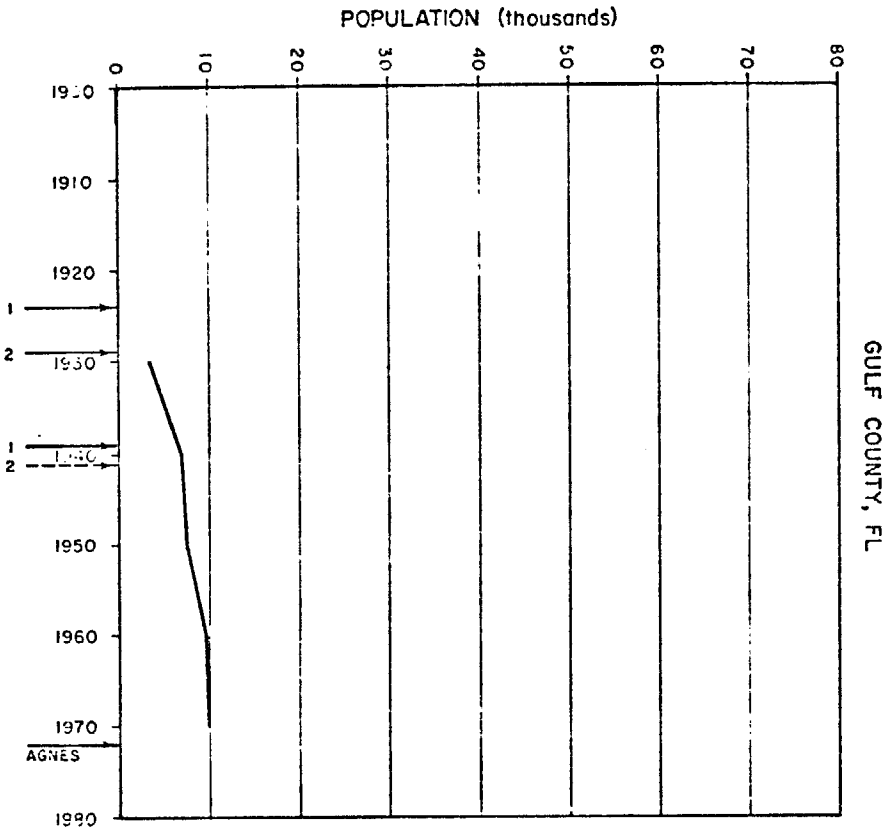


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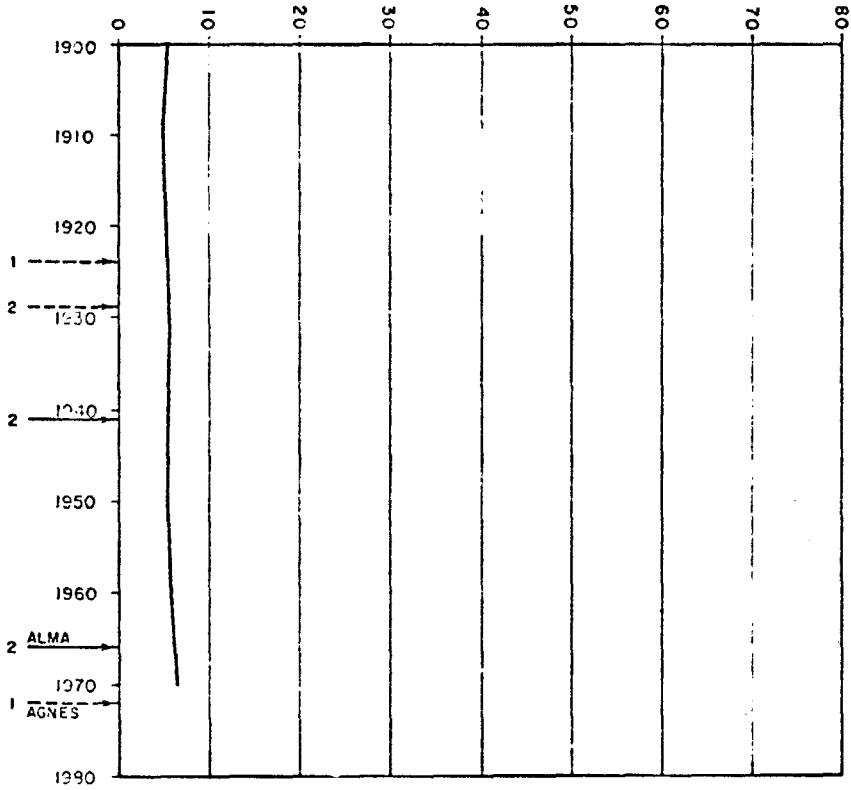




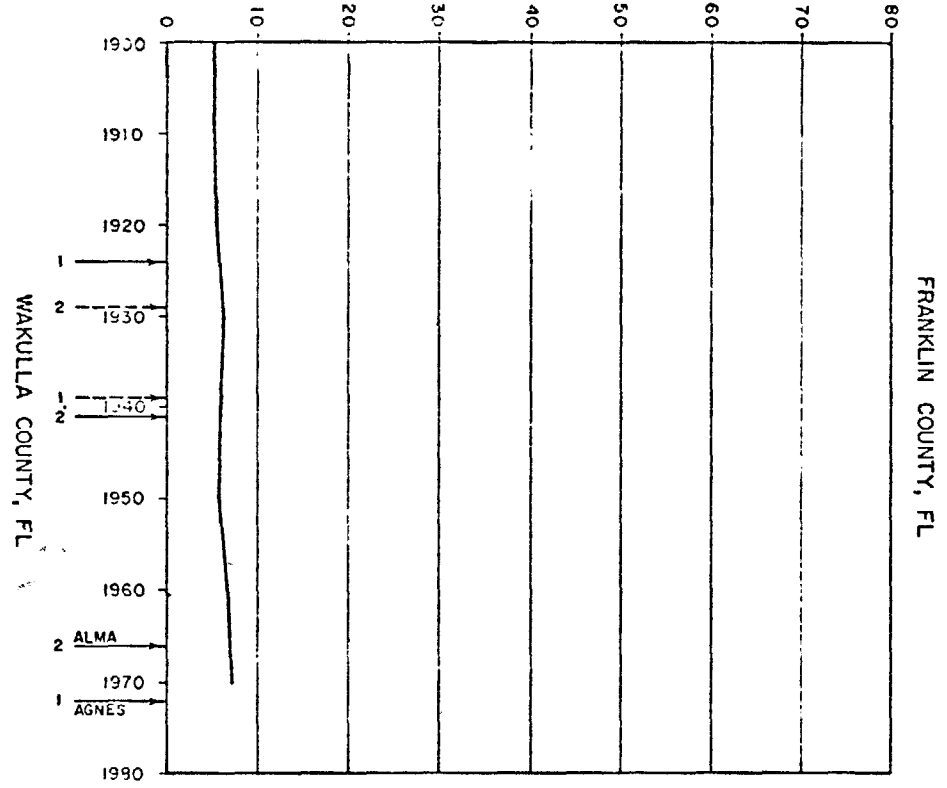


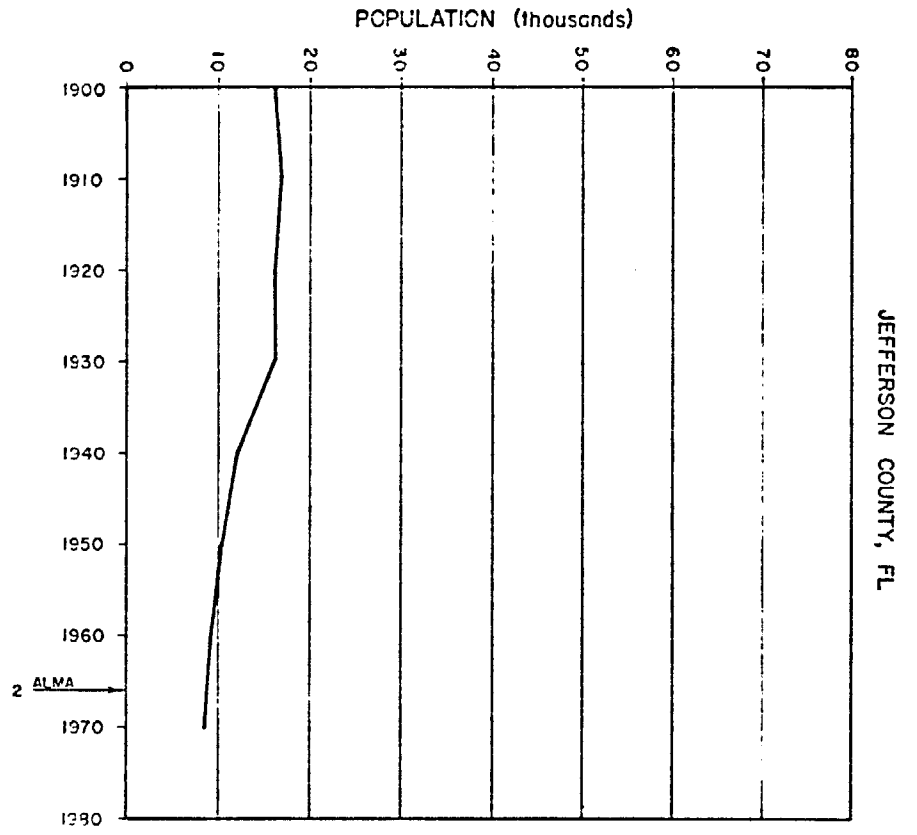
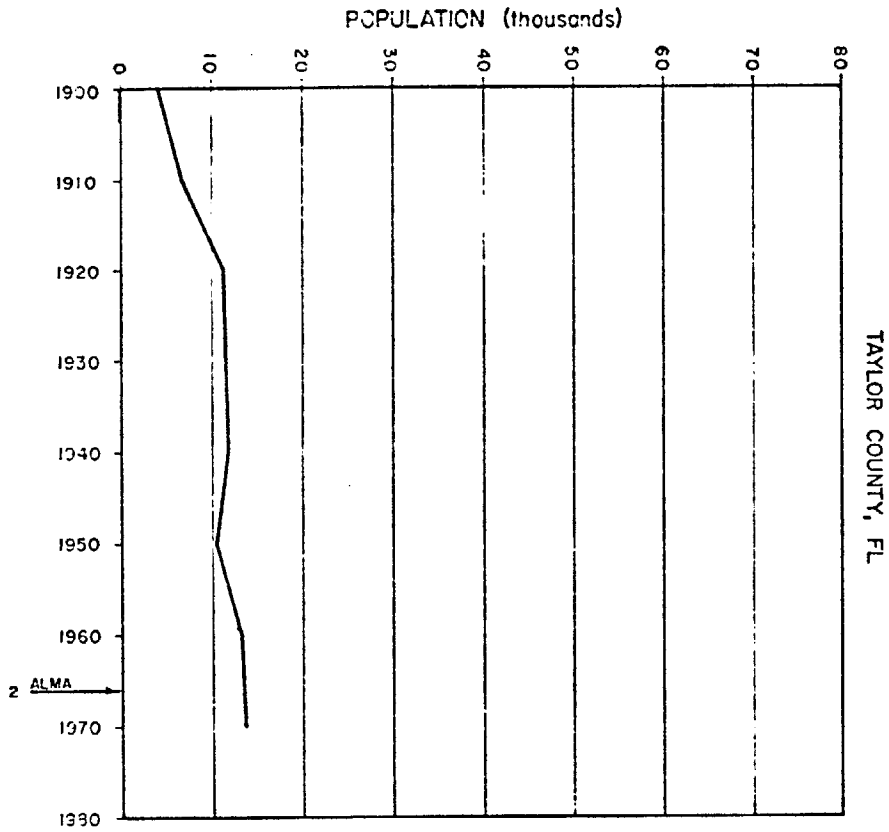


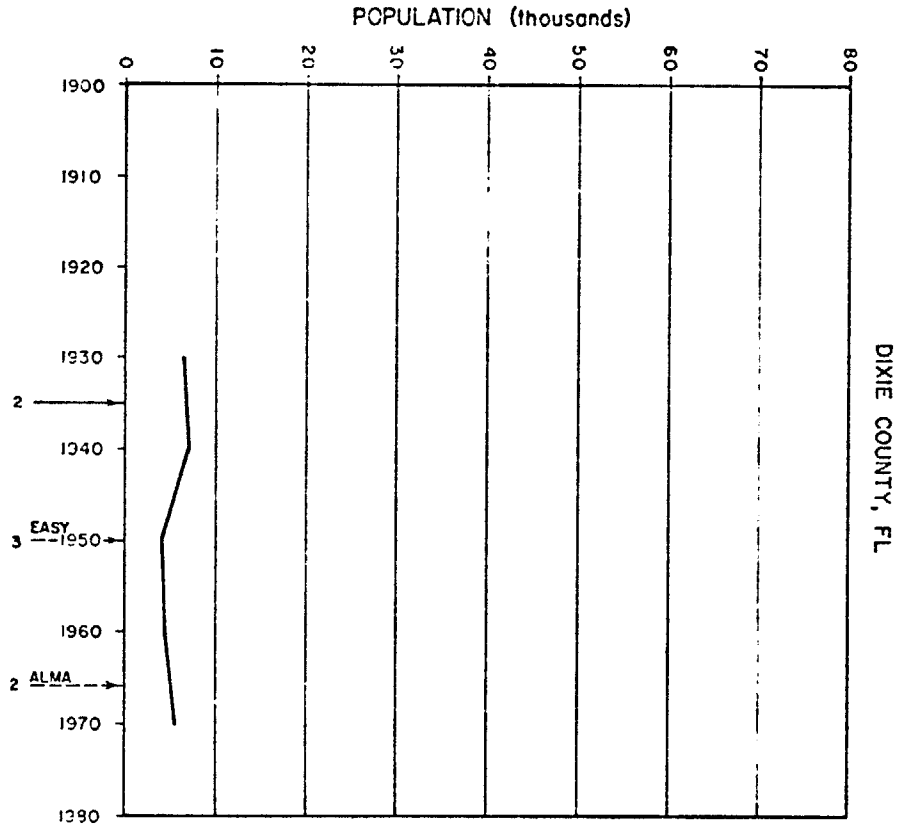
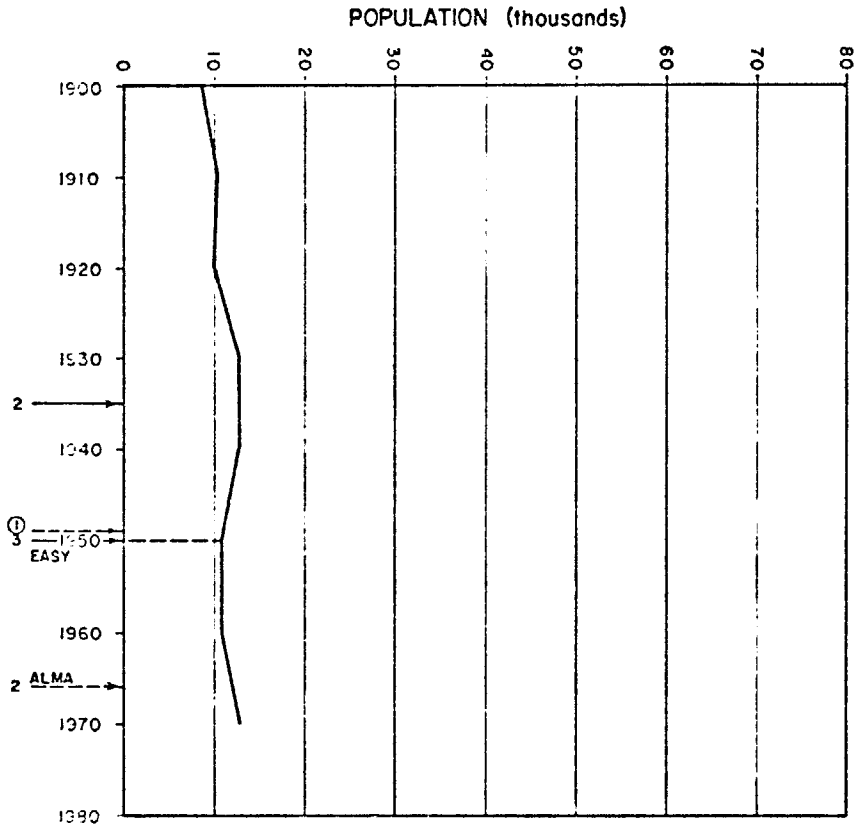
POPULATION (thousands)

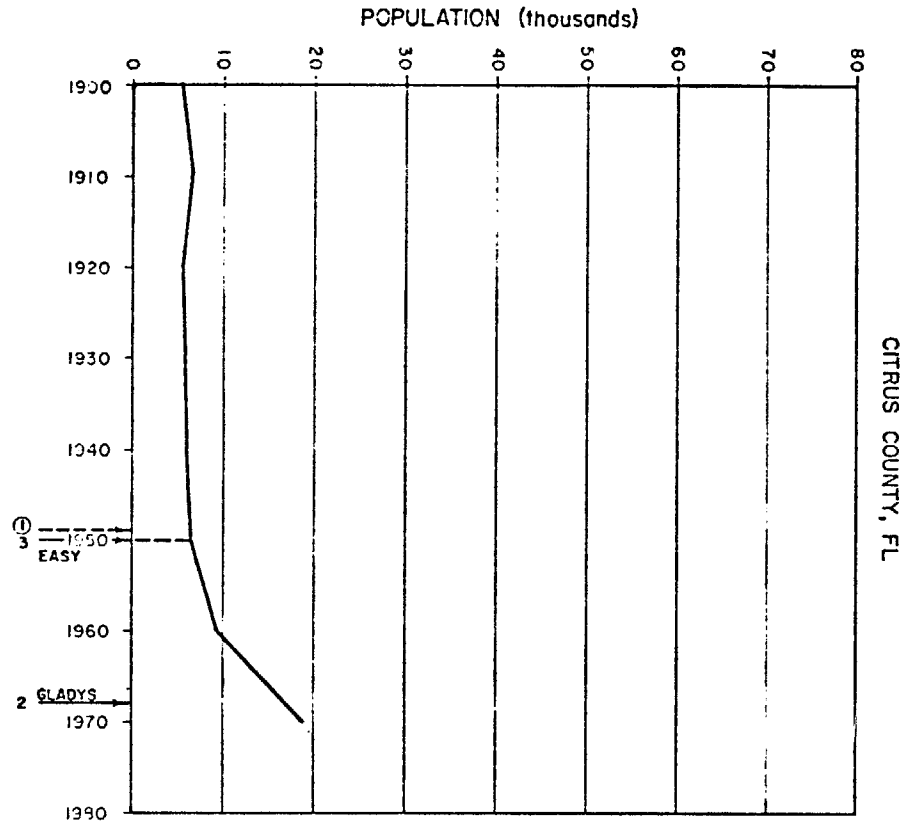
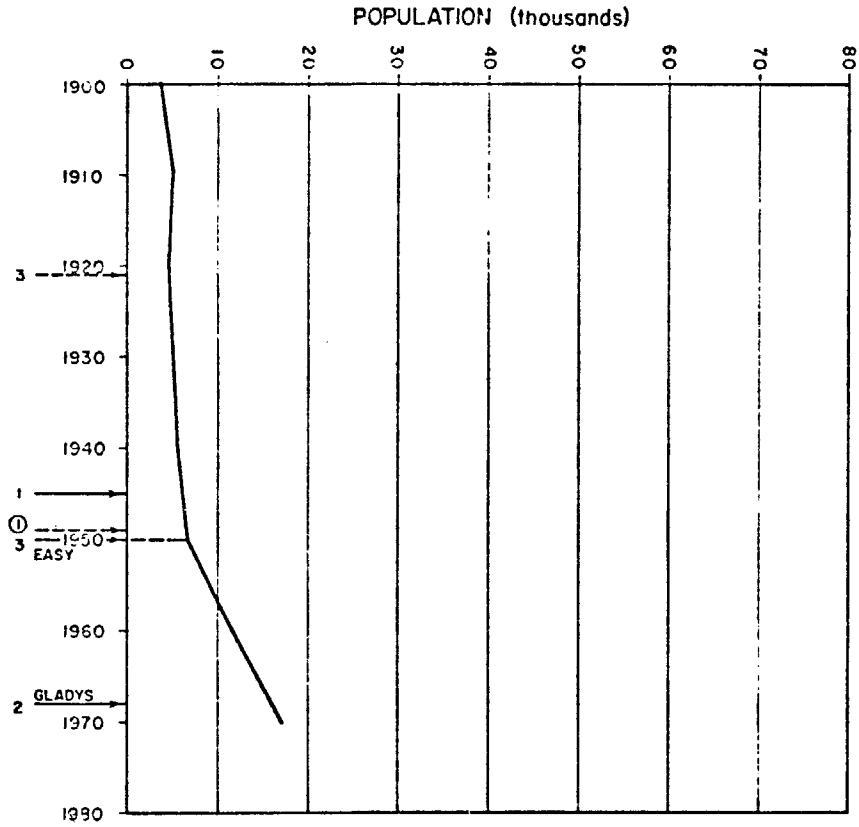


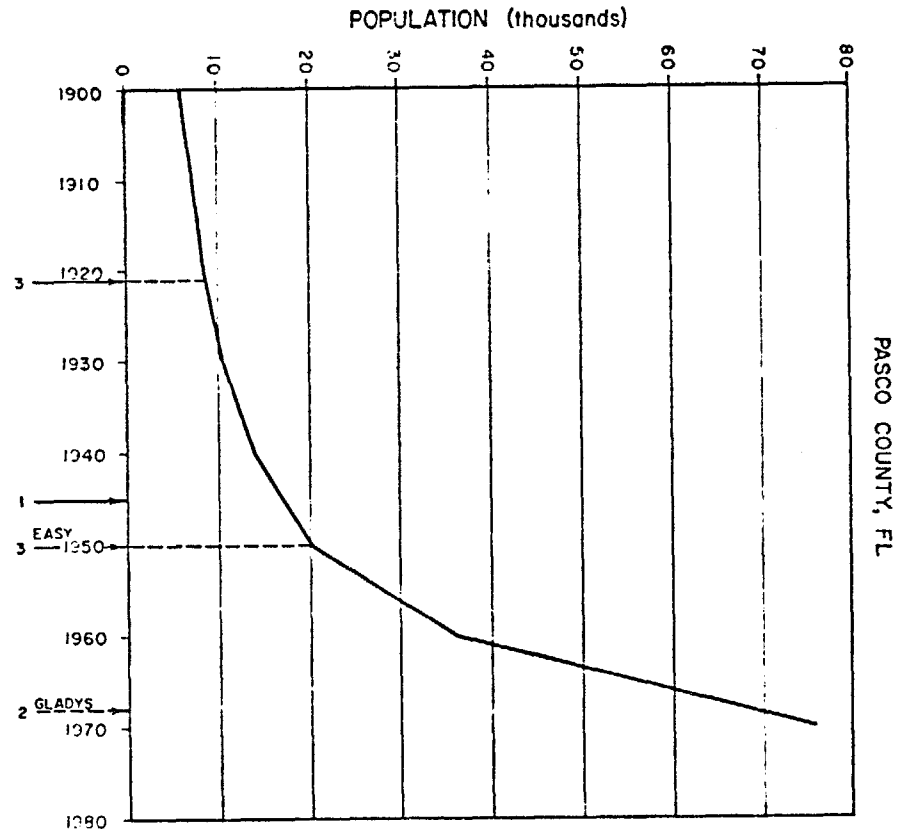
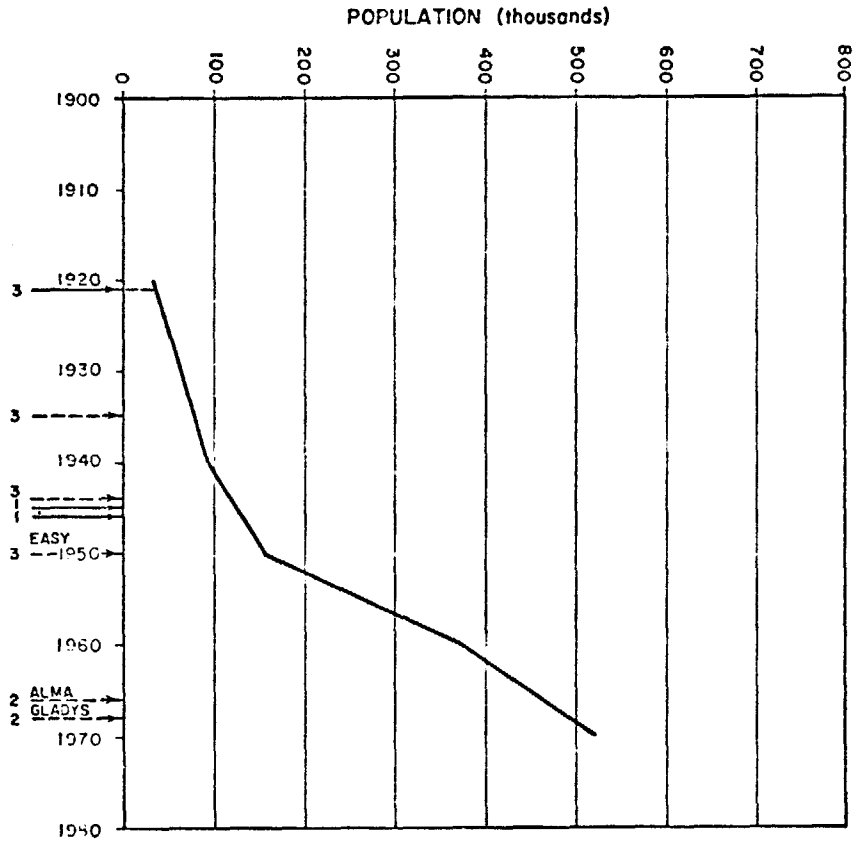
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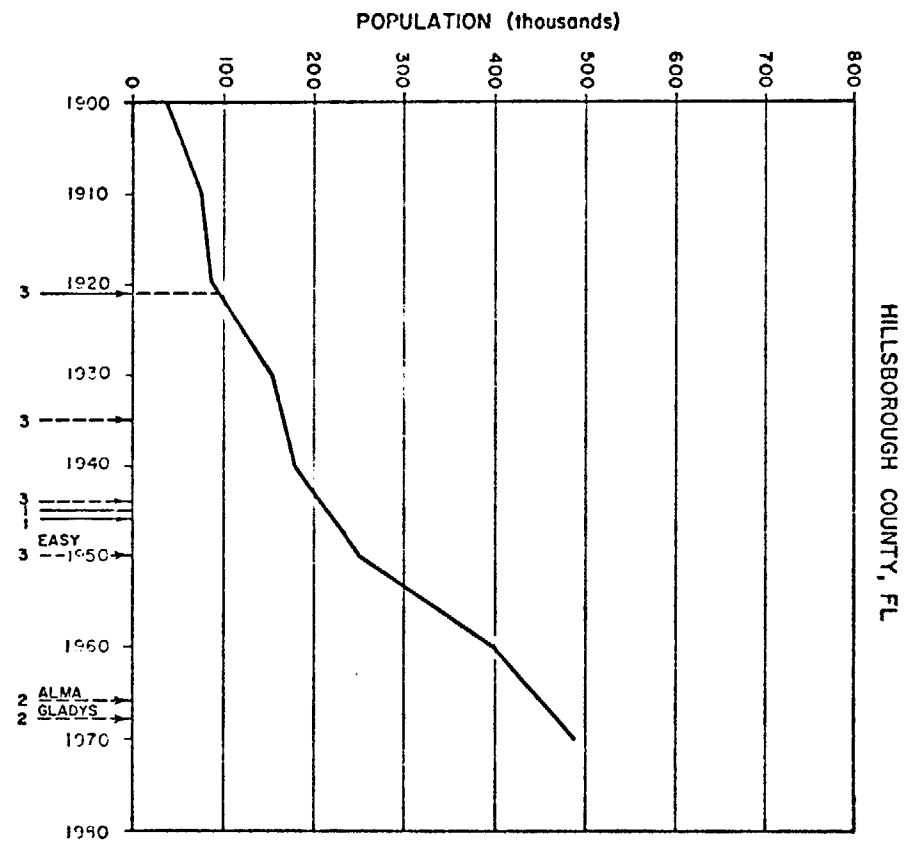
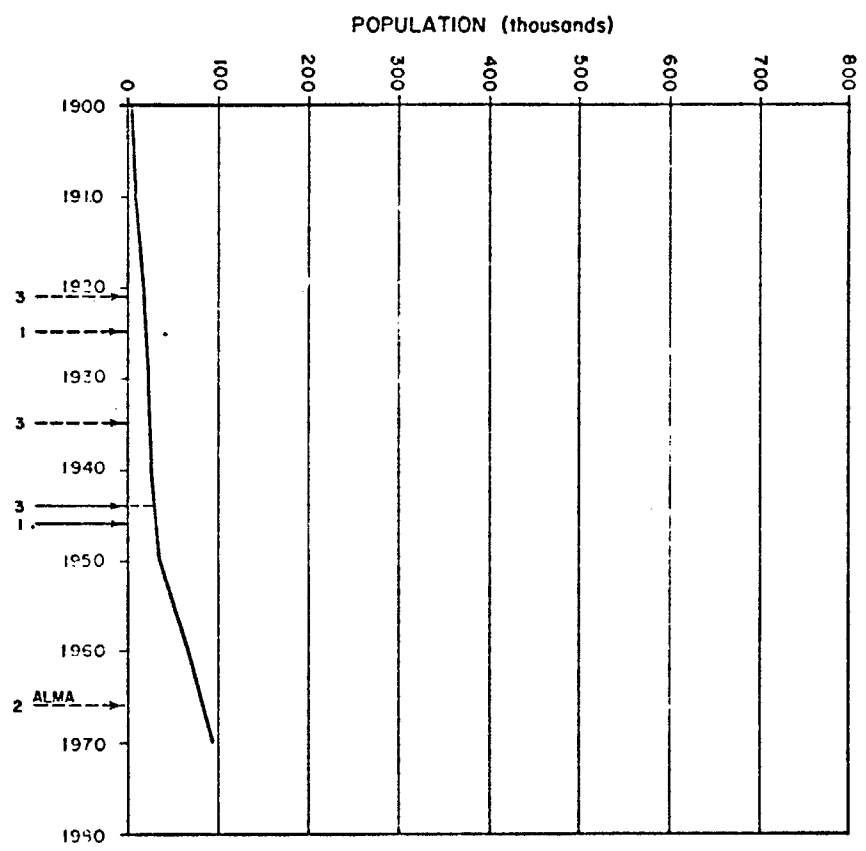




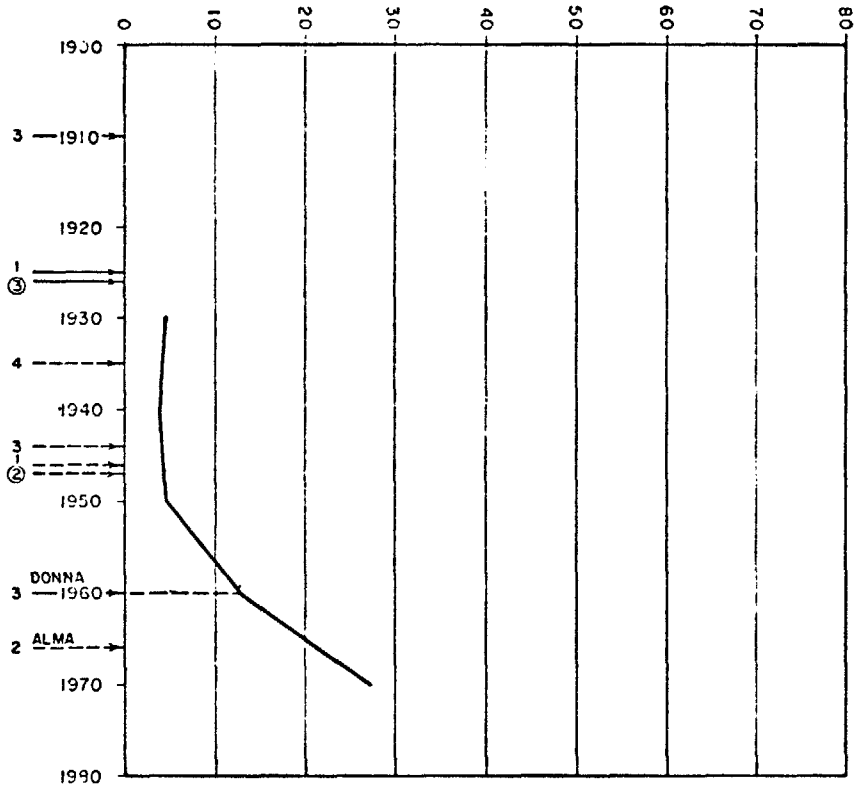






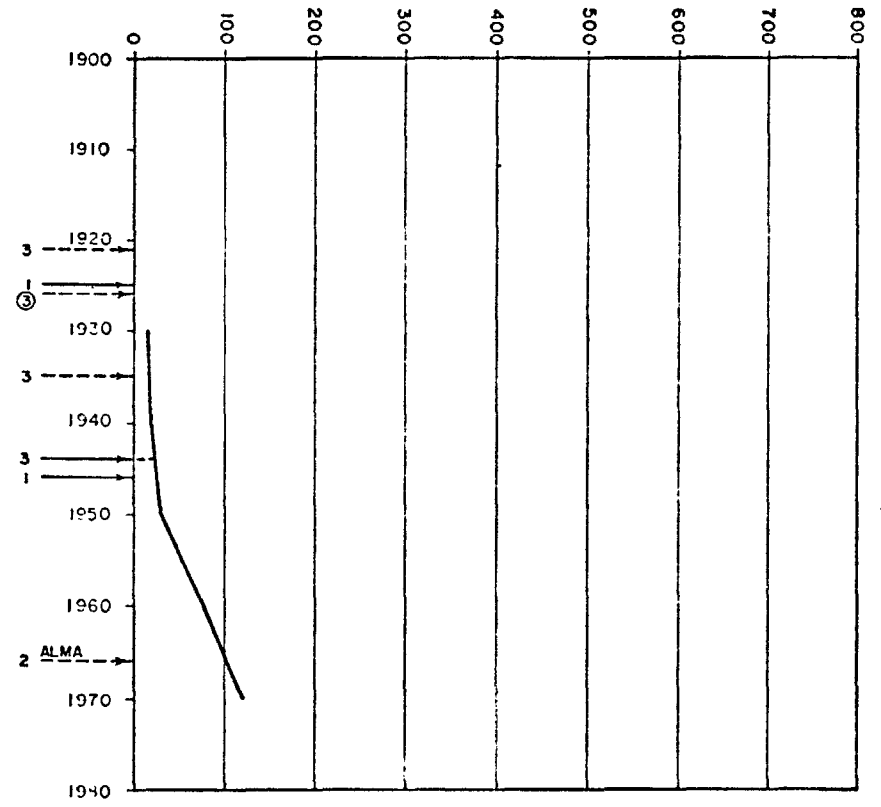


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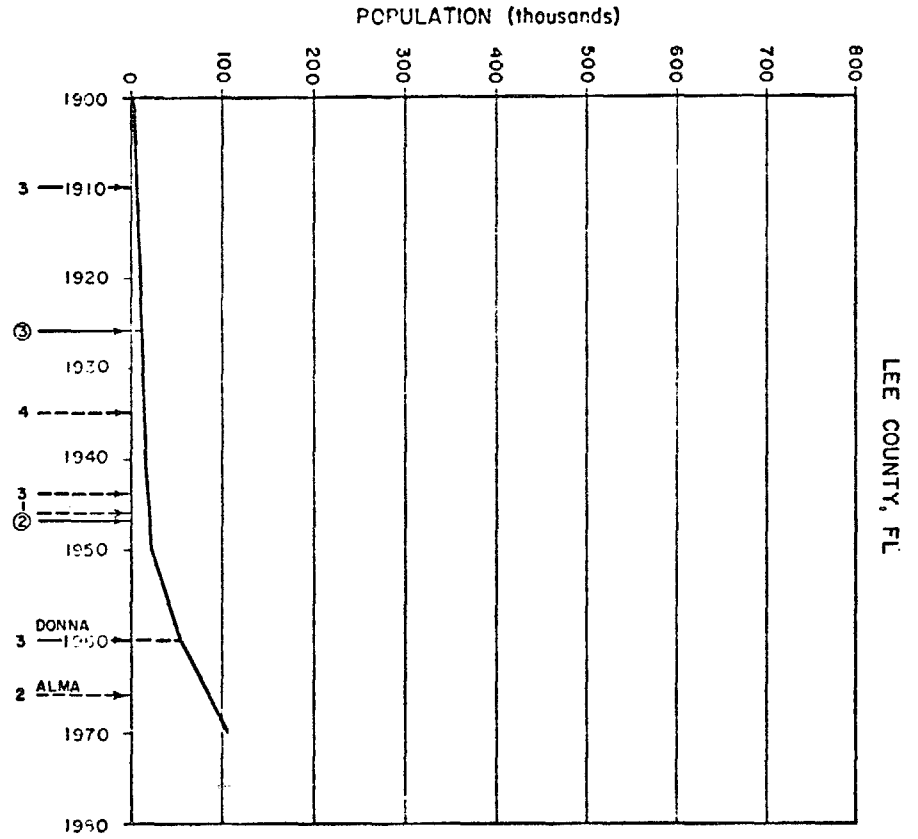
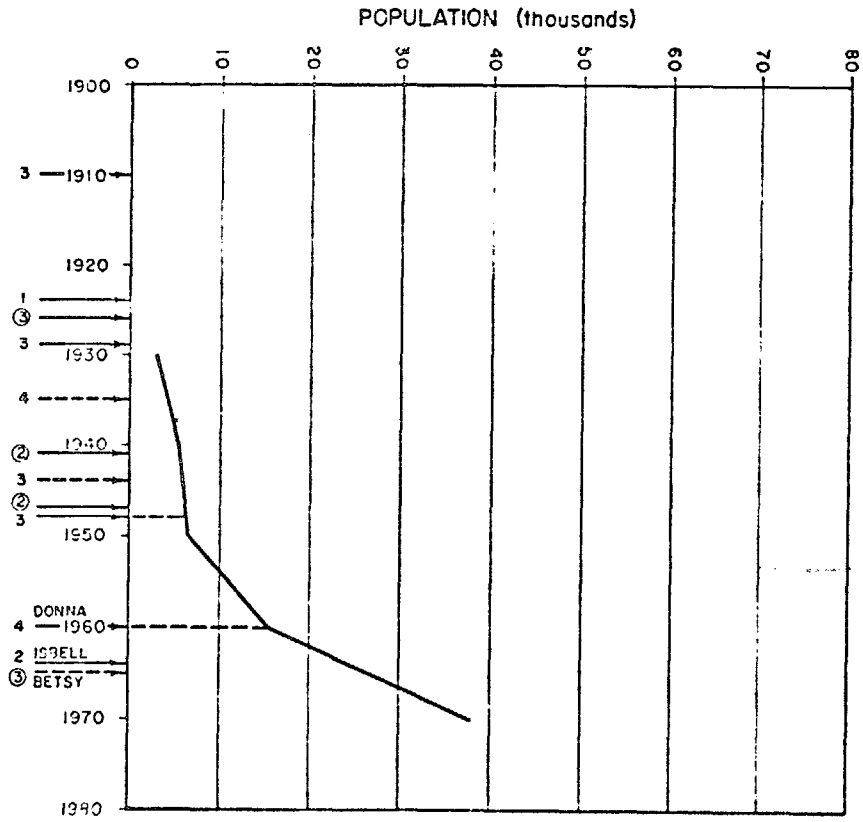


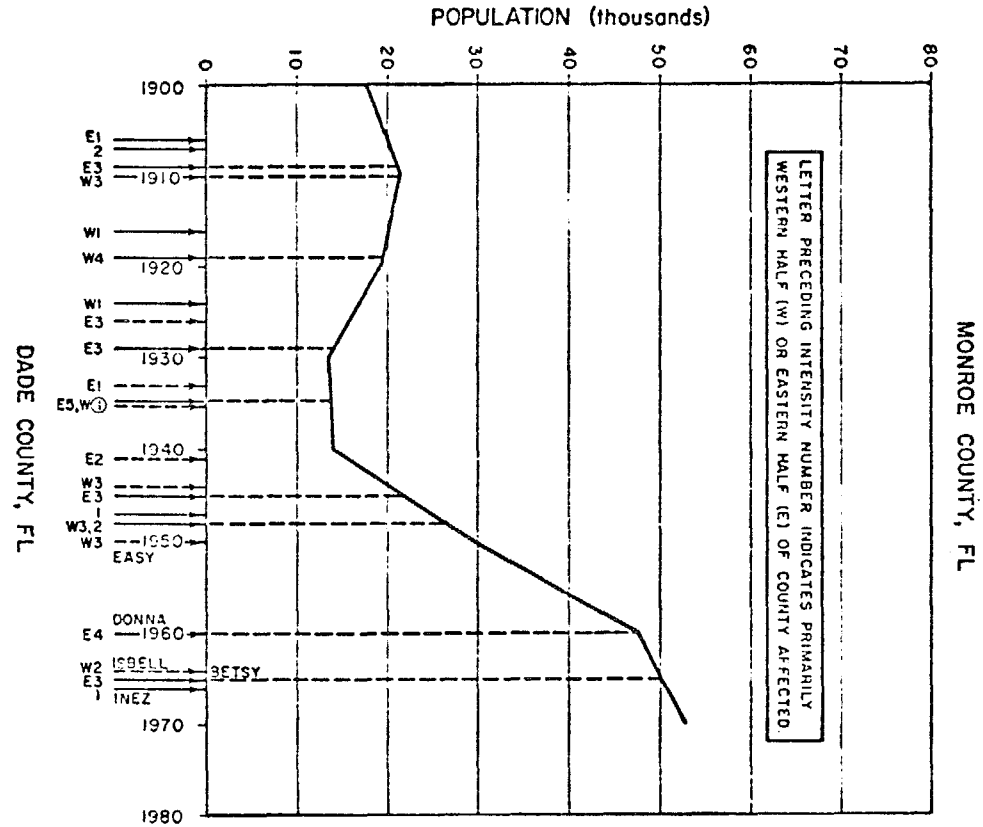
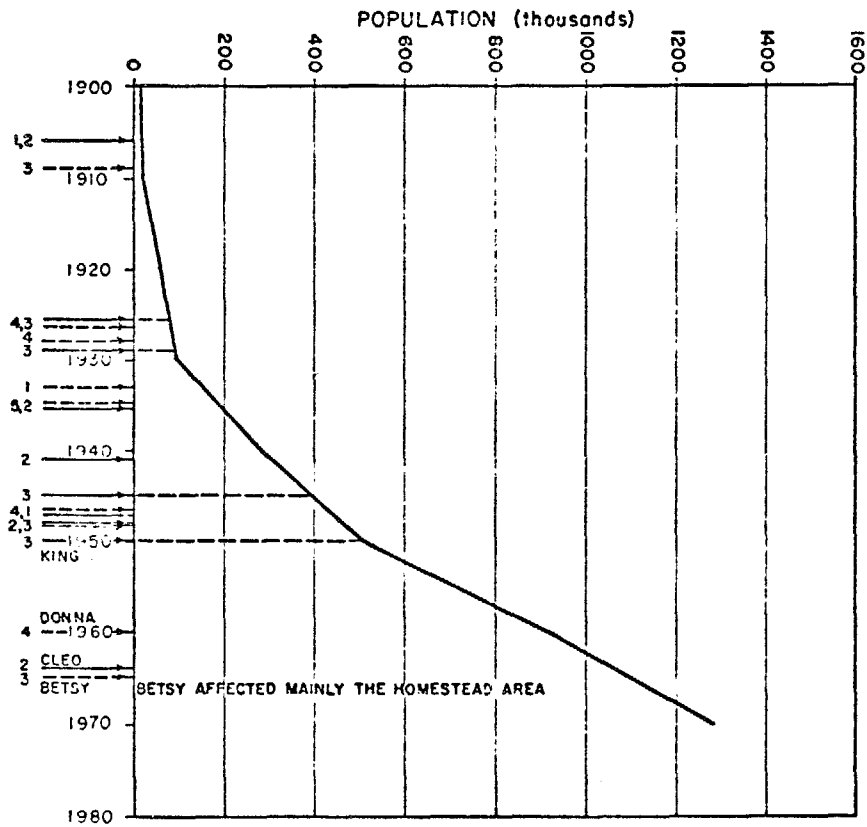
CHARLOTTE COUNTY, FL

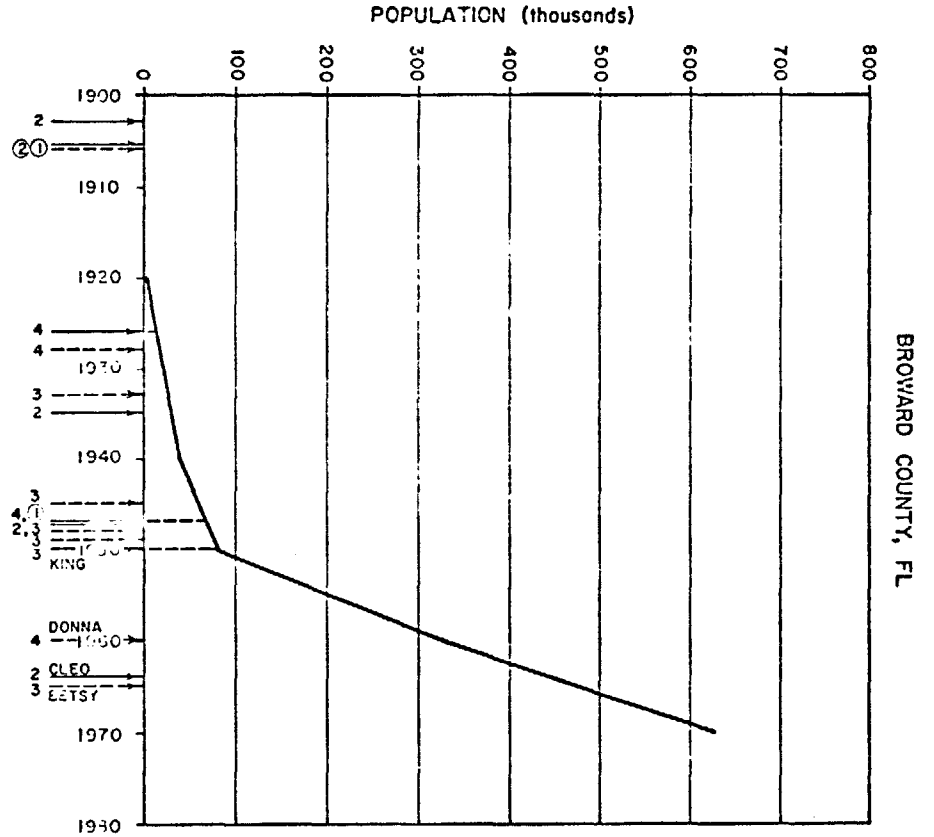
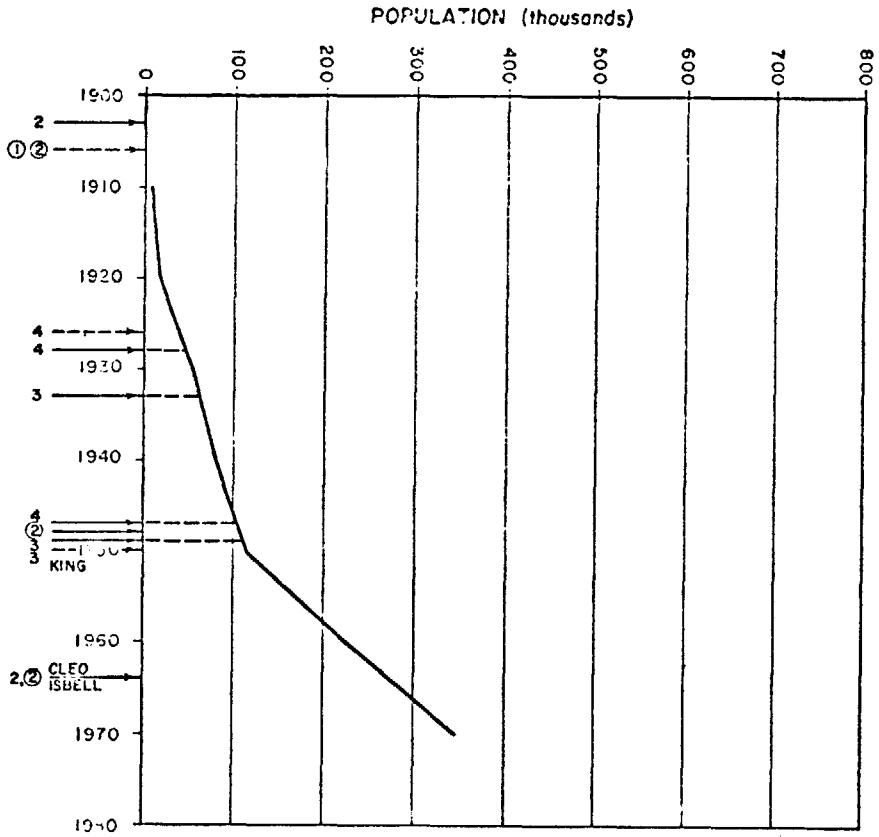
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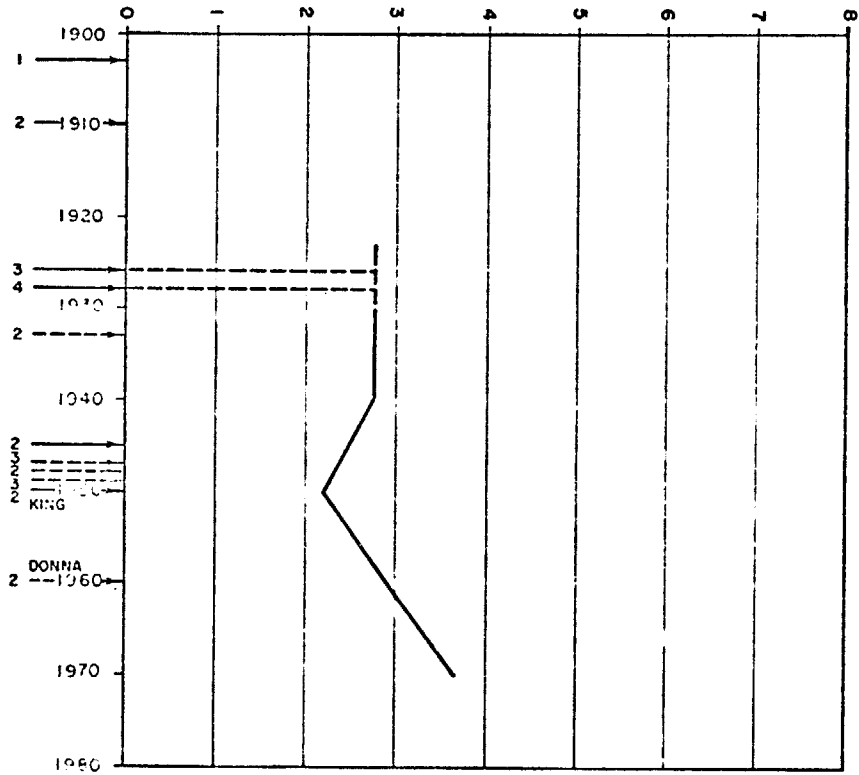
SARASOTA COUNTY, FL





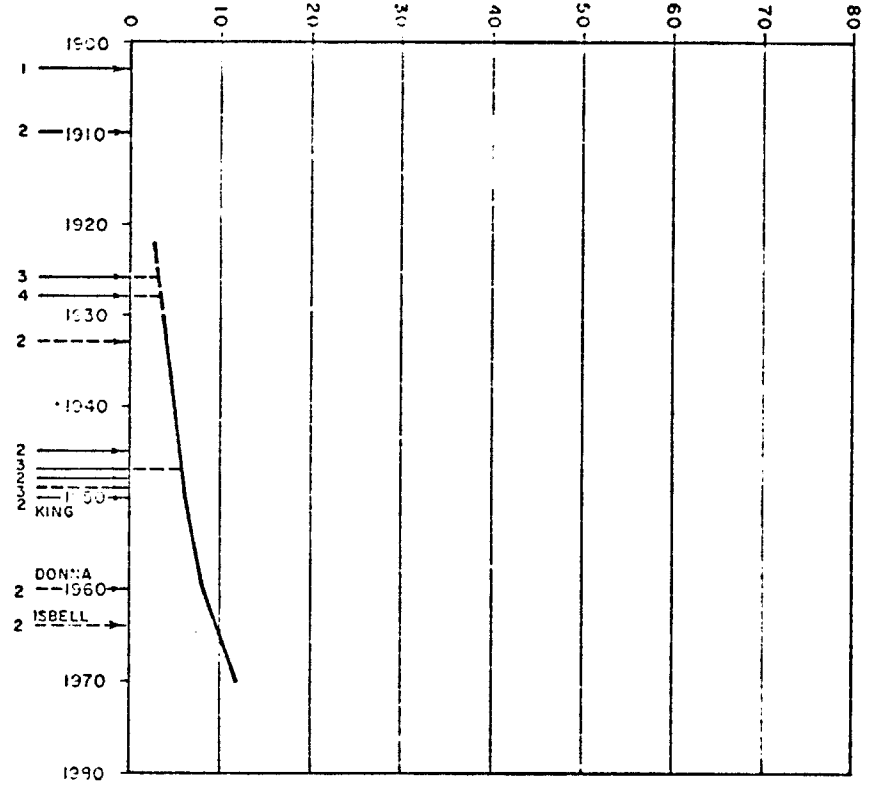


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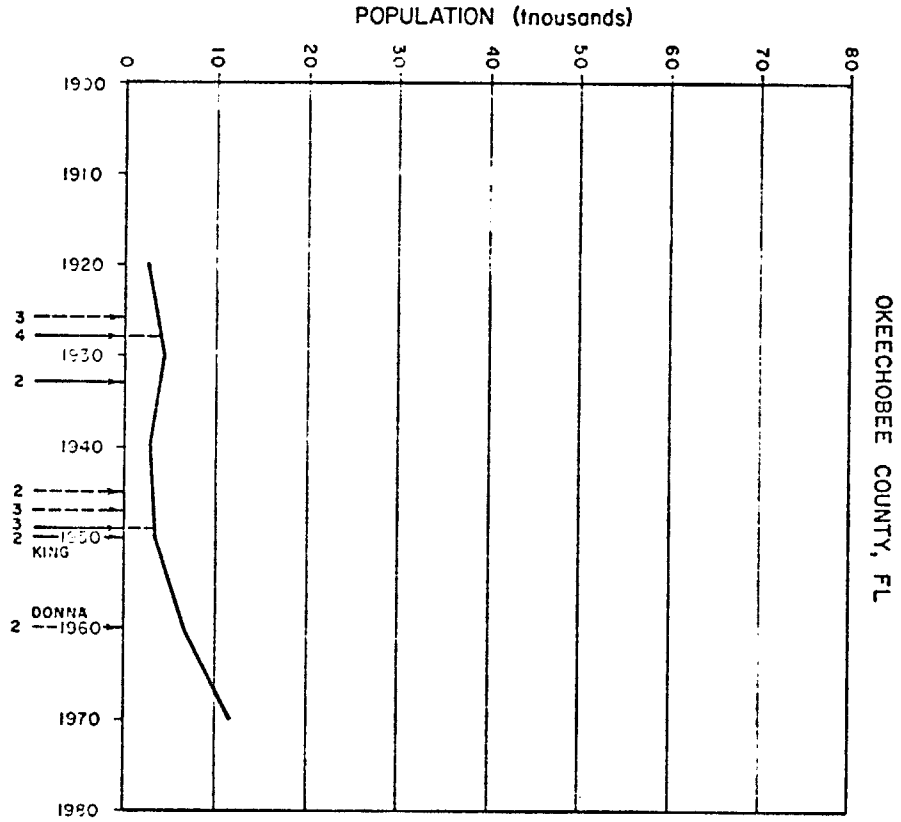
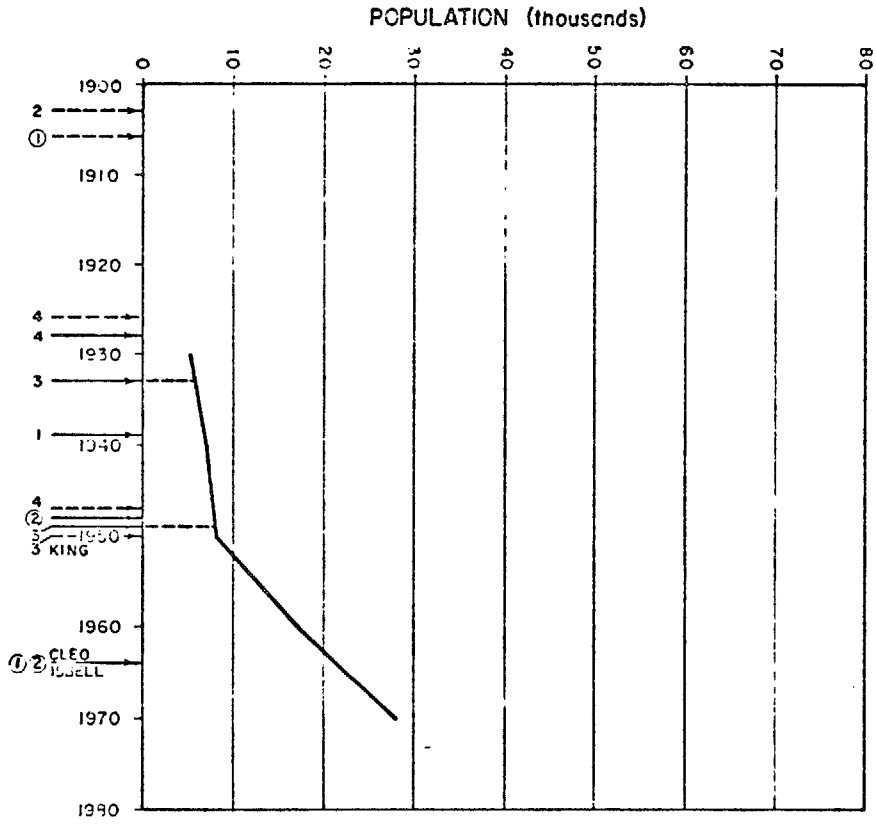


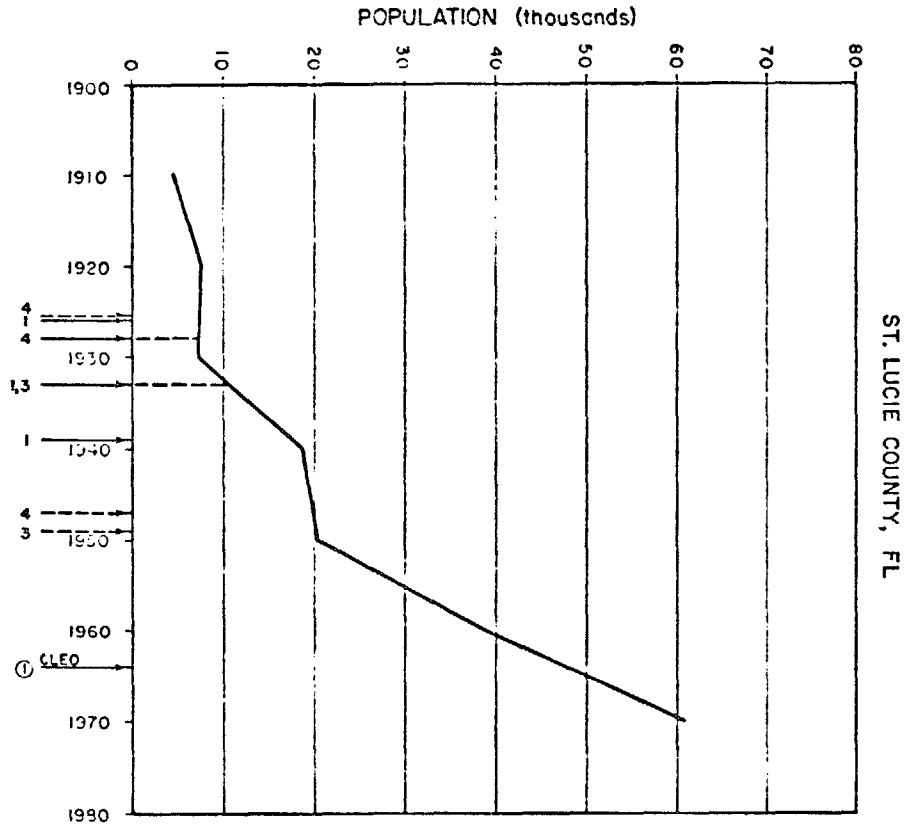
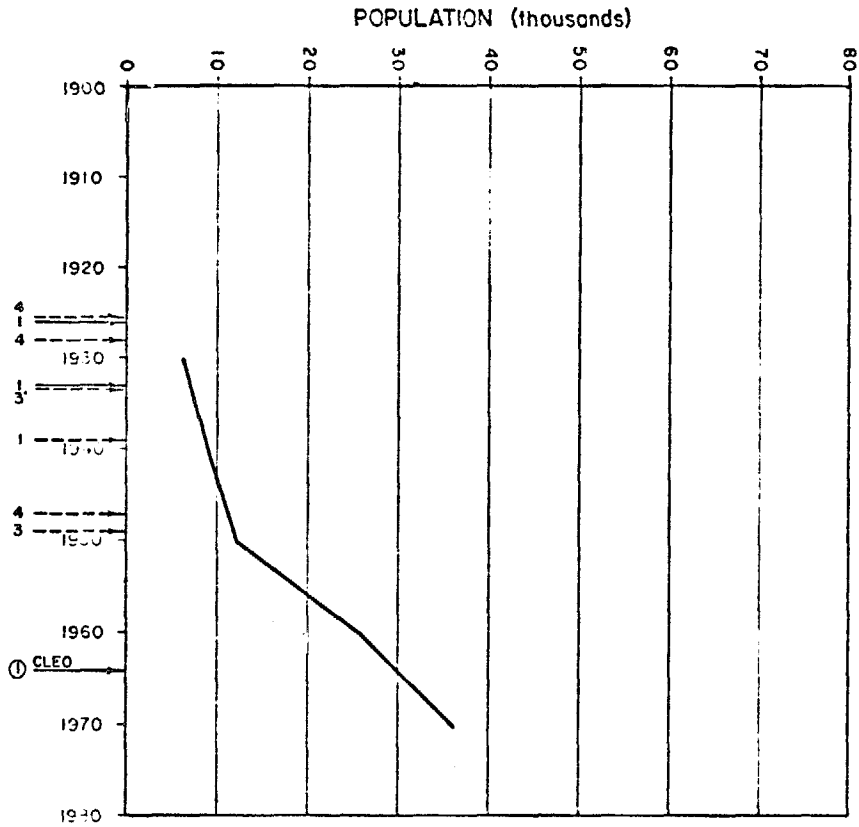
GLADES COUNTY, FL

POPULATION (thousands)



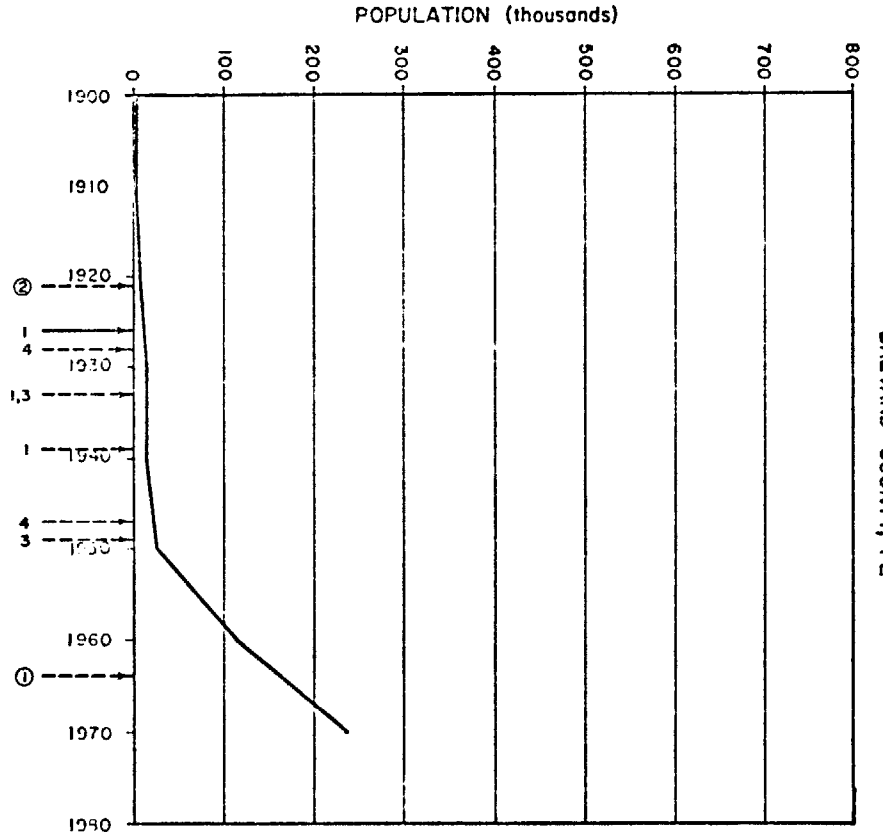
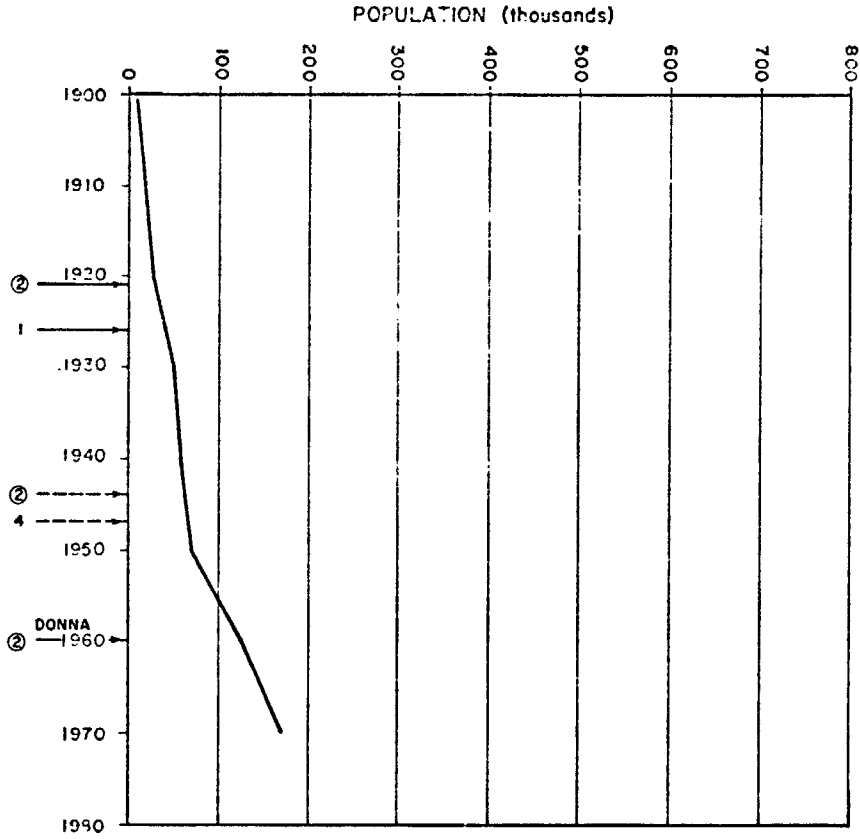
HENDRY COUNTY, FL

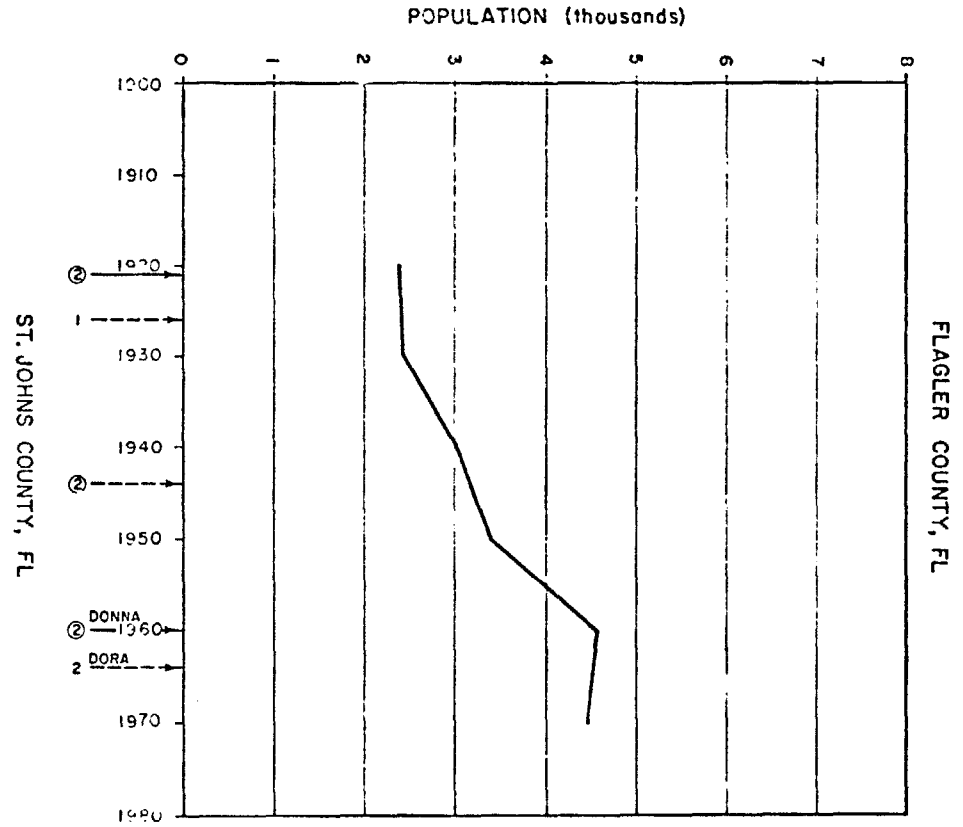
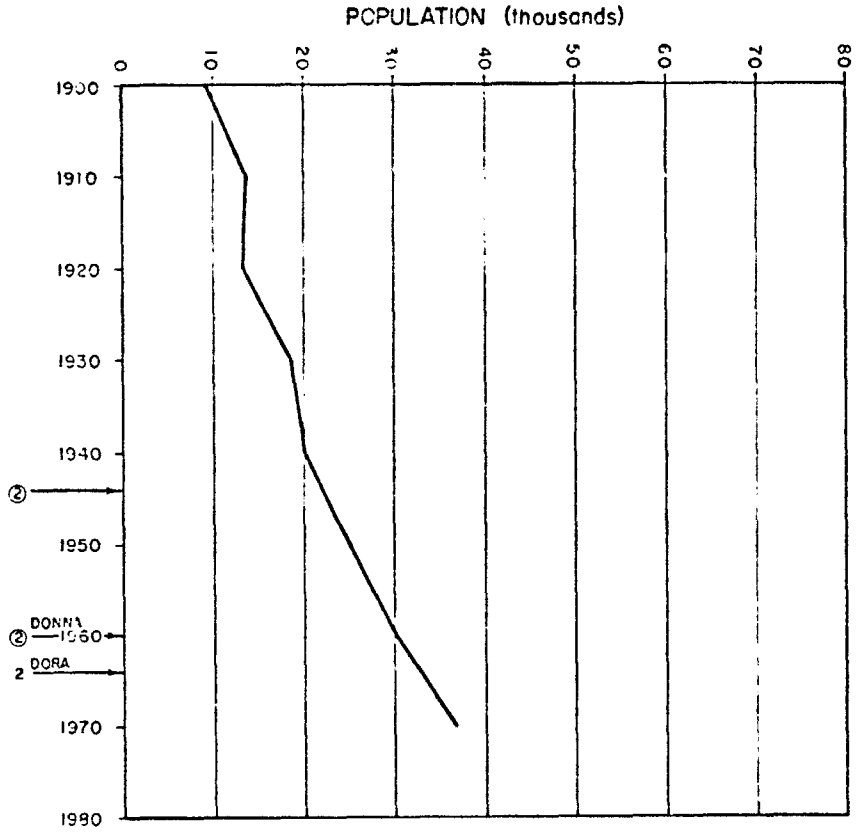


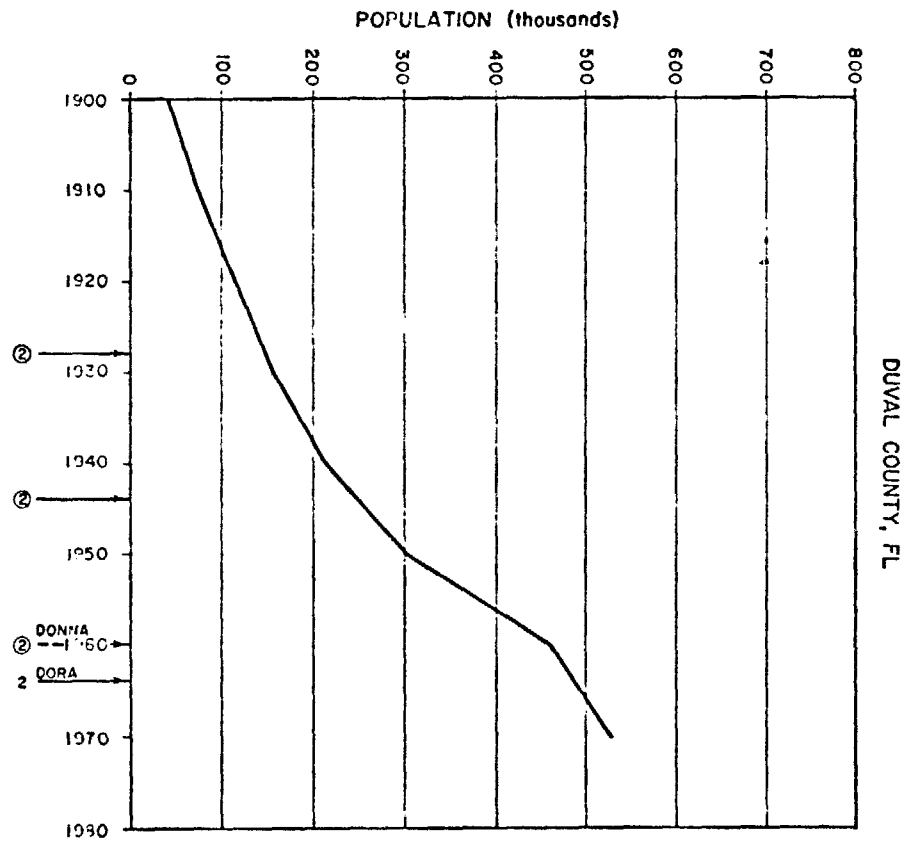
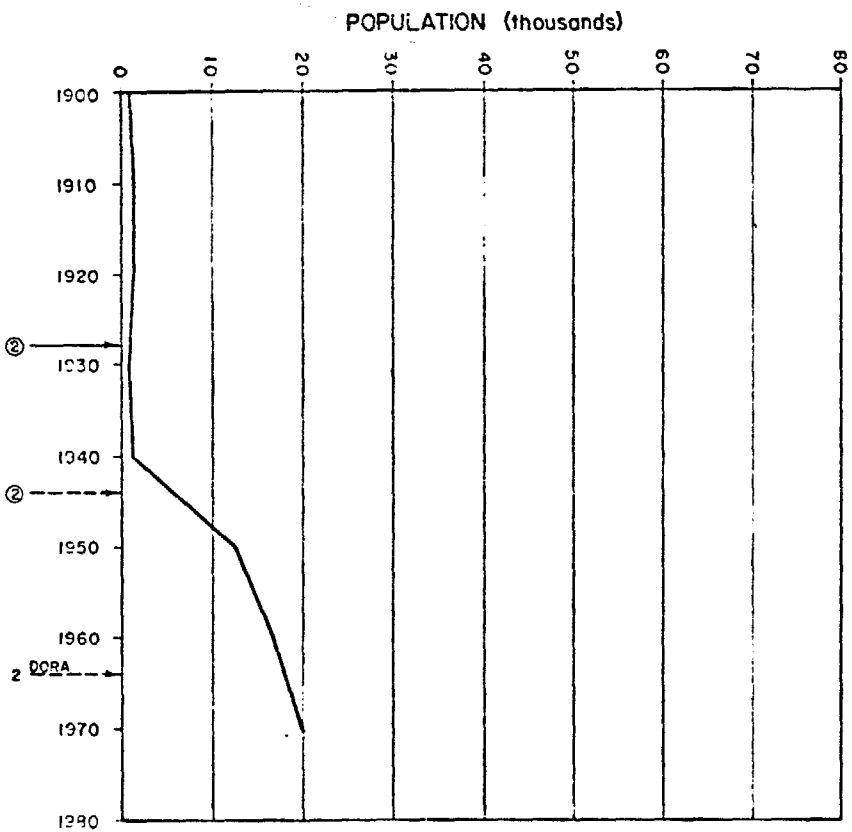


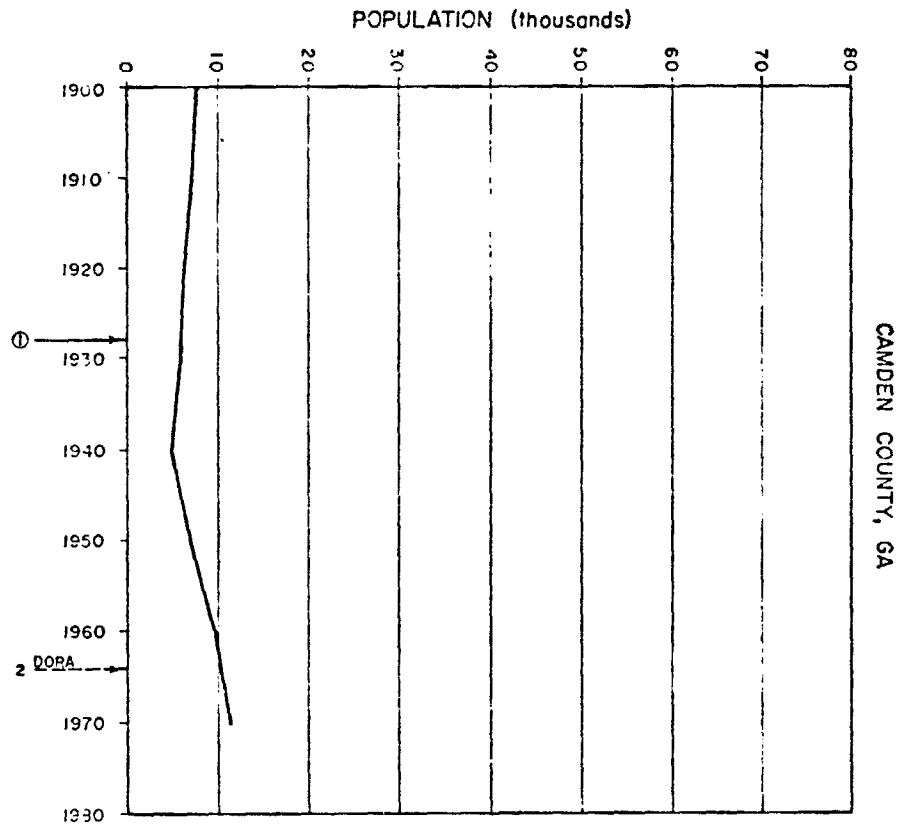
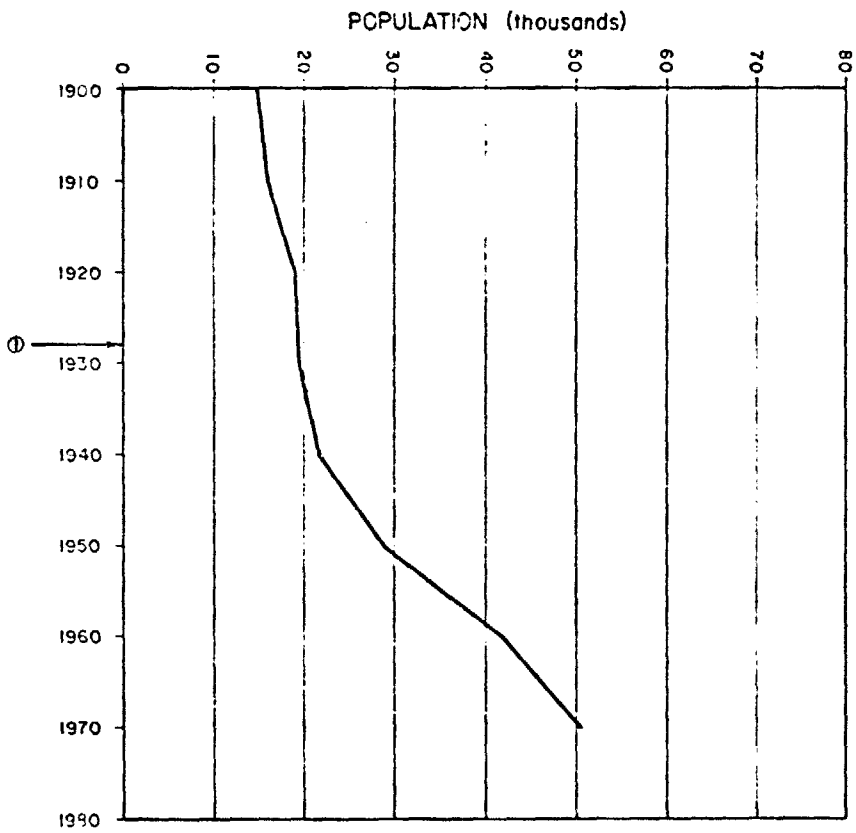
① CLEO

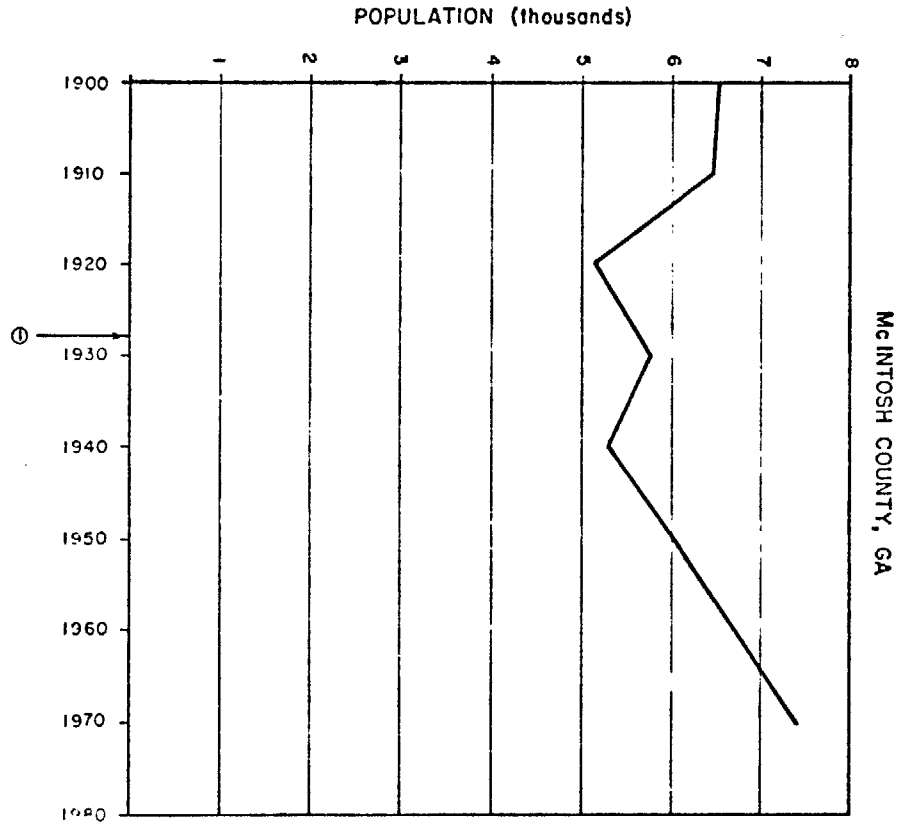
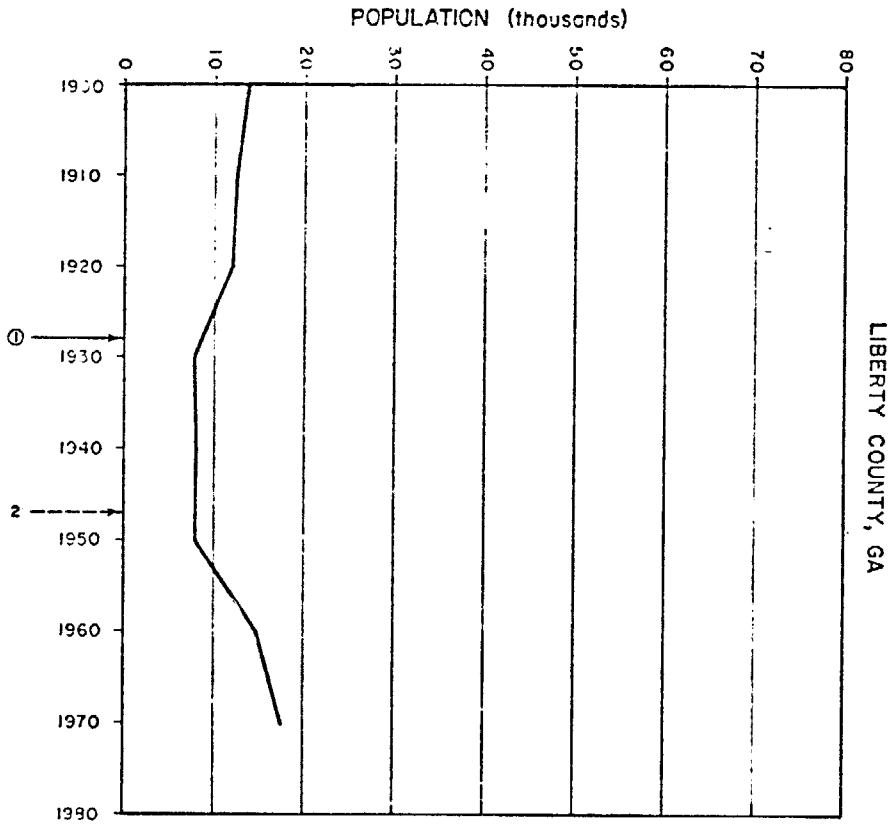
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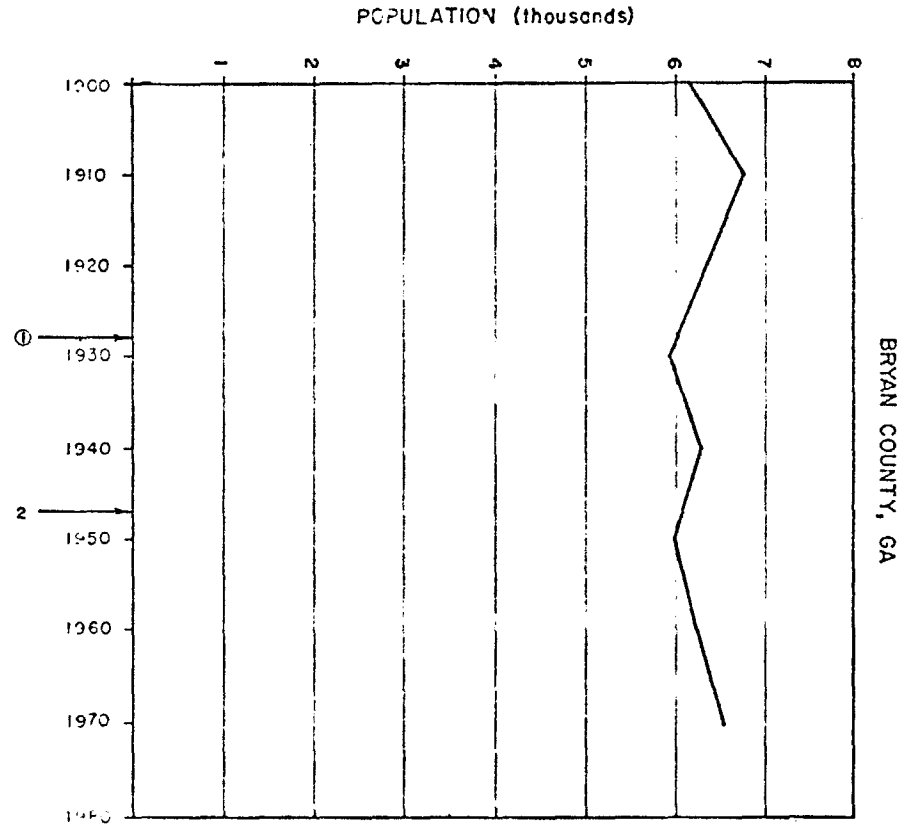
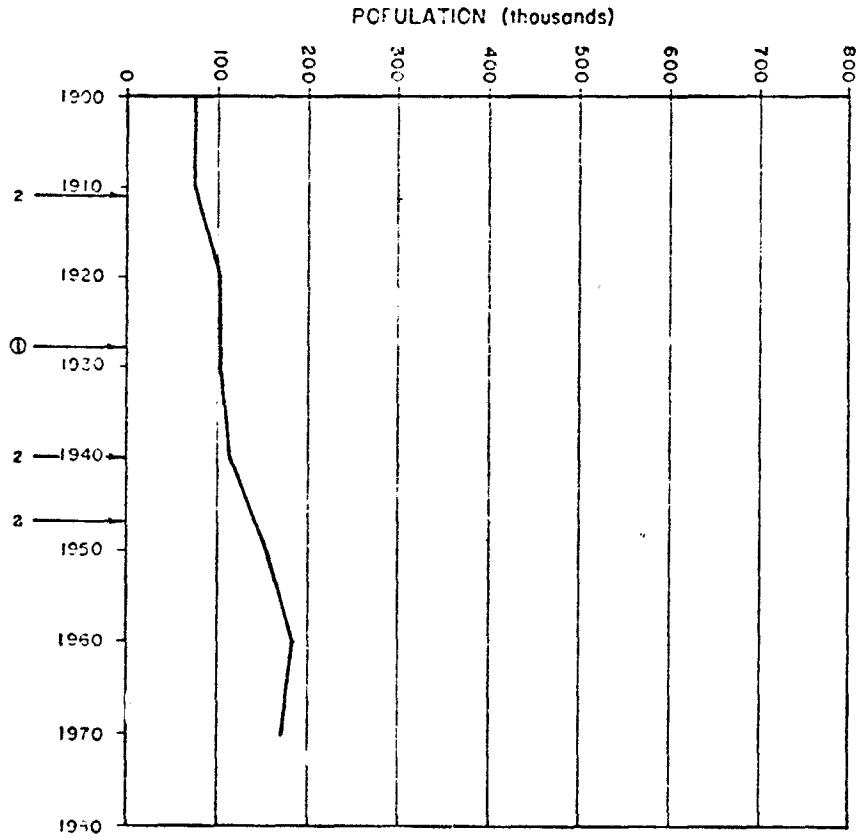


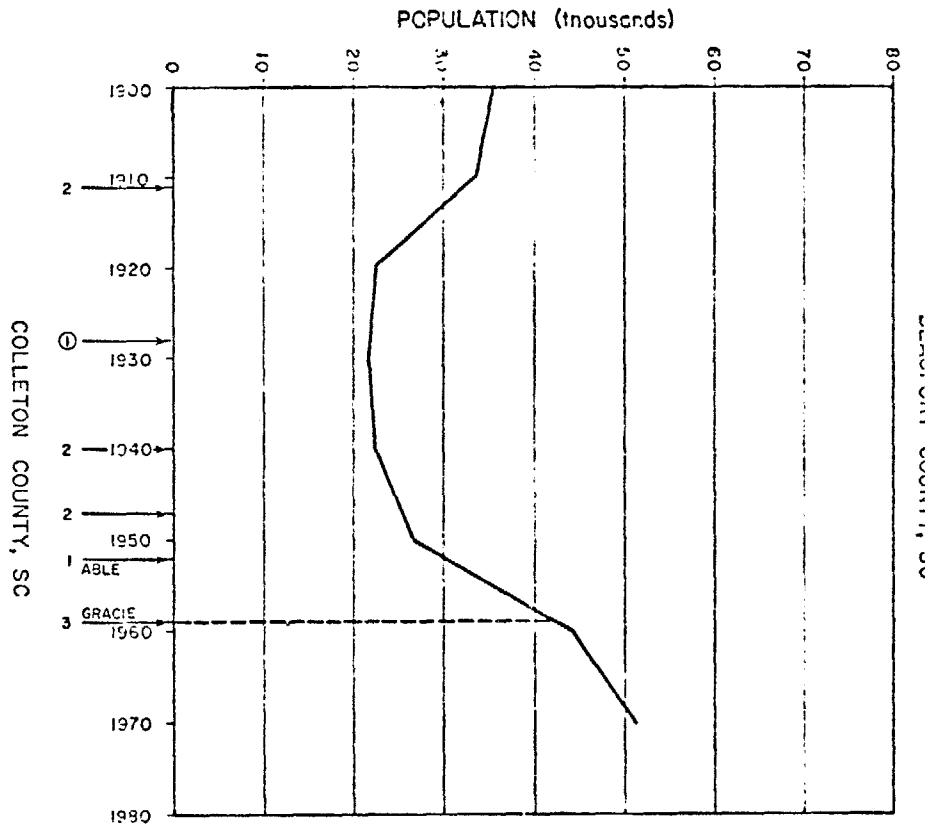
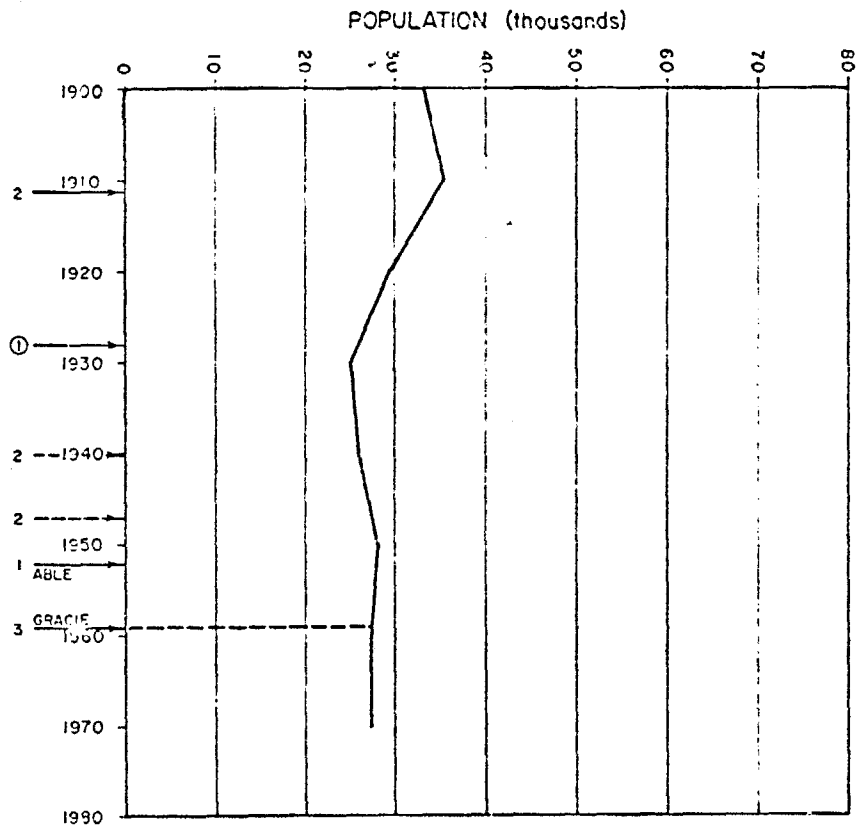




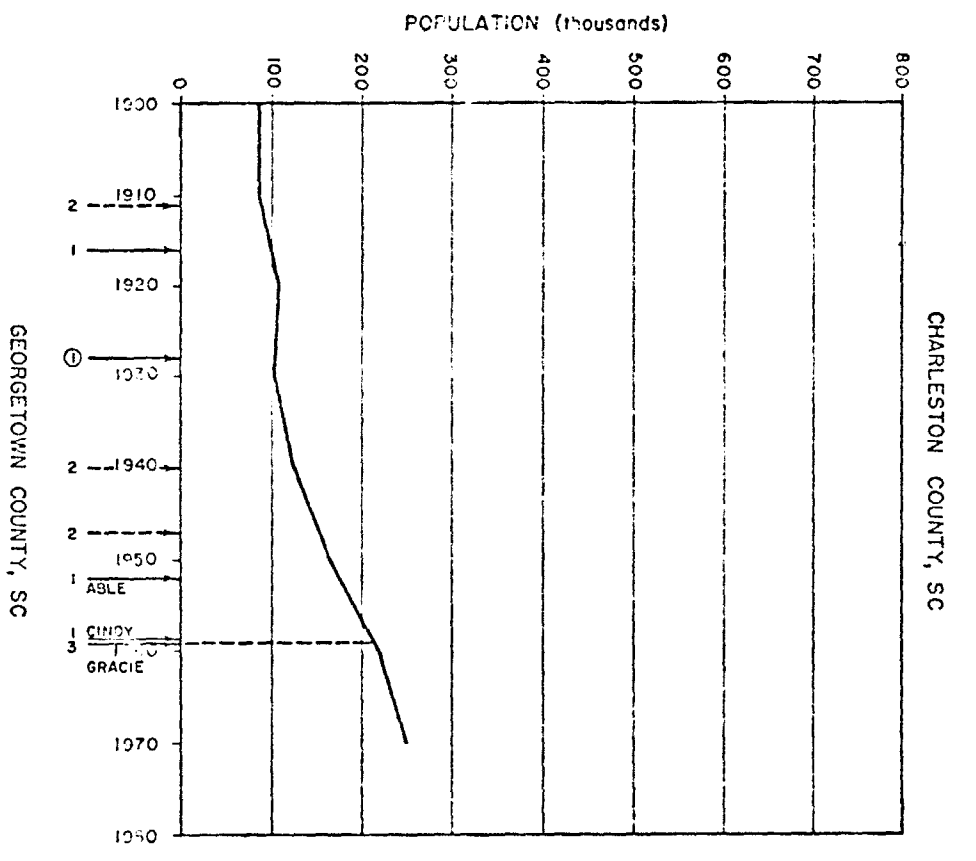
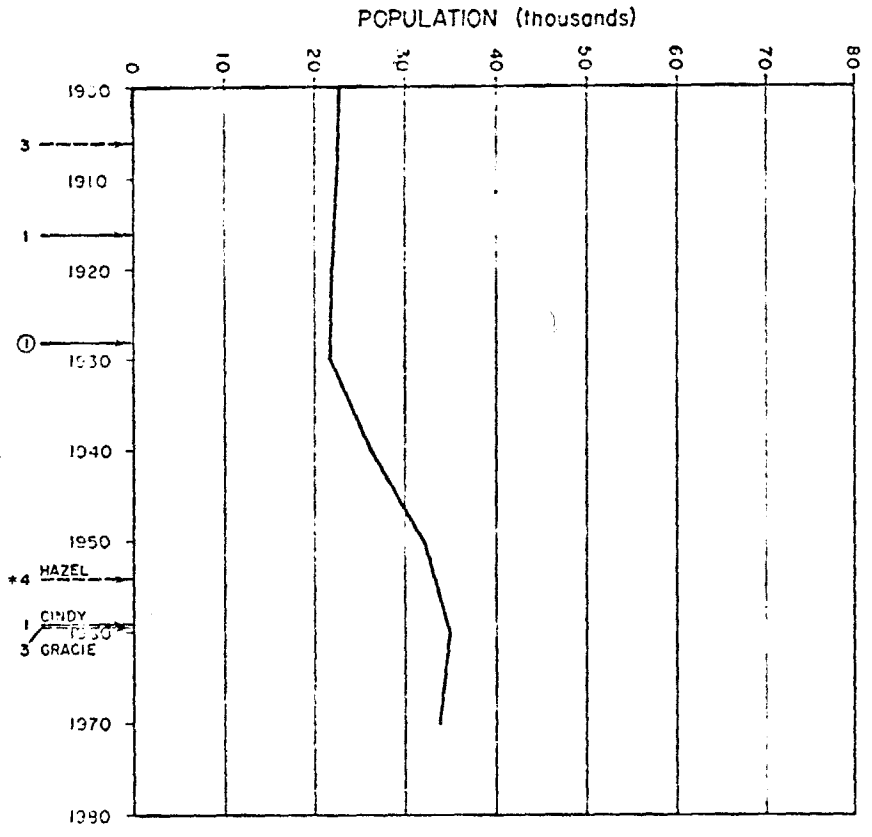




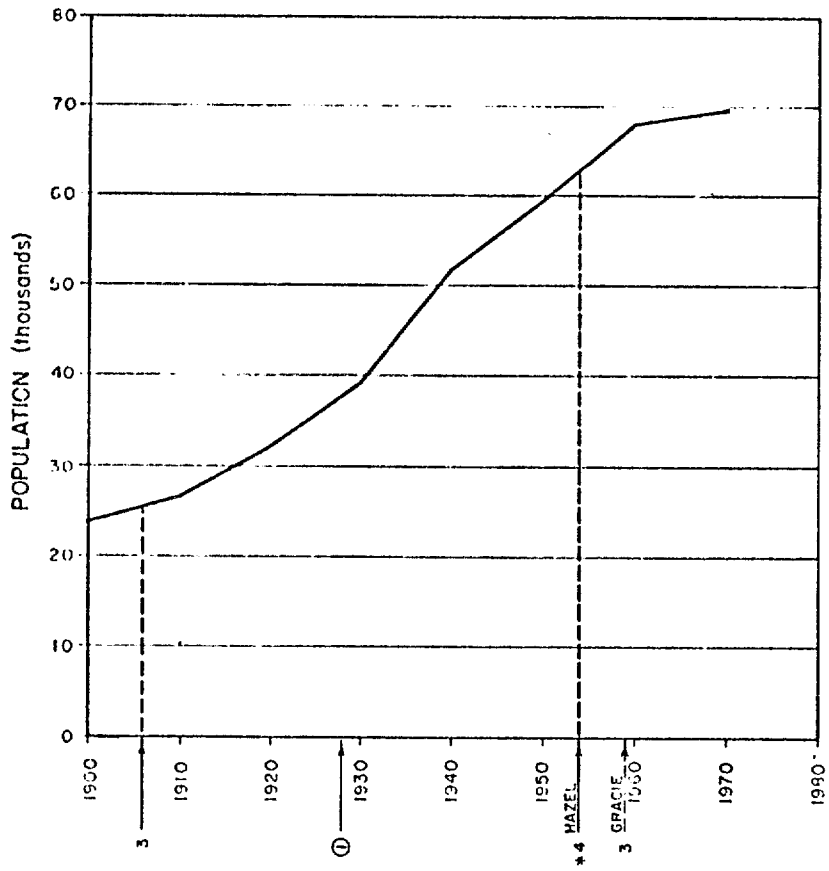




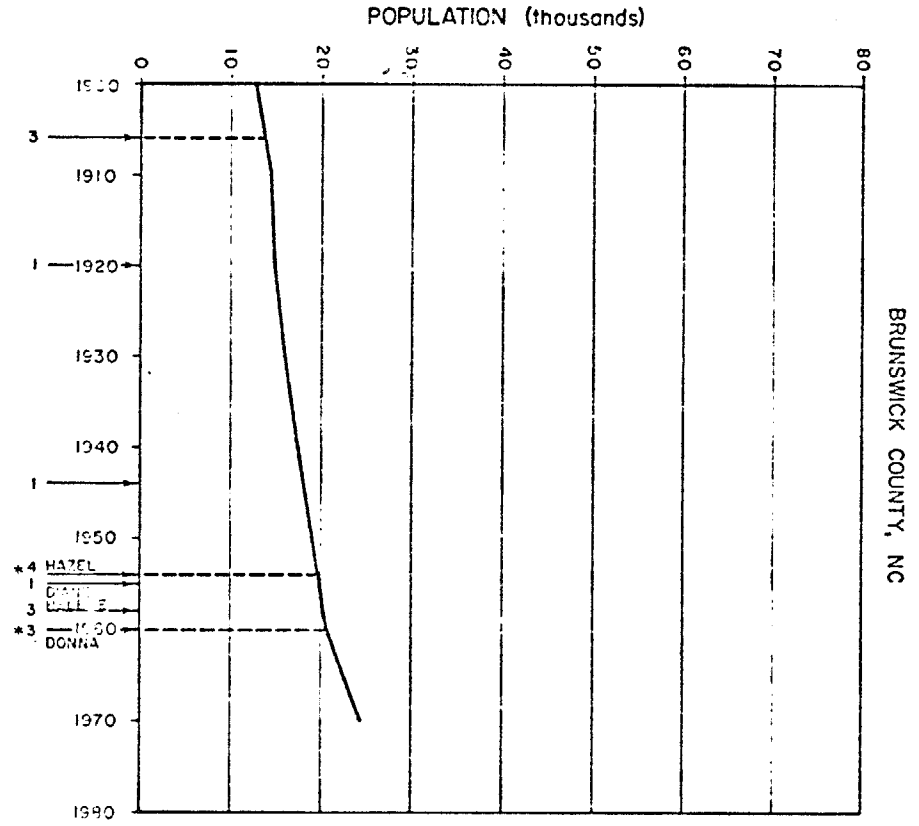
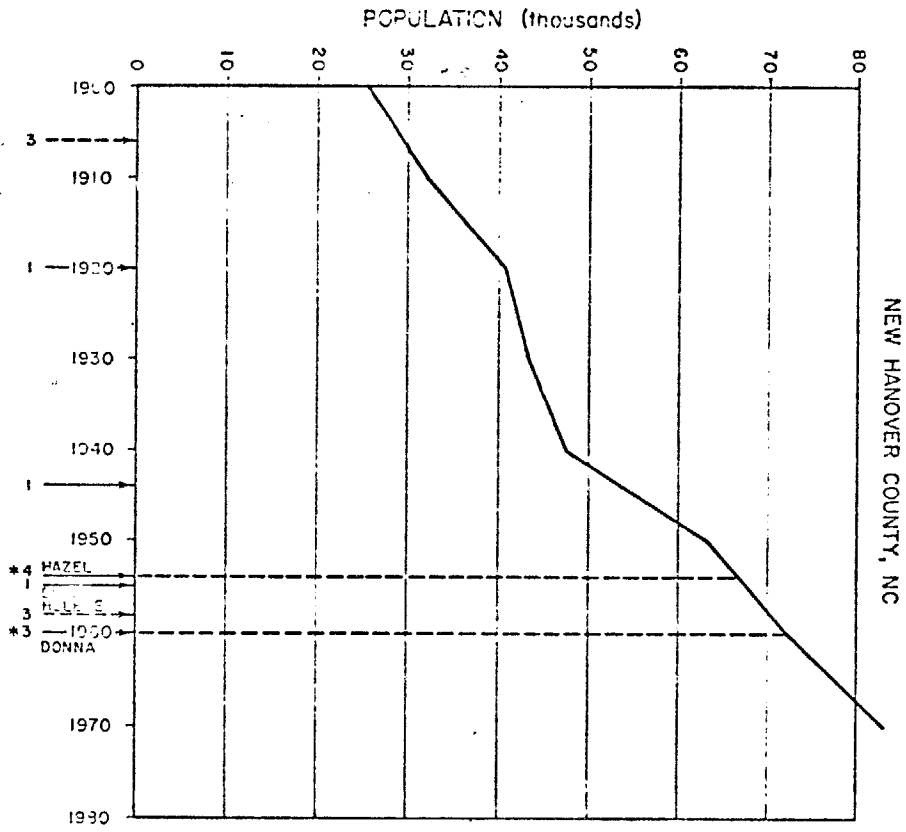
COLLETON COUNTY, SC

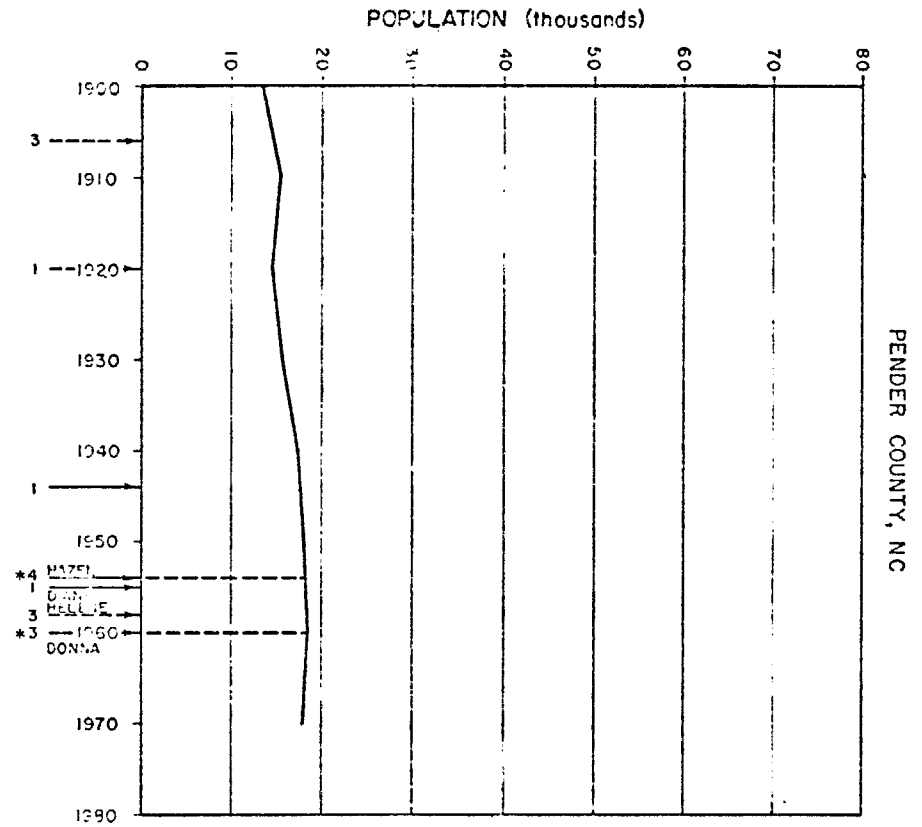
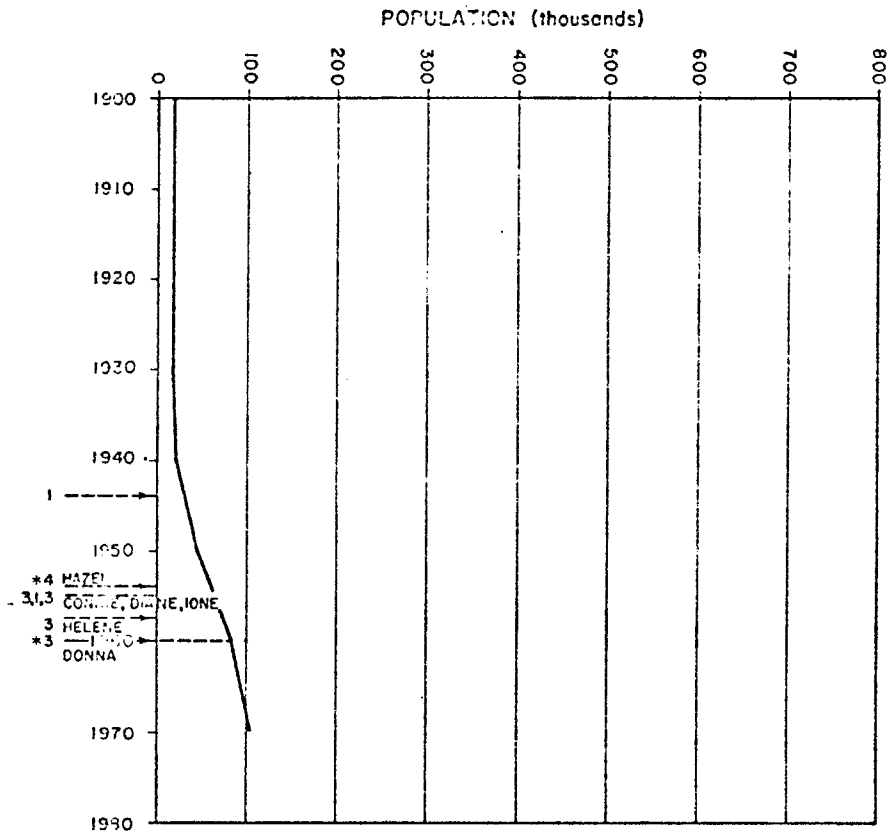


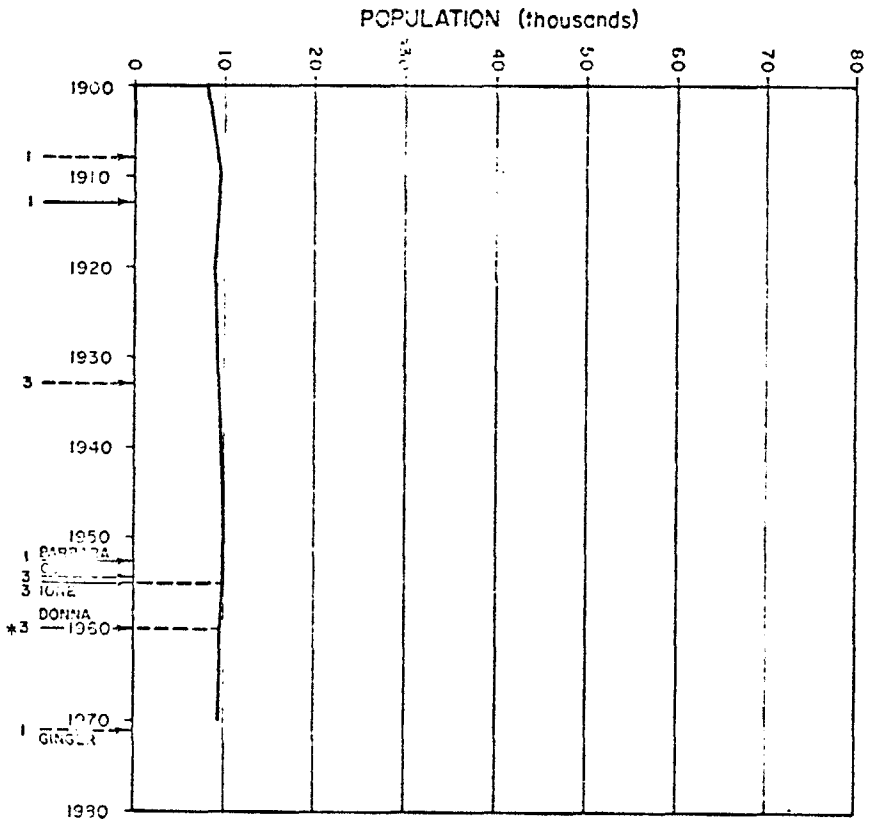
HORRY COUNTY, SC



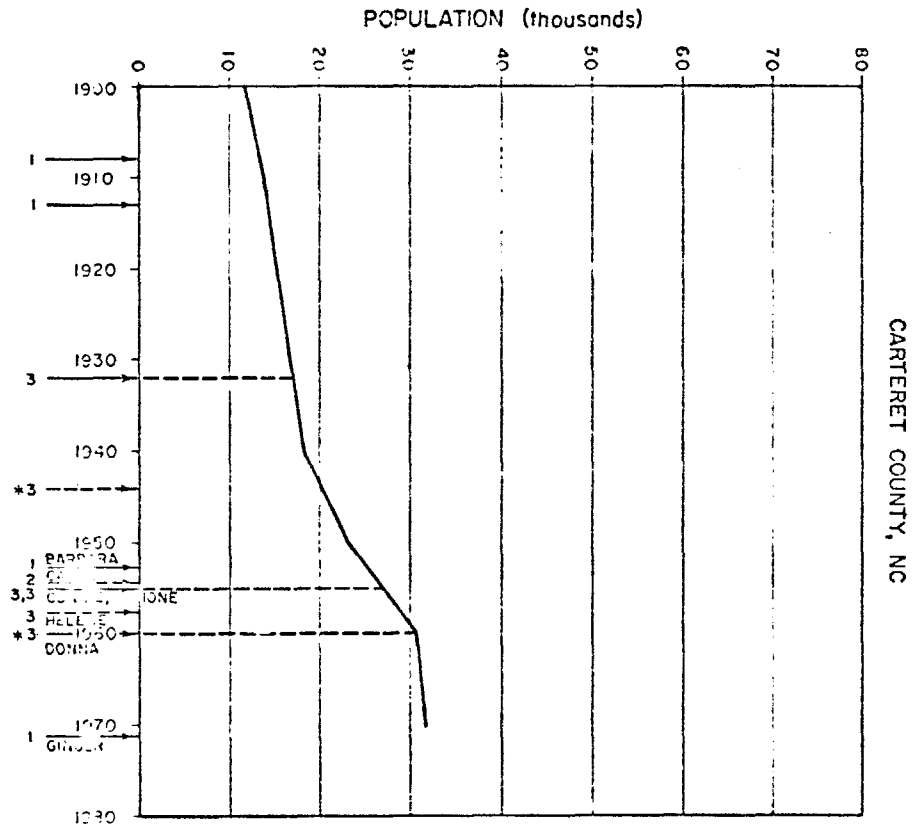
END OF SOUTH CAROLINA COUNTIES



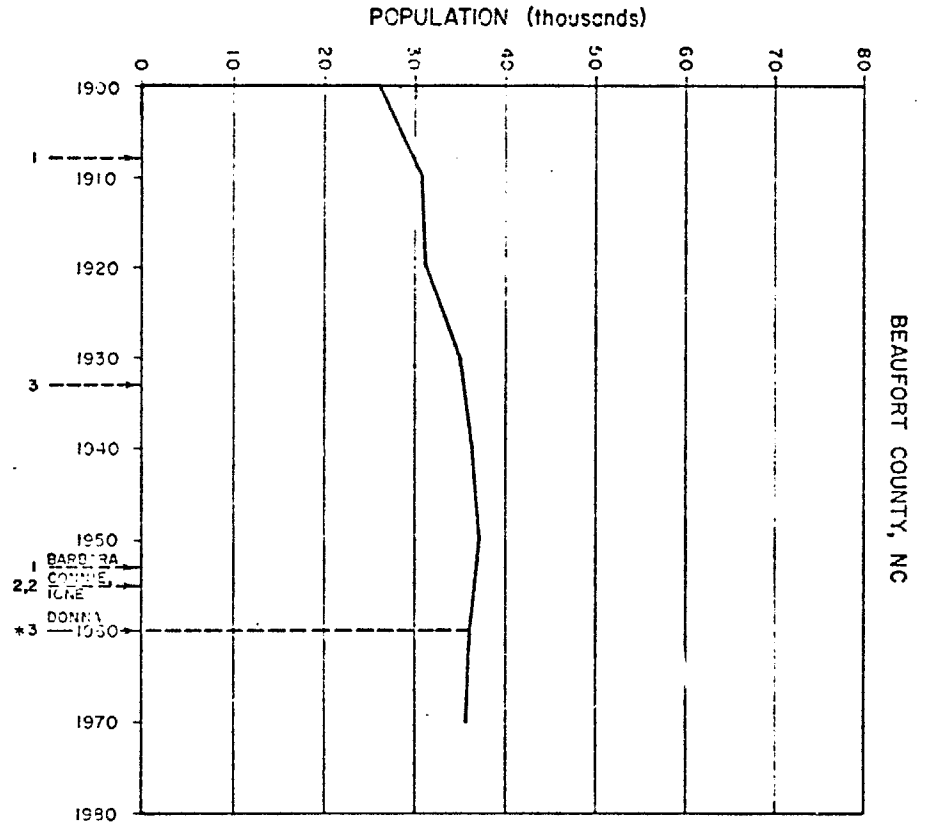
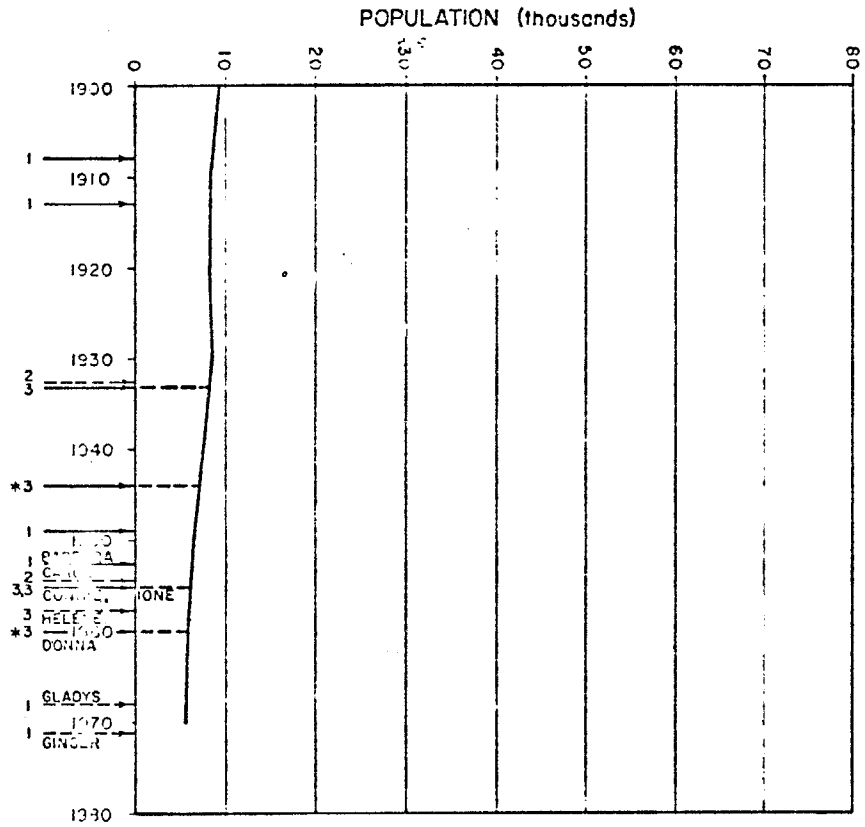




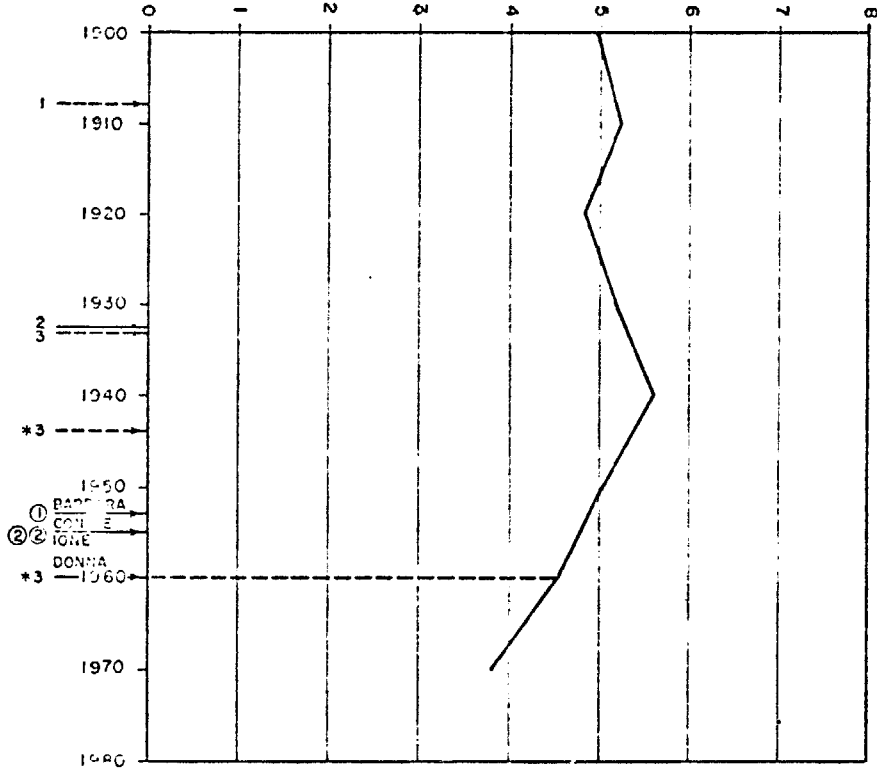
PAMLICO COUNTY, NC



CARTERET COUNTY, NC

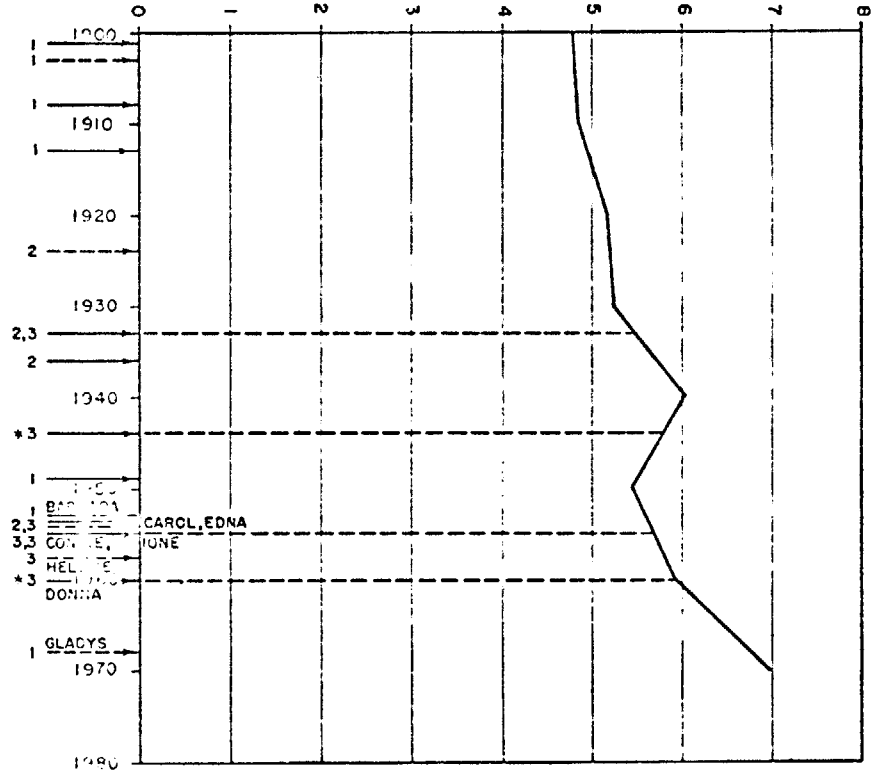


POPULATION (thousands)

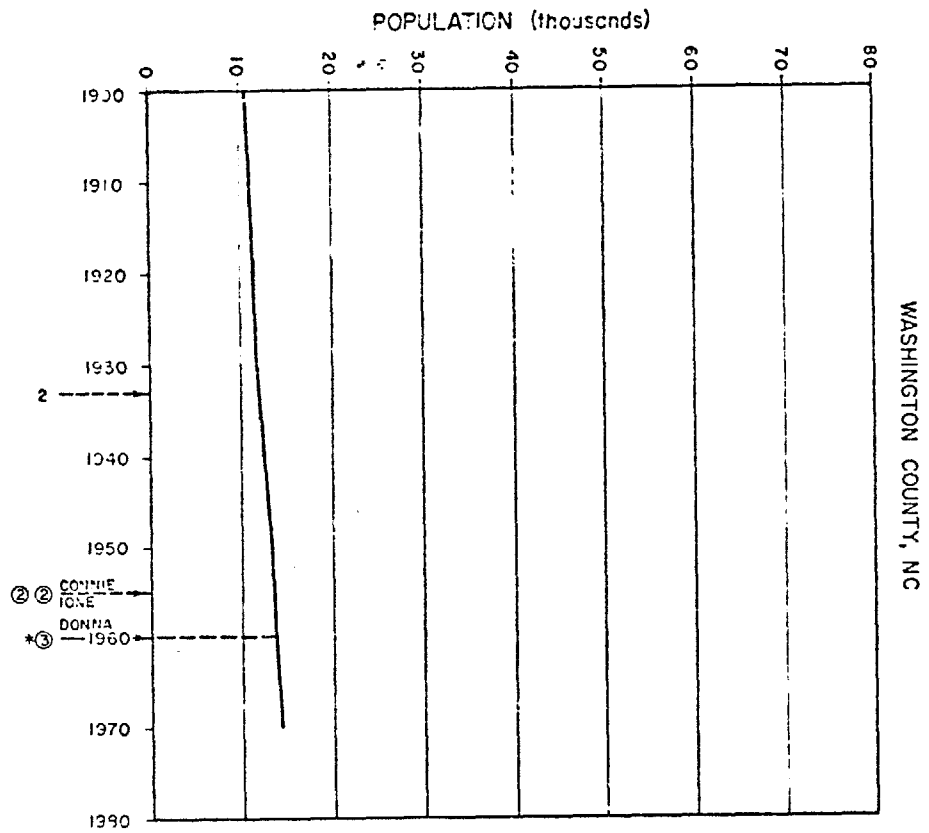
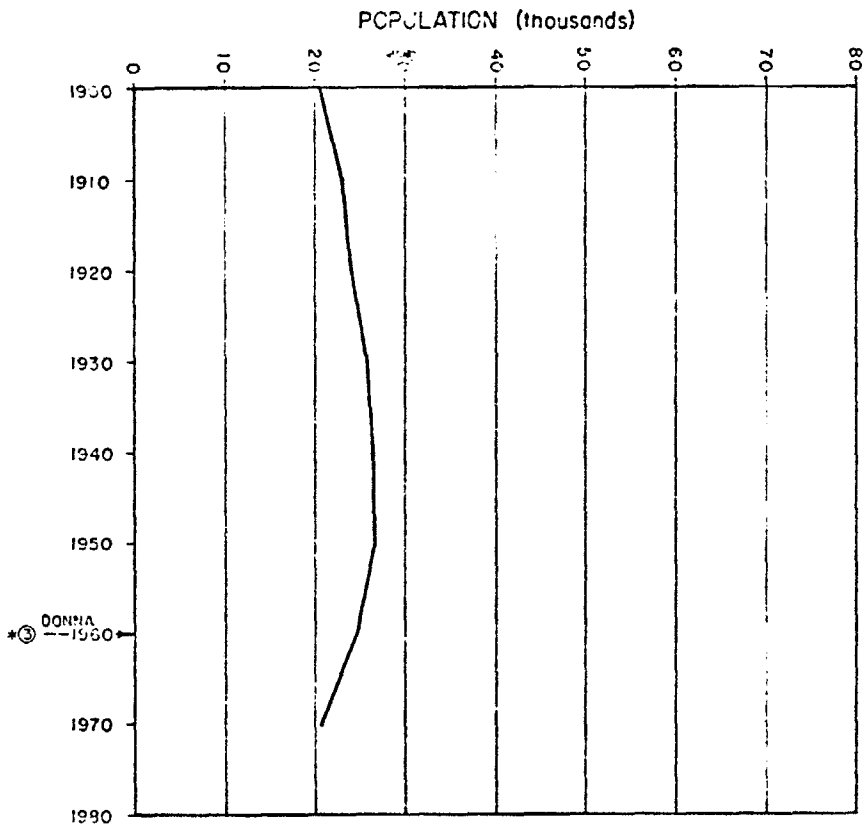


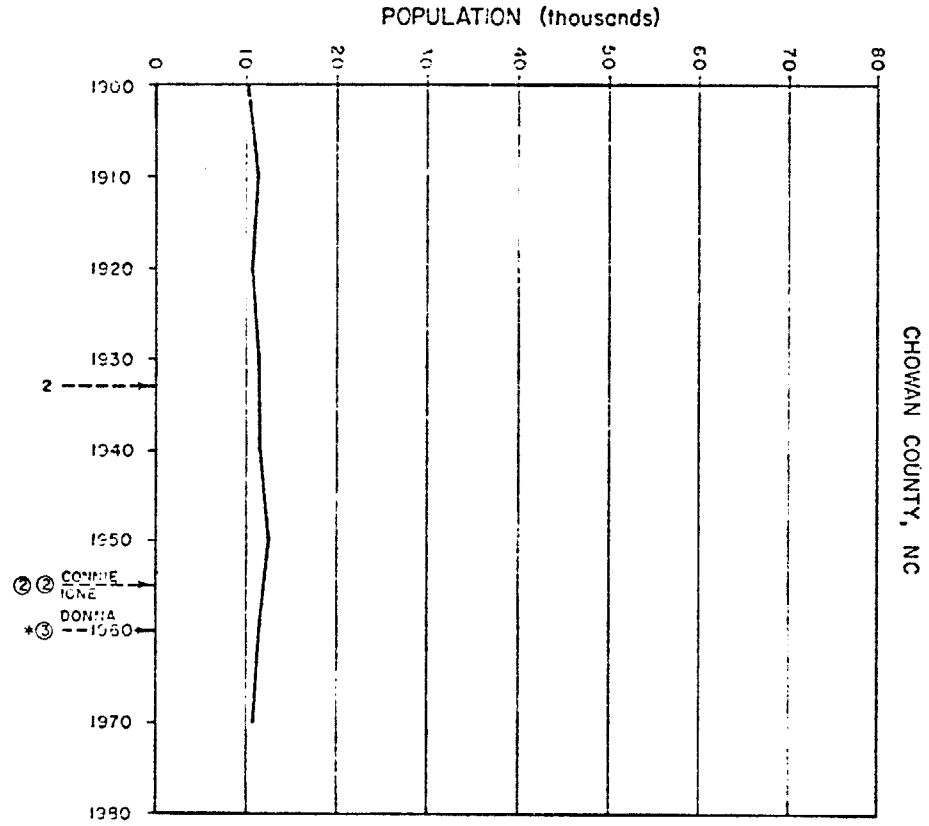
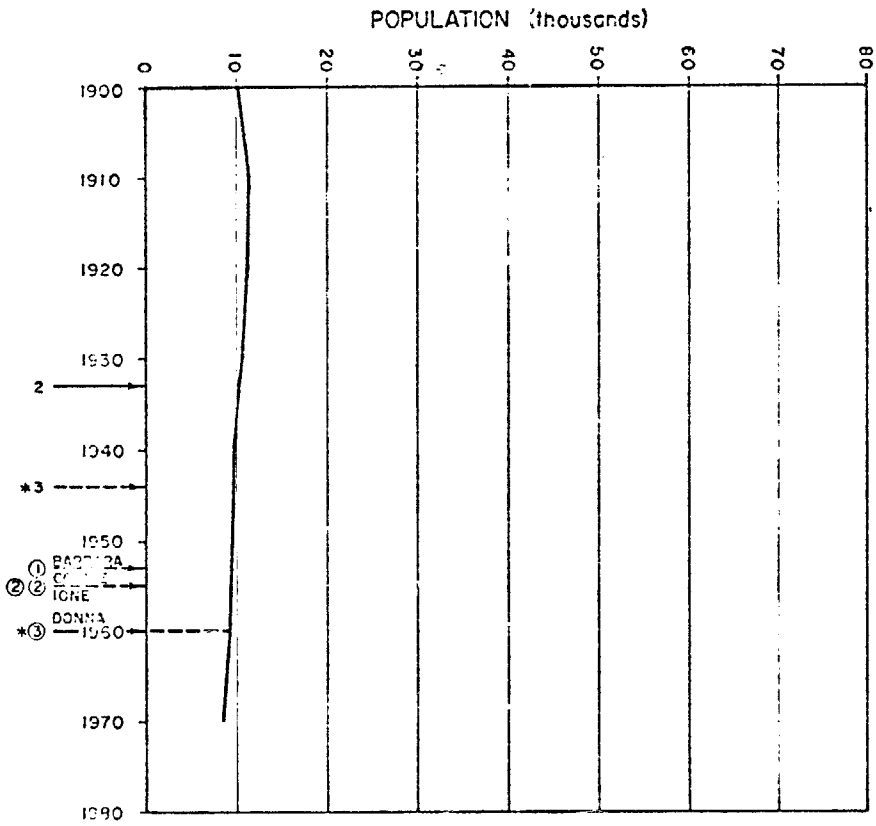
TYRRELL COUNTY, NC

POPULATION (thousands)

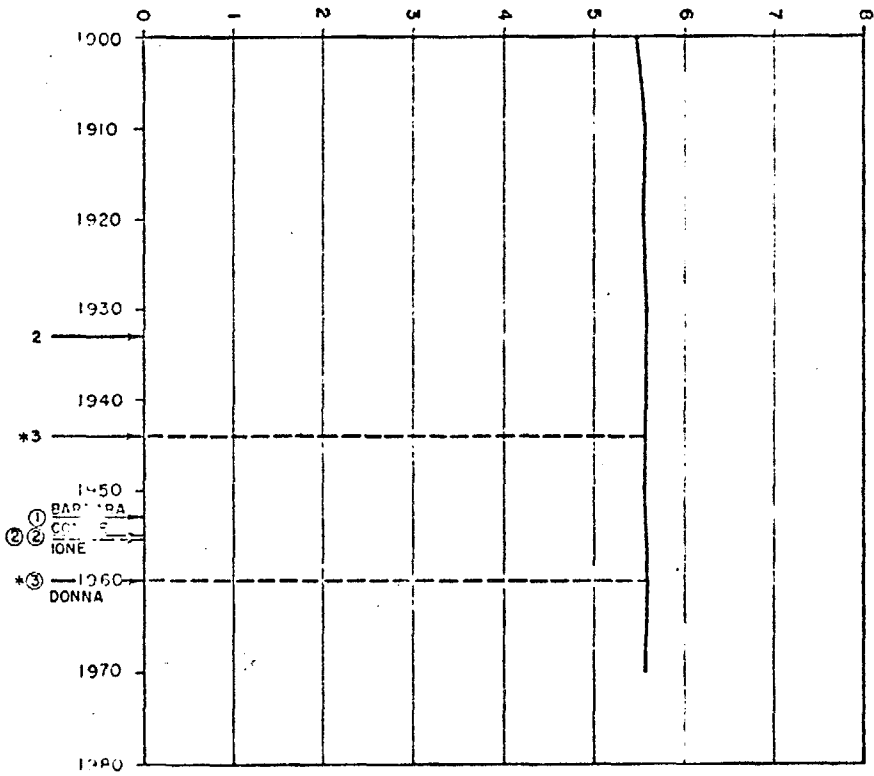


DARE COUNTY, NC



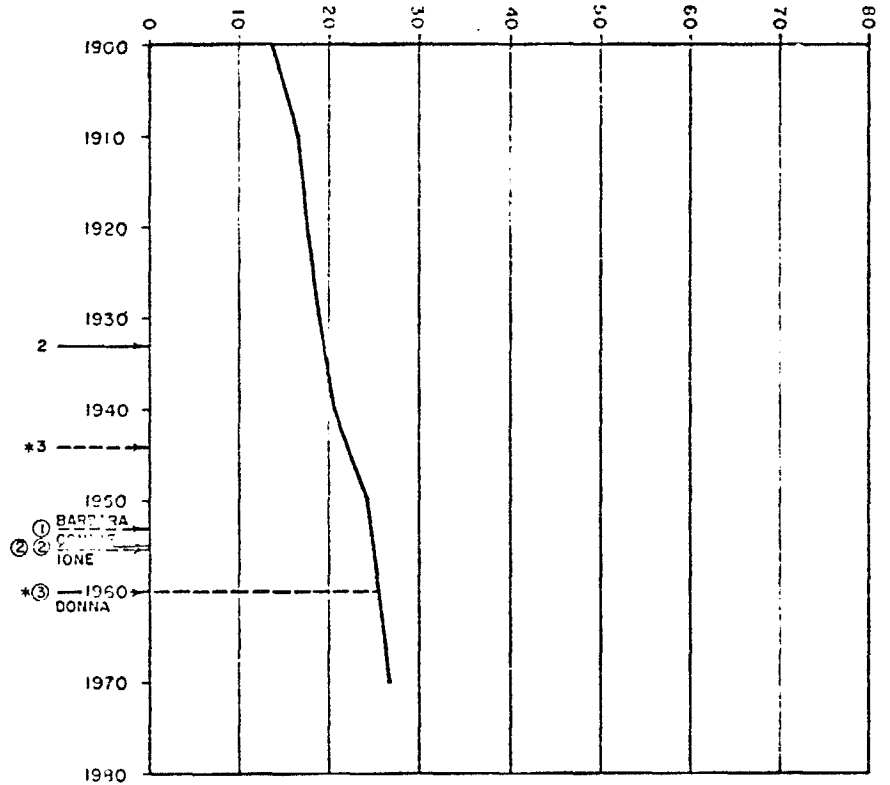


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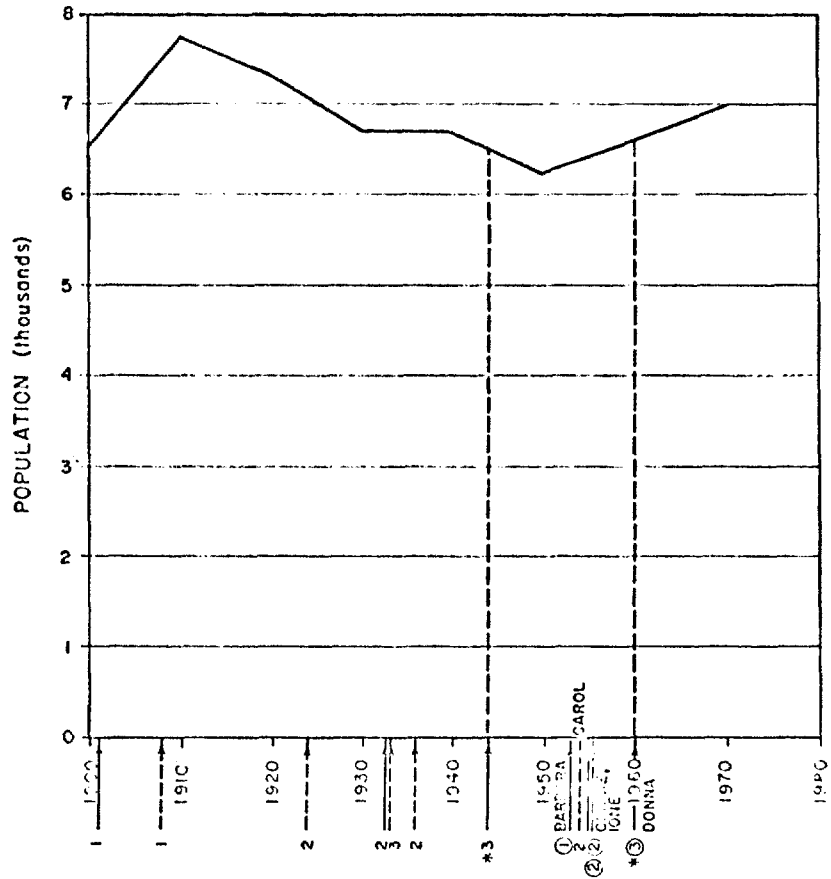
CAMDEN COUNTY, NC

POPULATION (thousands)

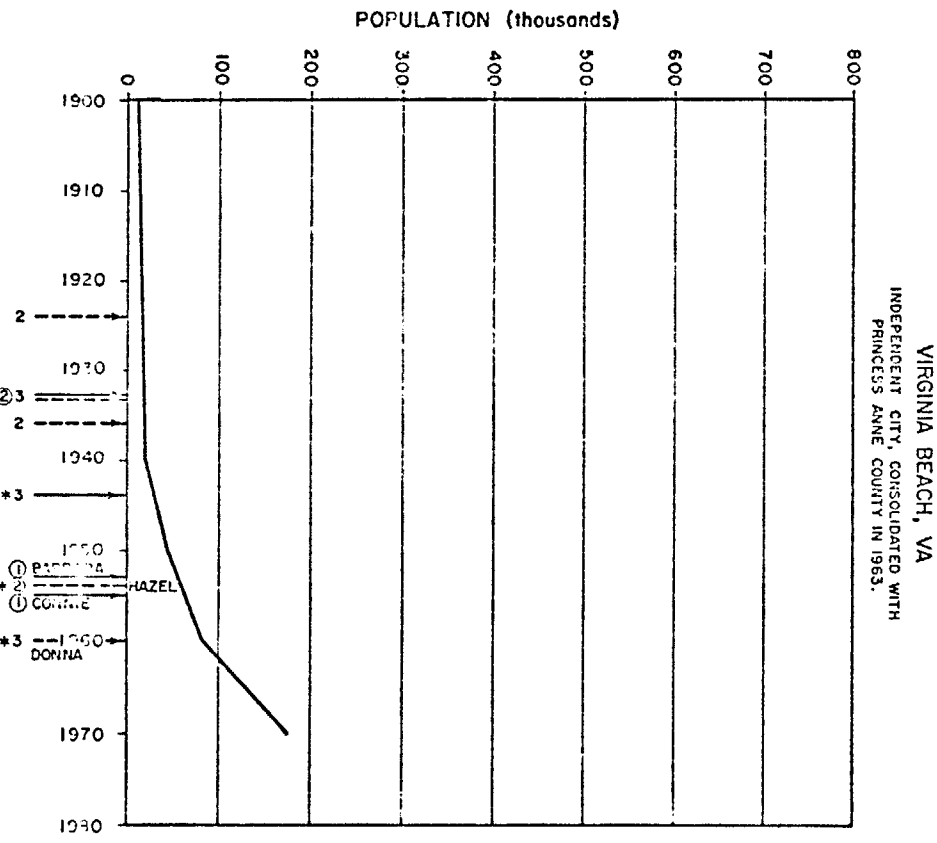
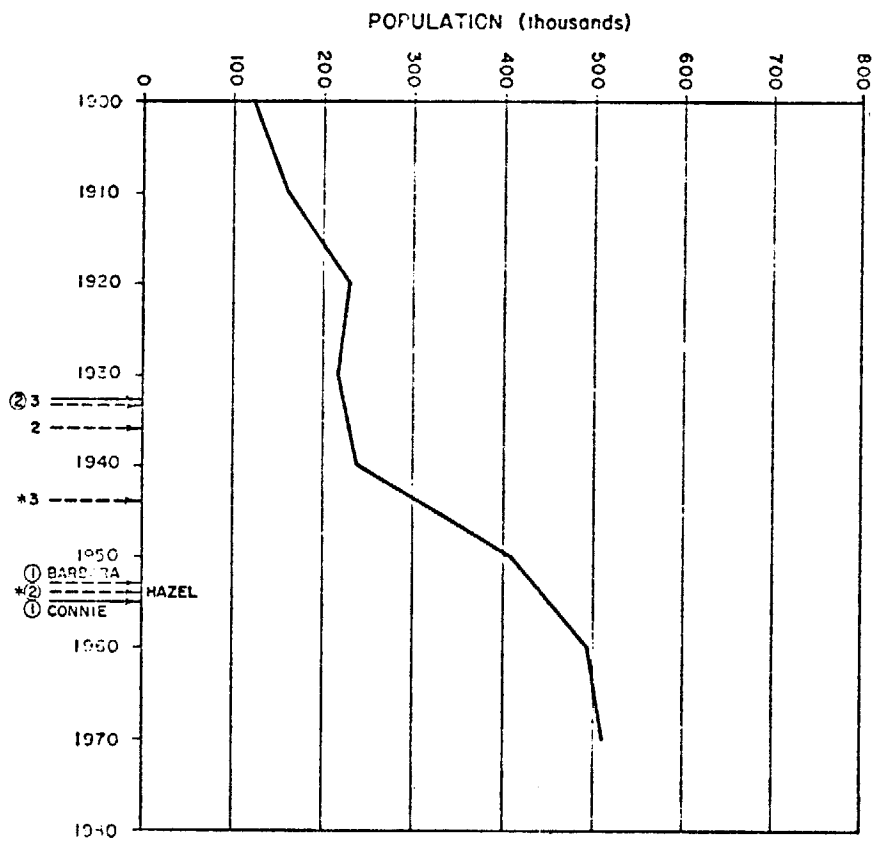


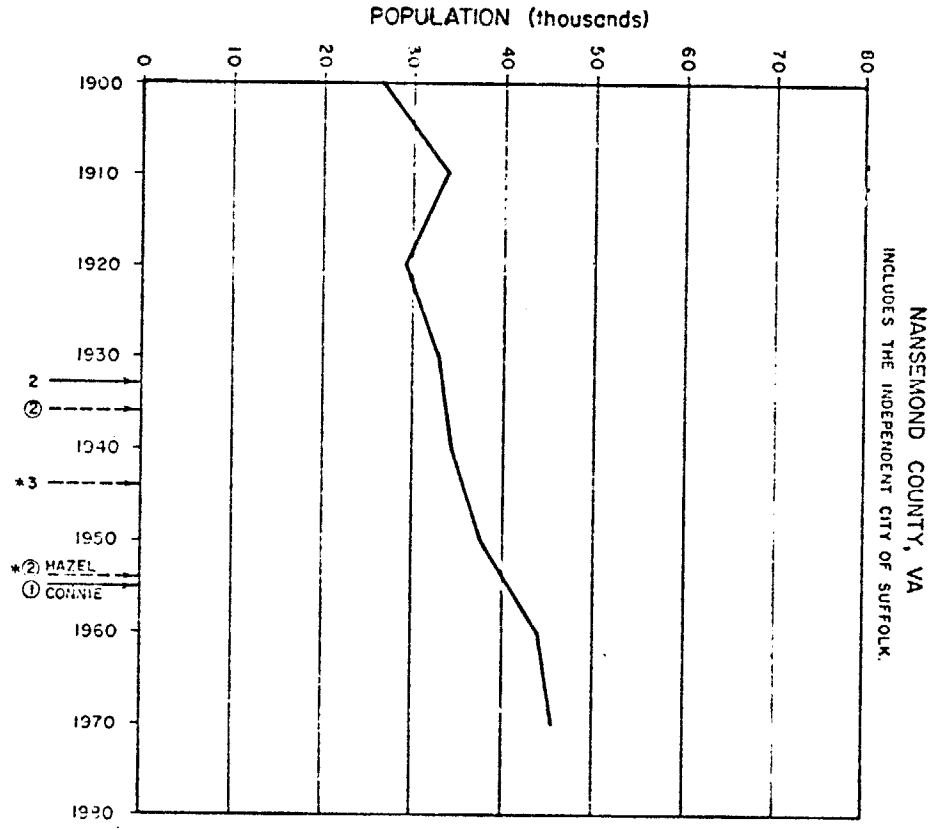
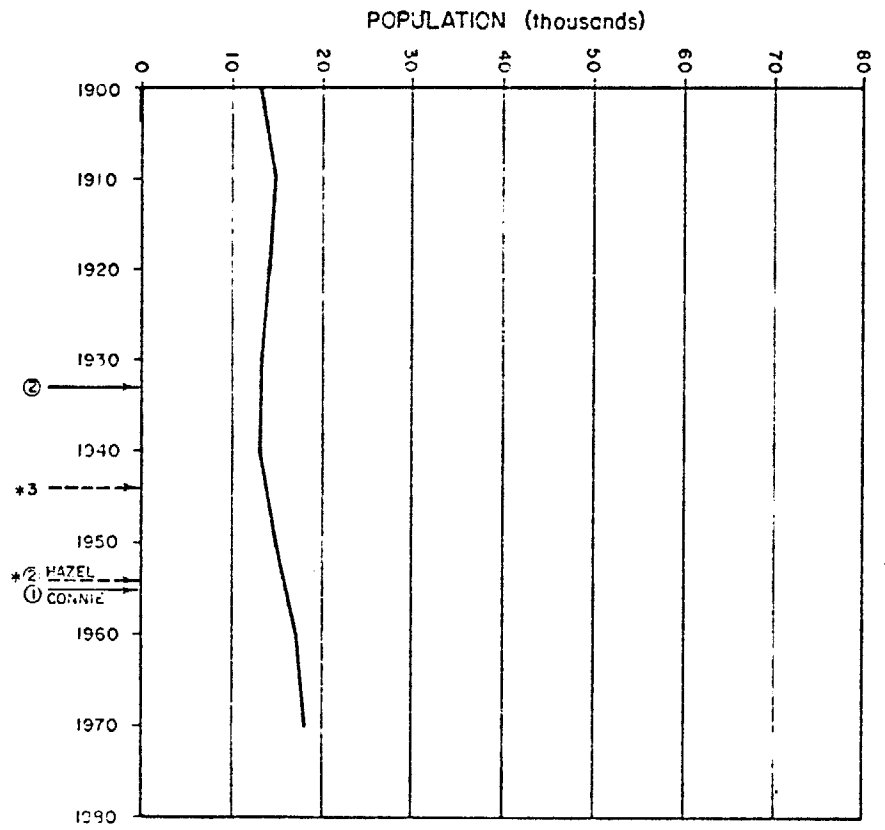
PASQUOTANK COUNTY, NC

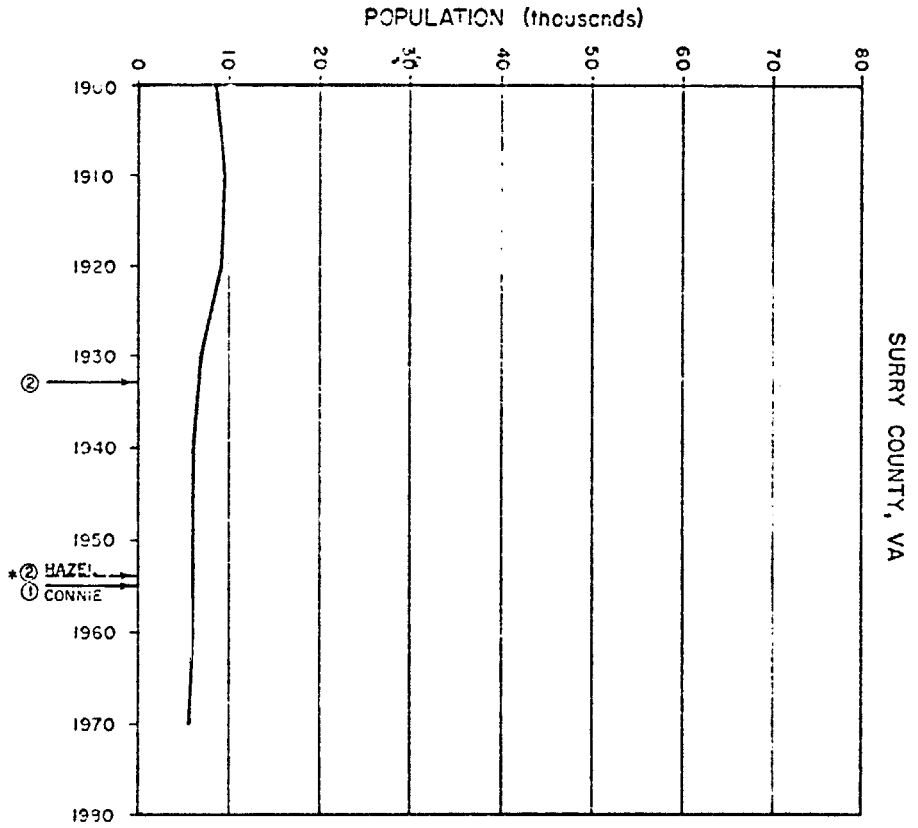
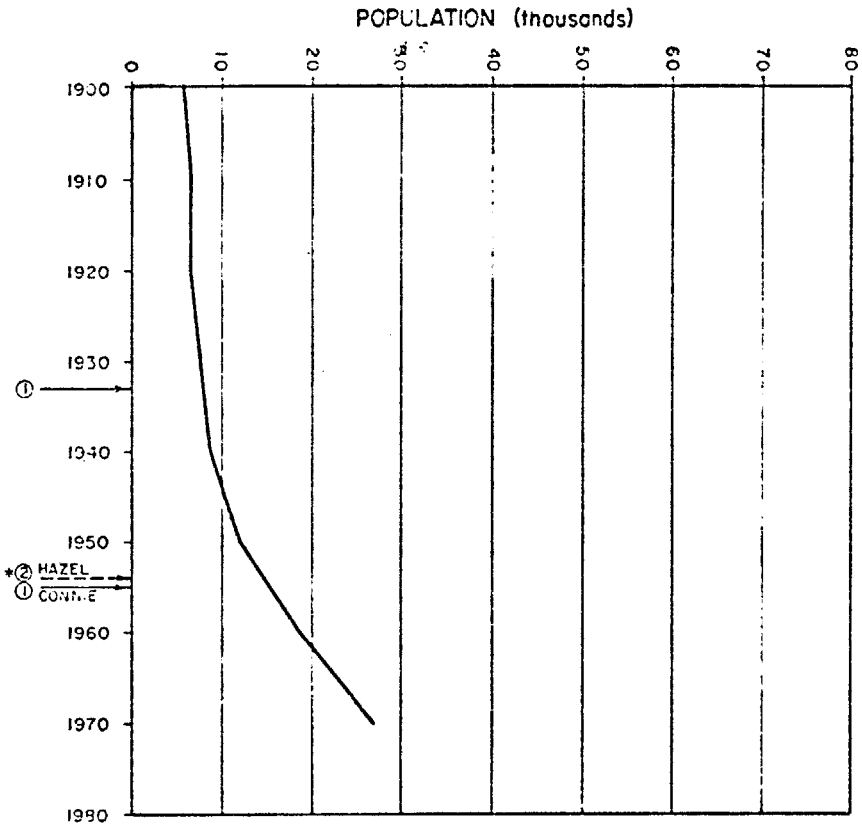
CURRITUCK COUNTY, NC

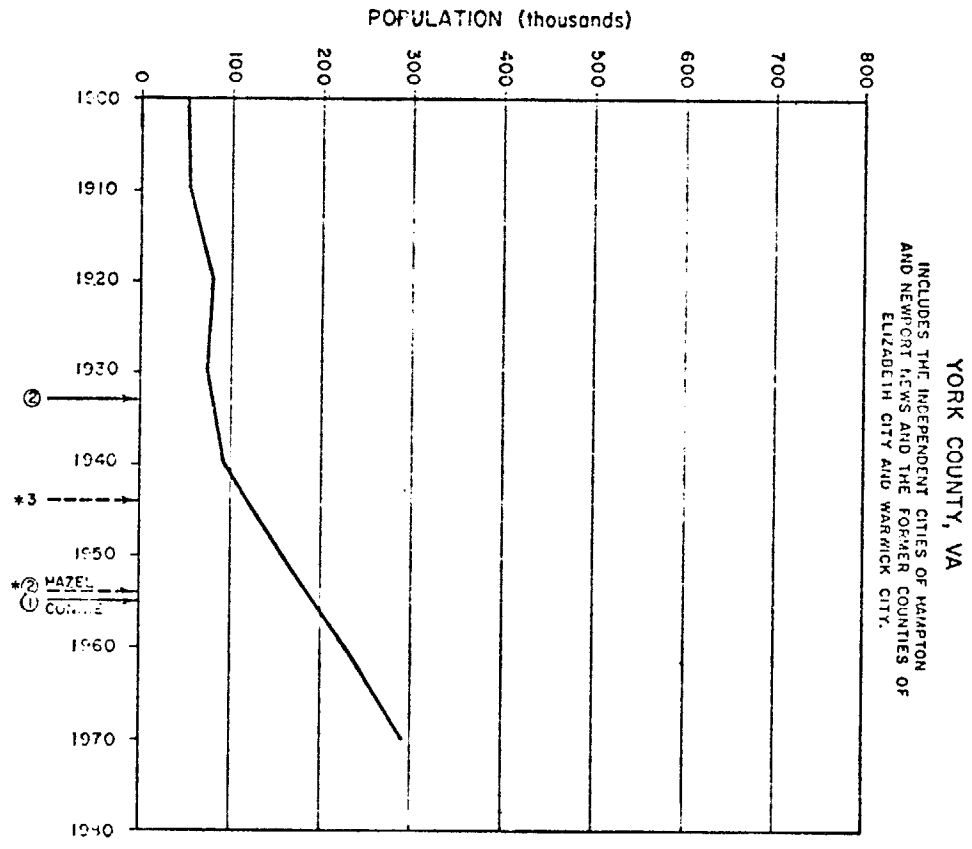
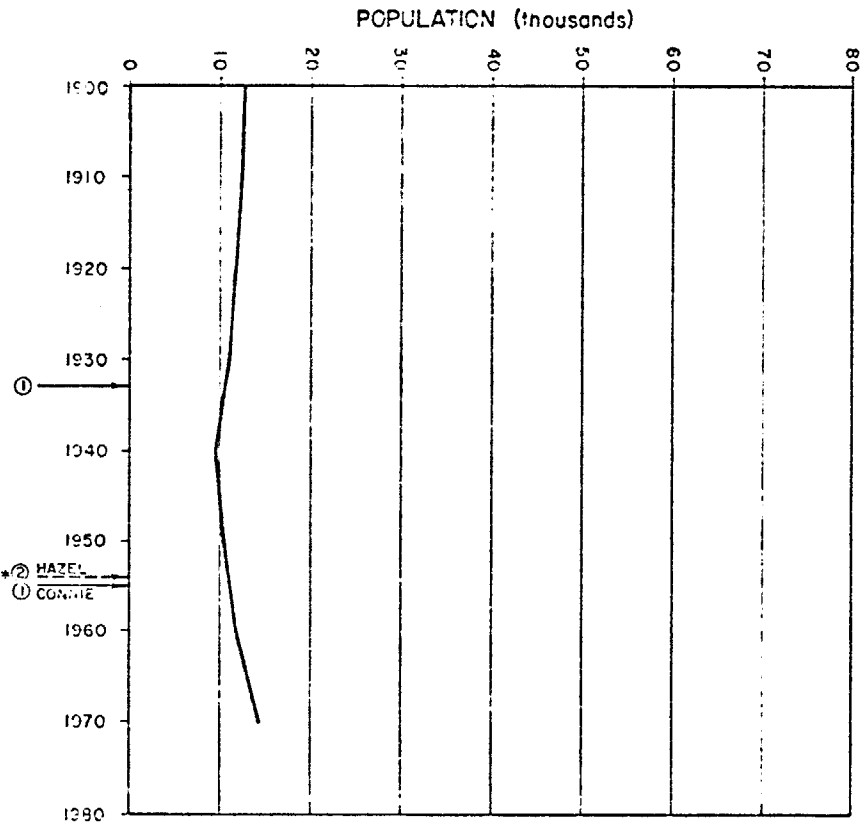


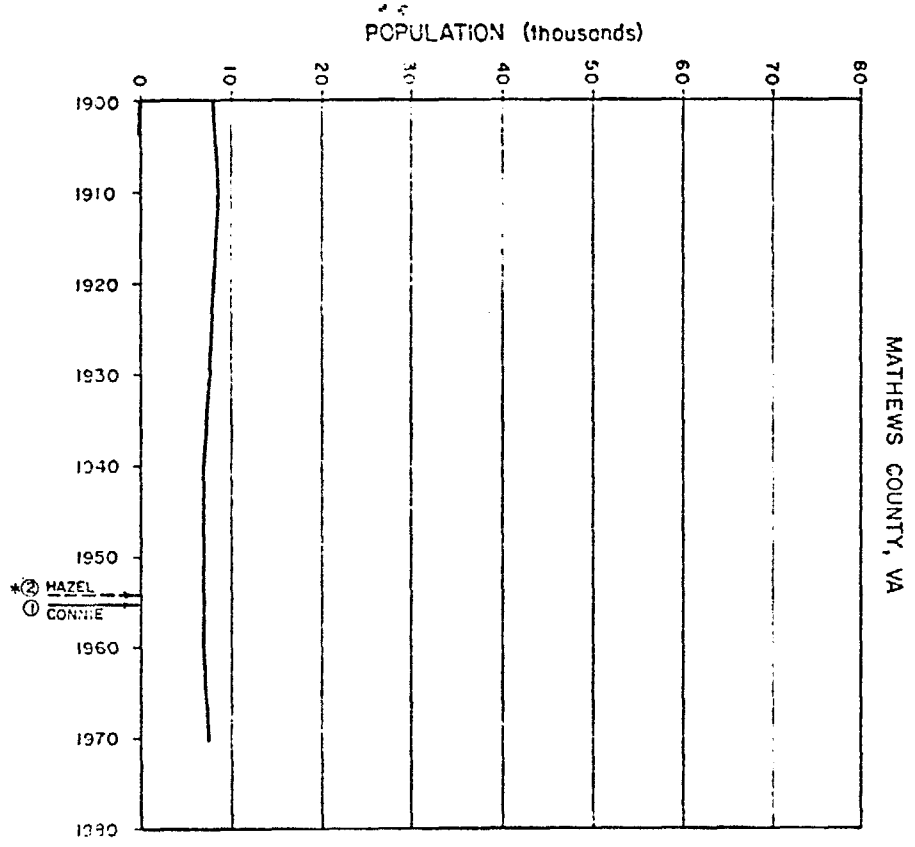
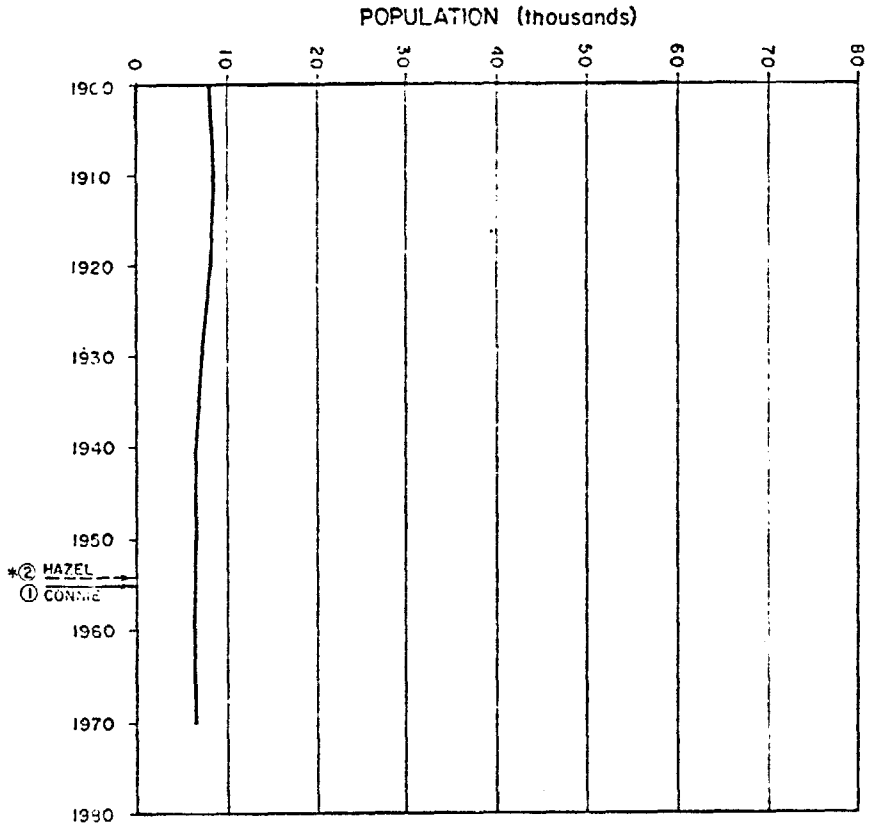
END OF NORTH CAROLINA COUNTIES

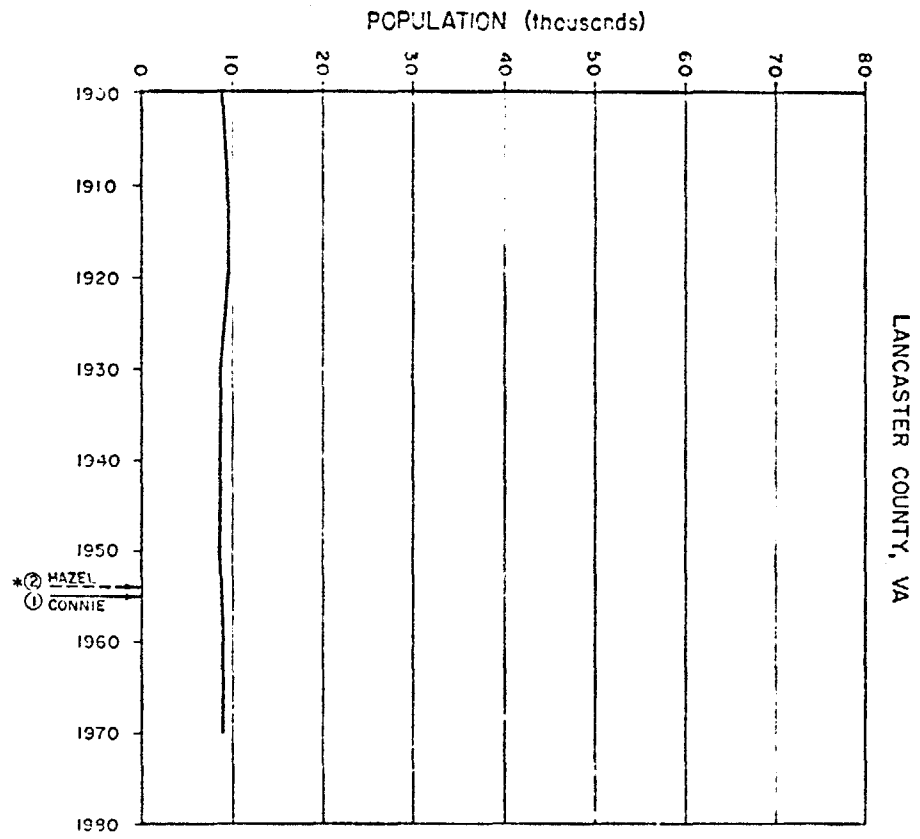
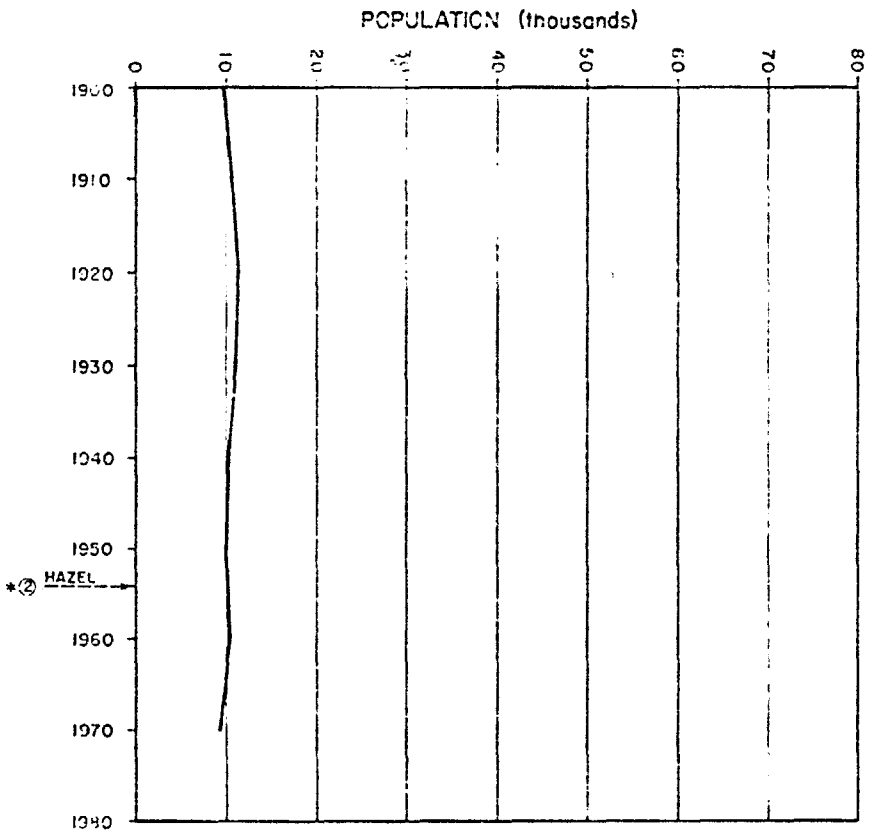


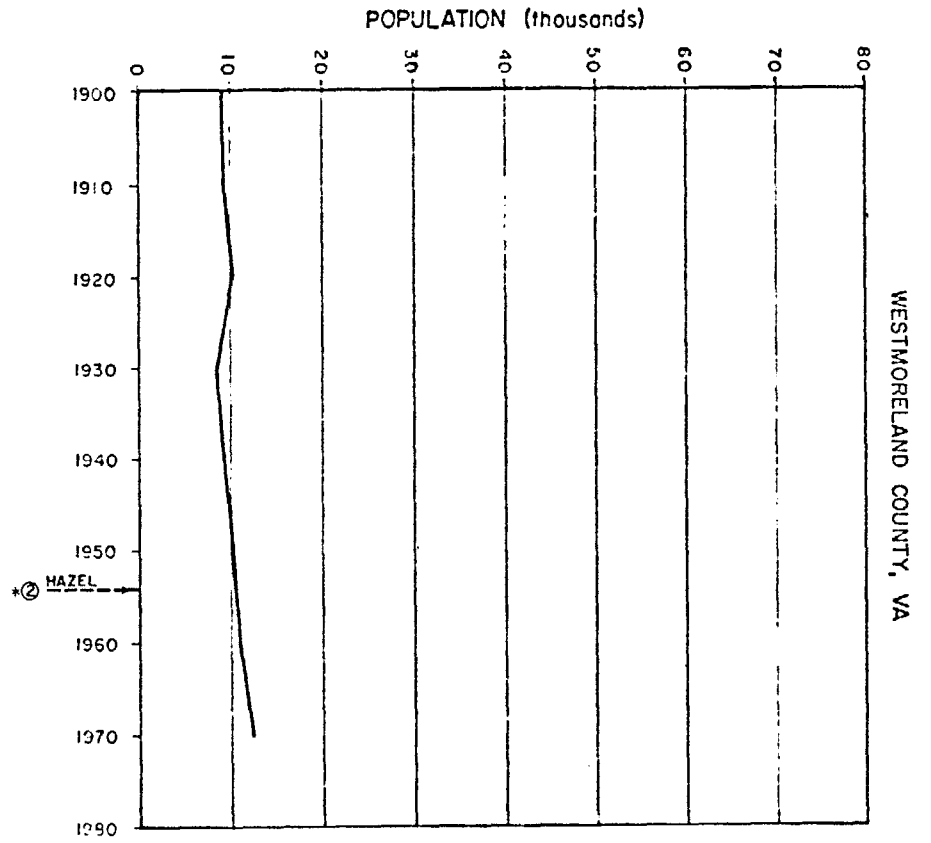
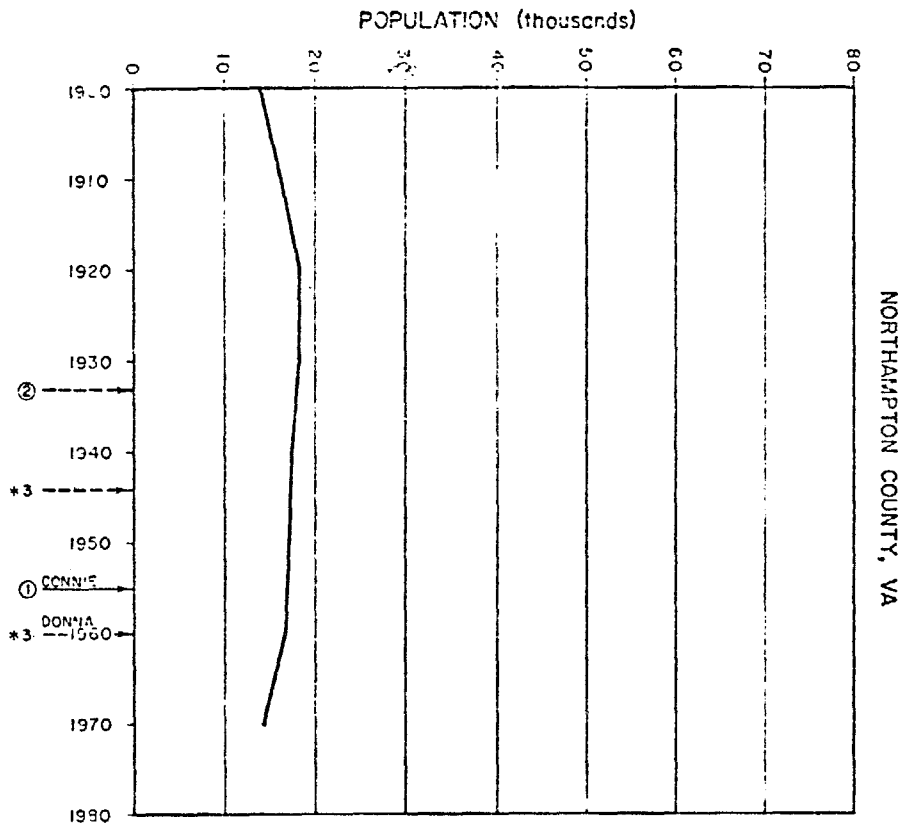


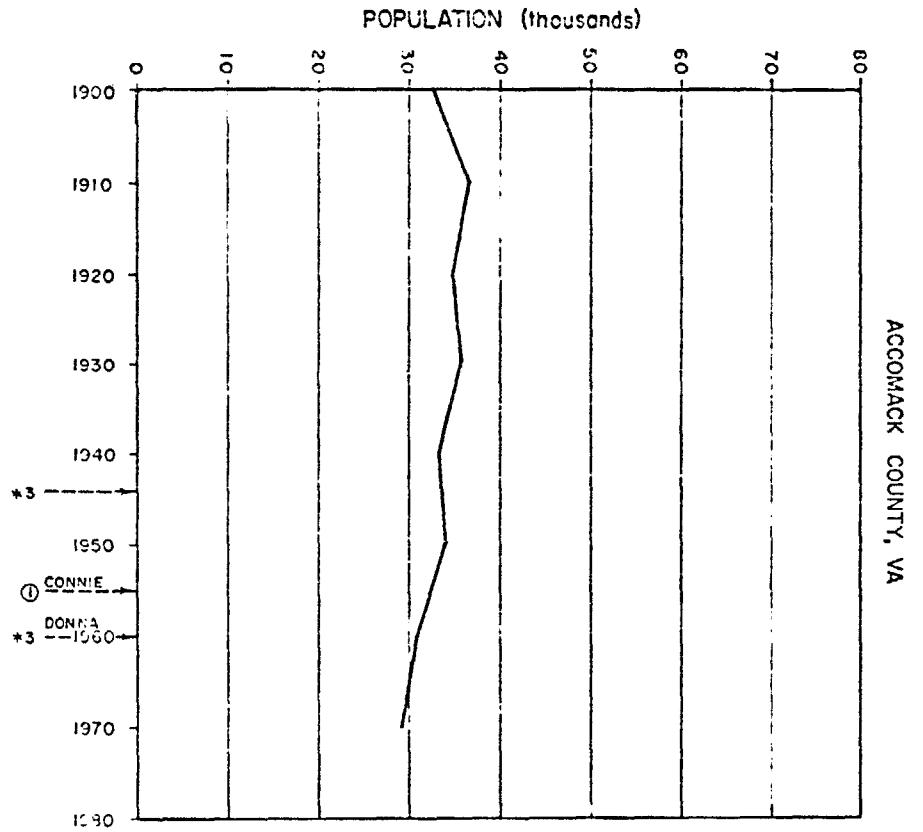
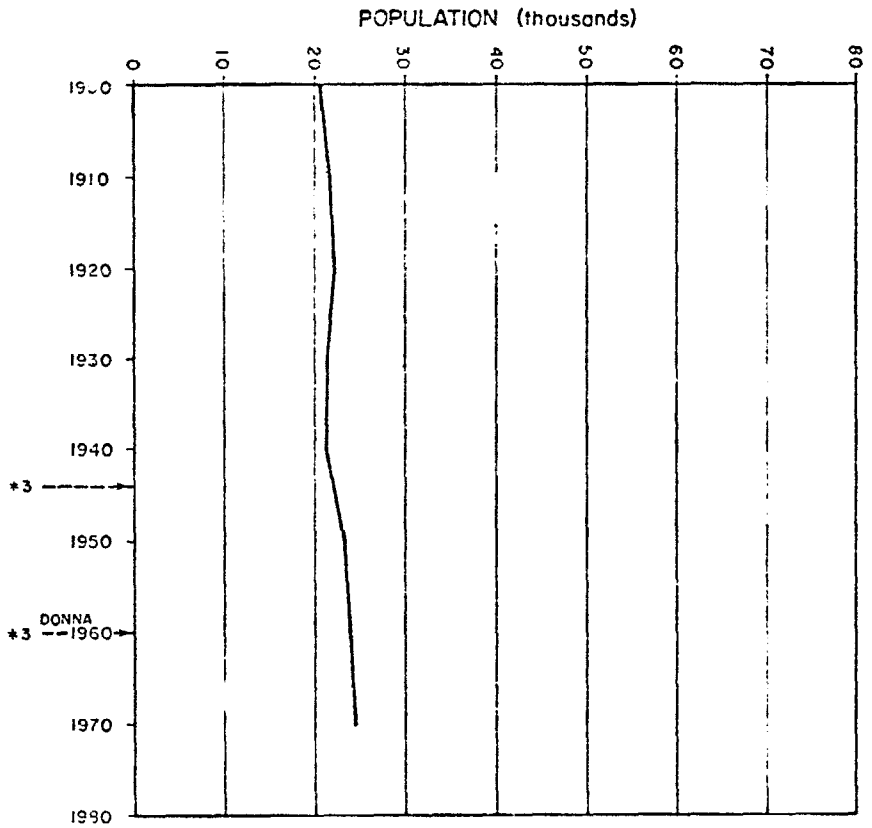


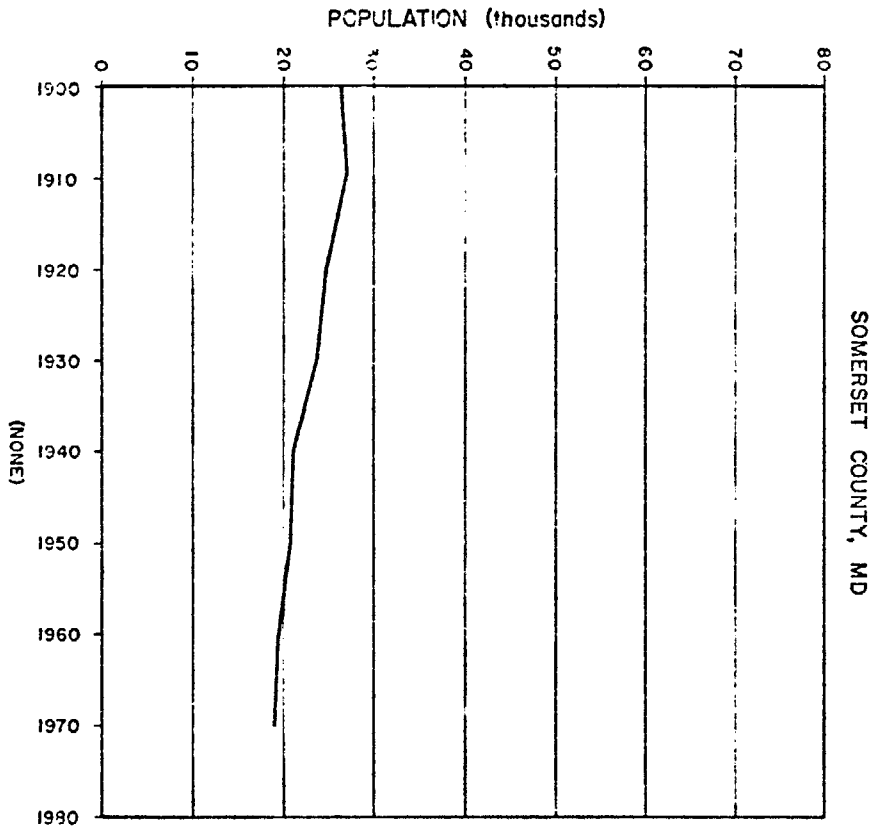
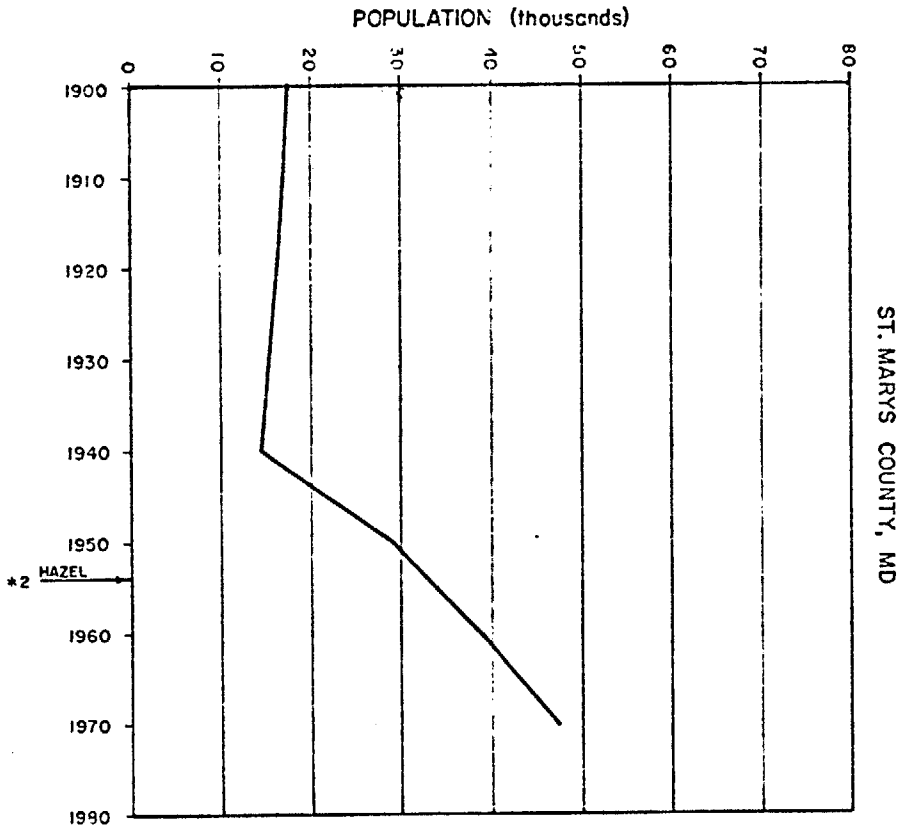


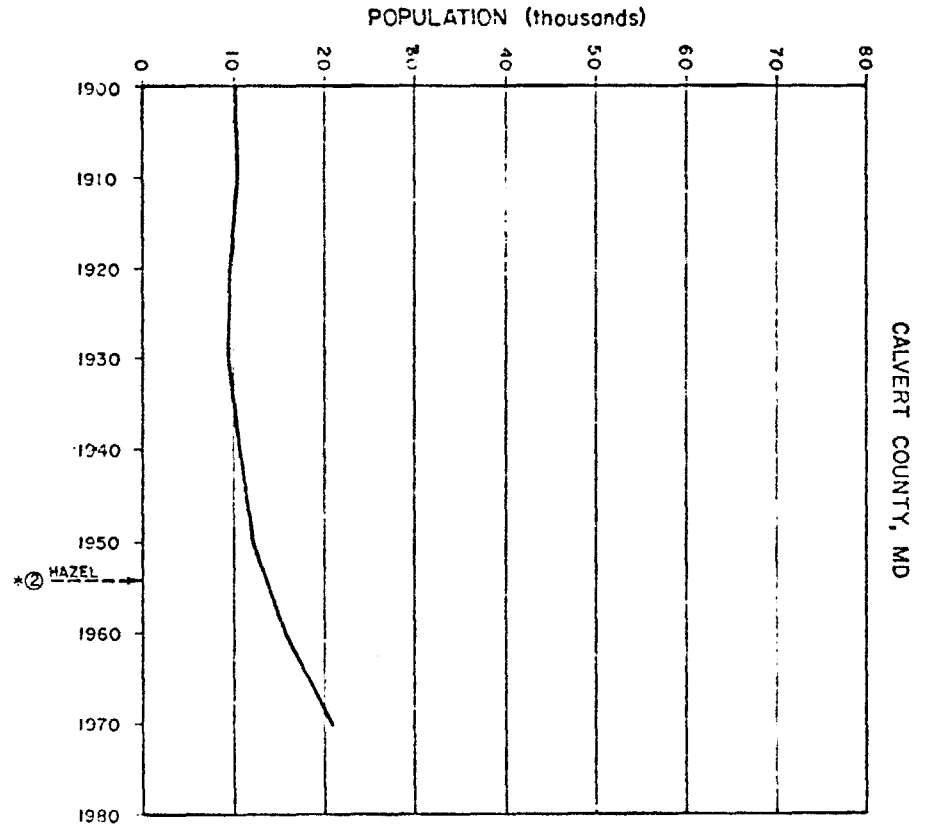
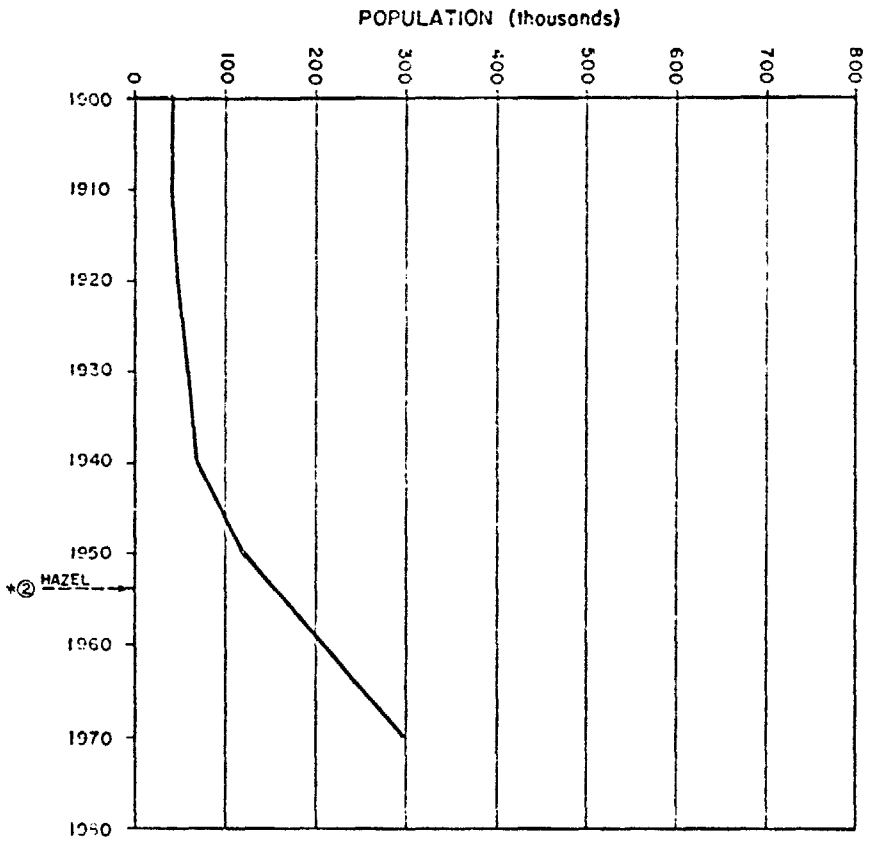


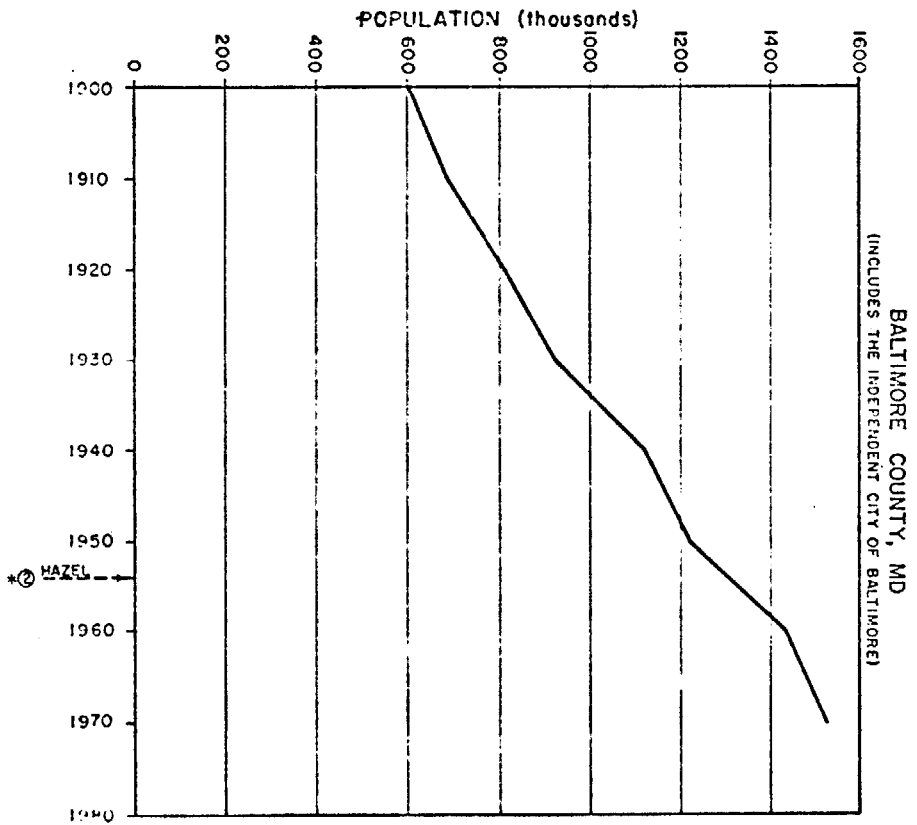
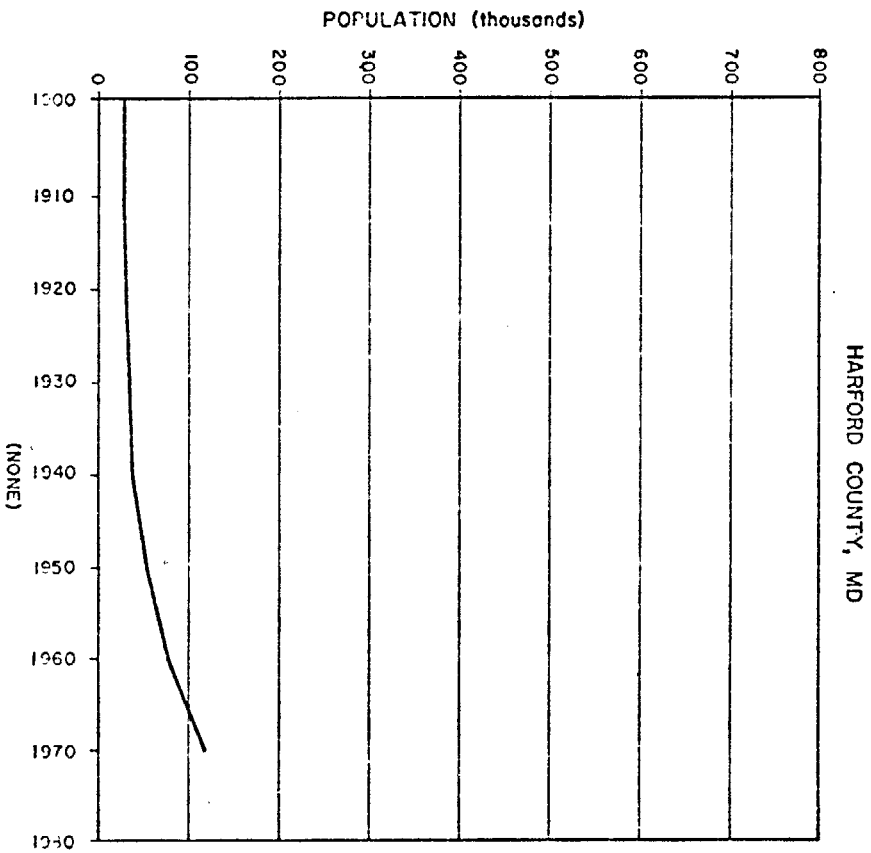


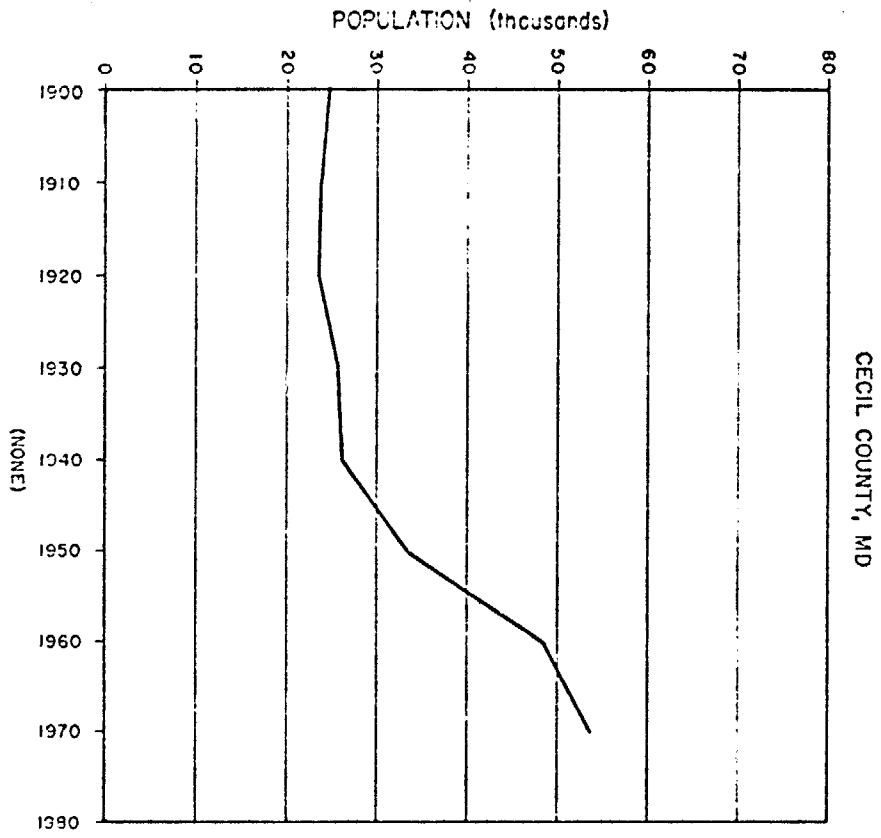
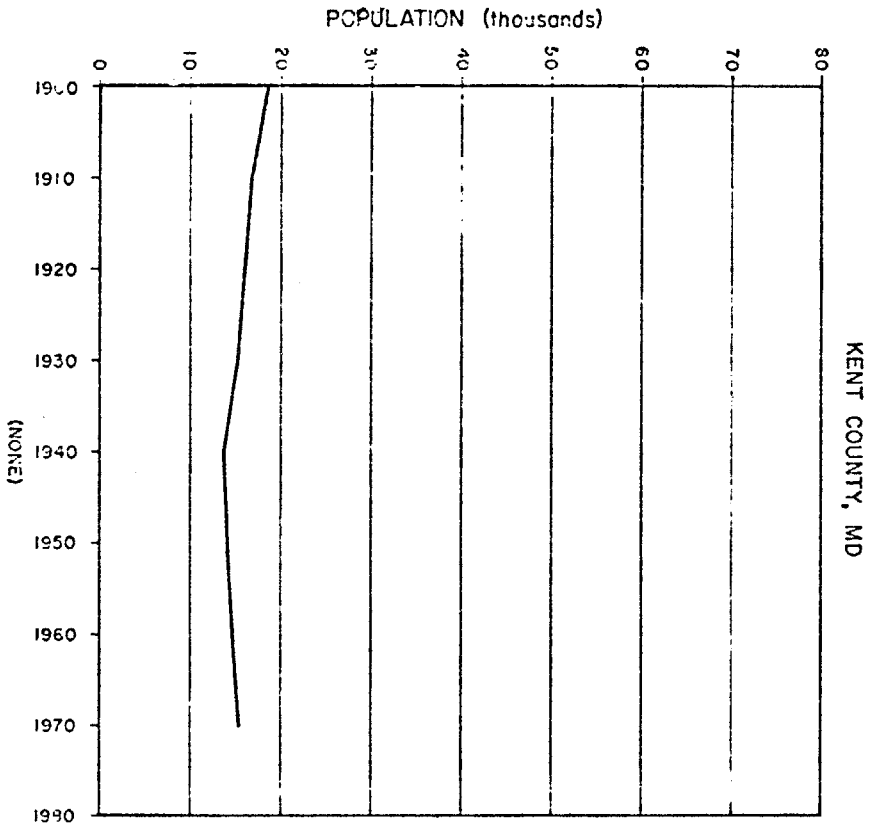


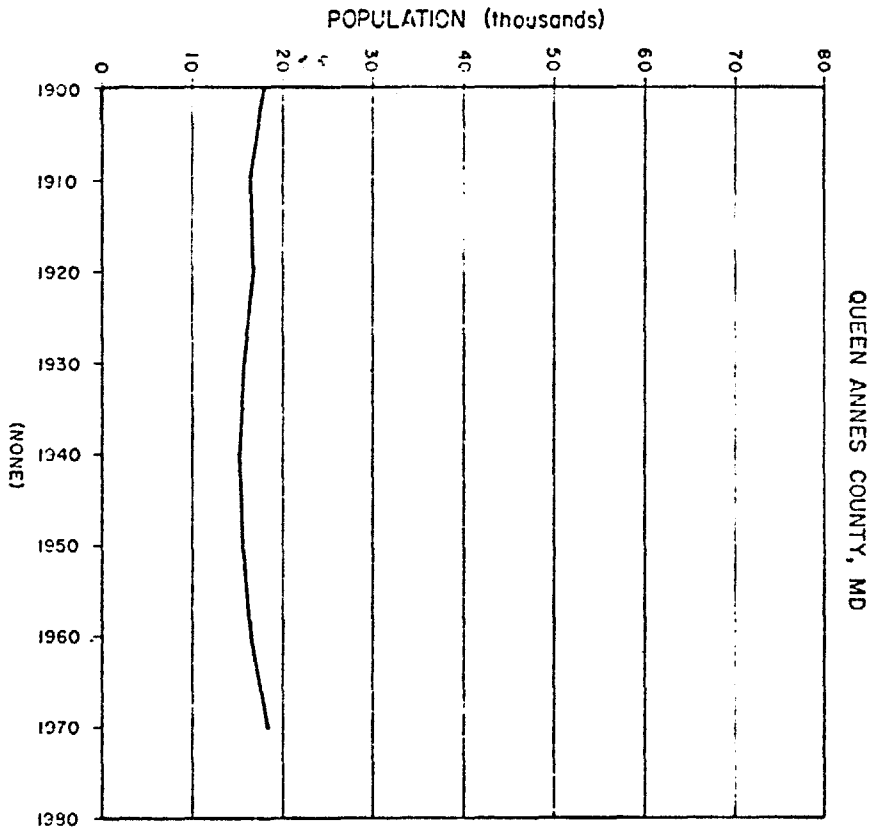
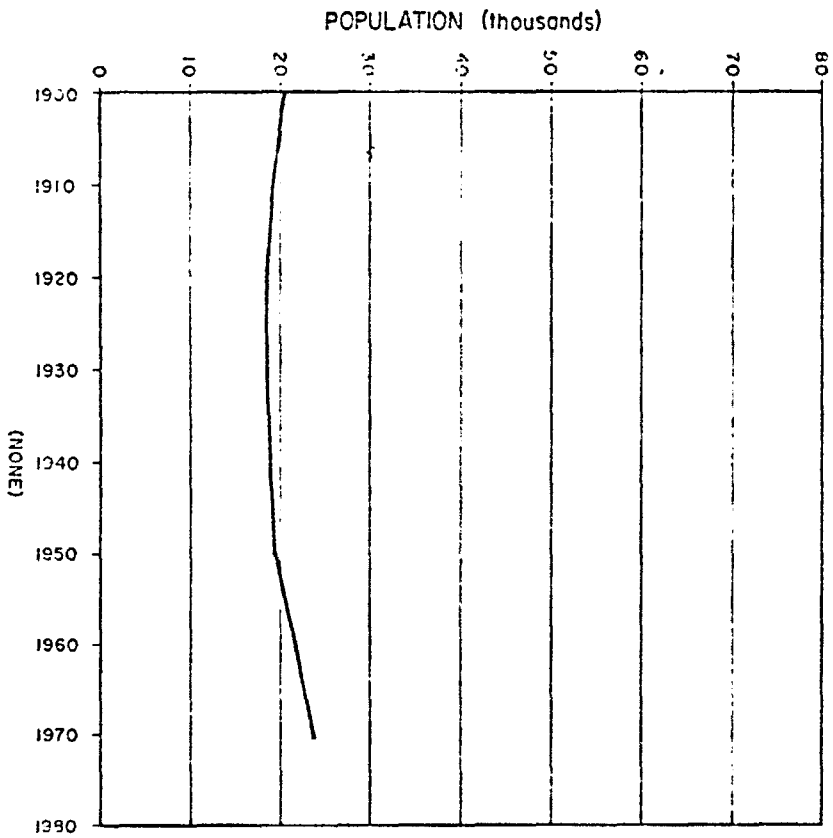


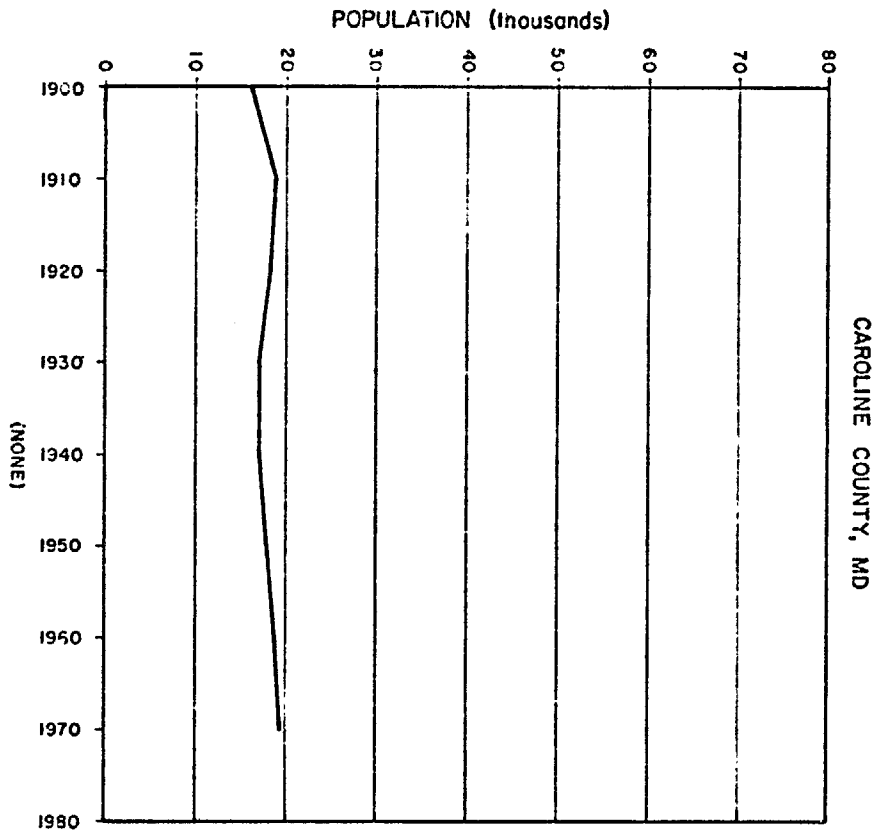
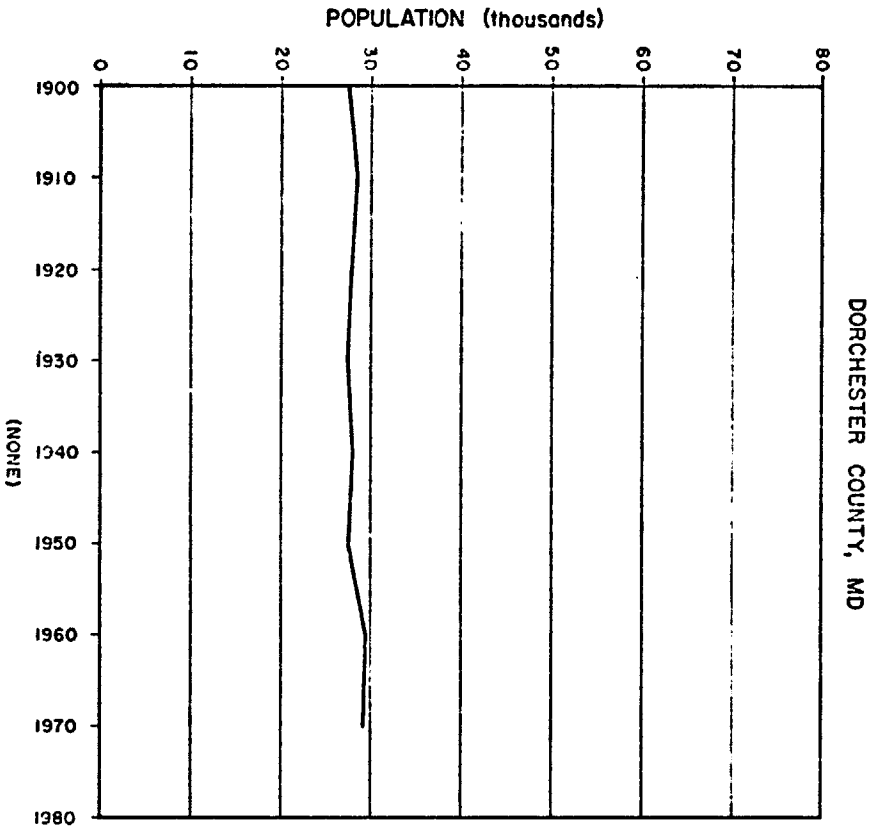




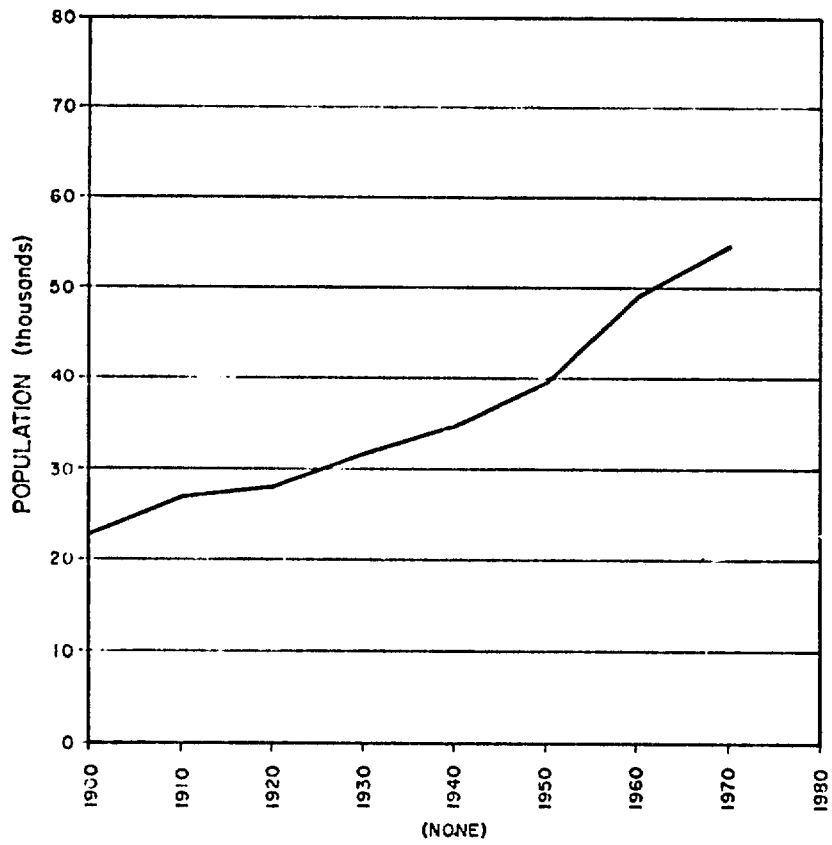




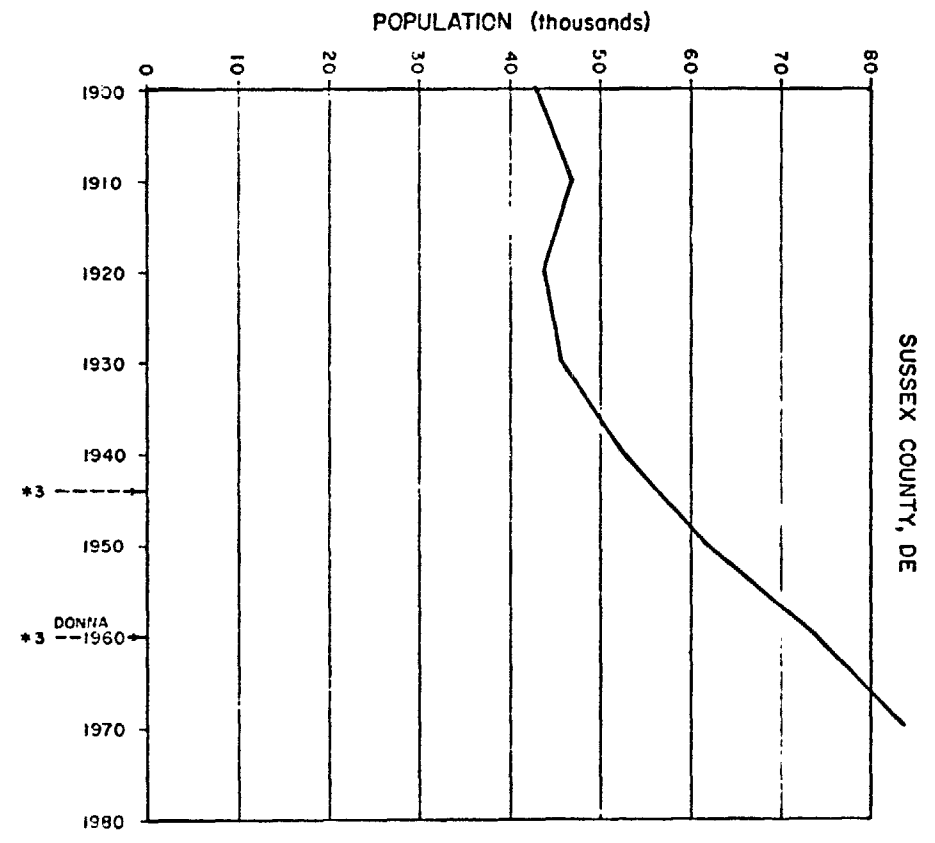
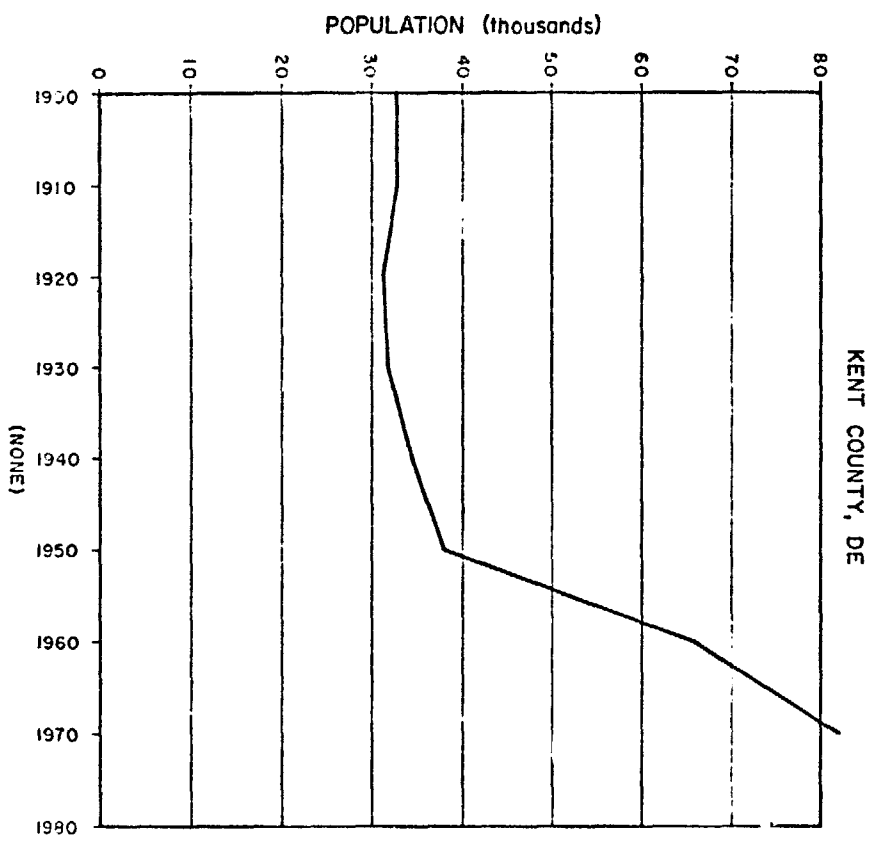




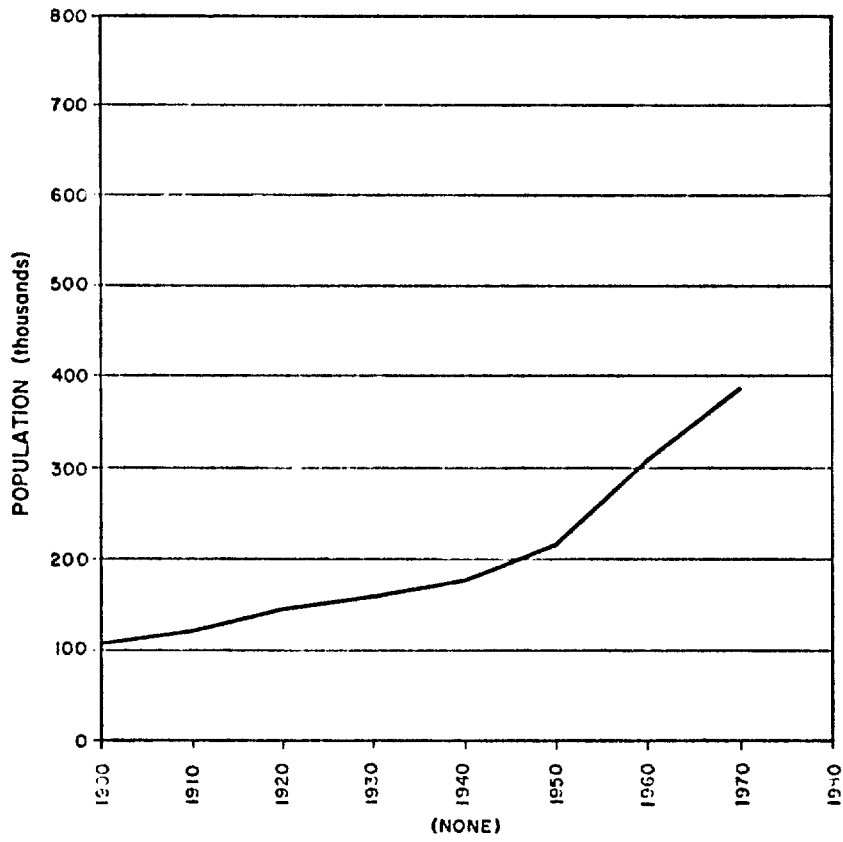
WICOMICO COUNTY, MD



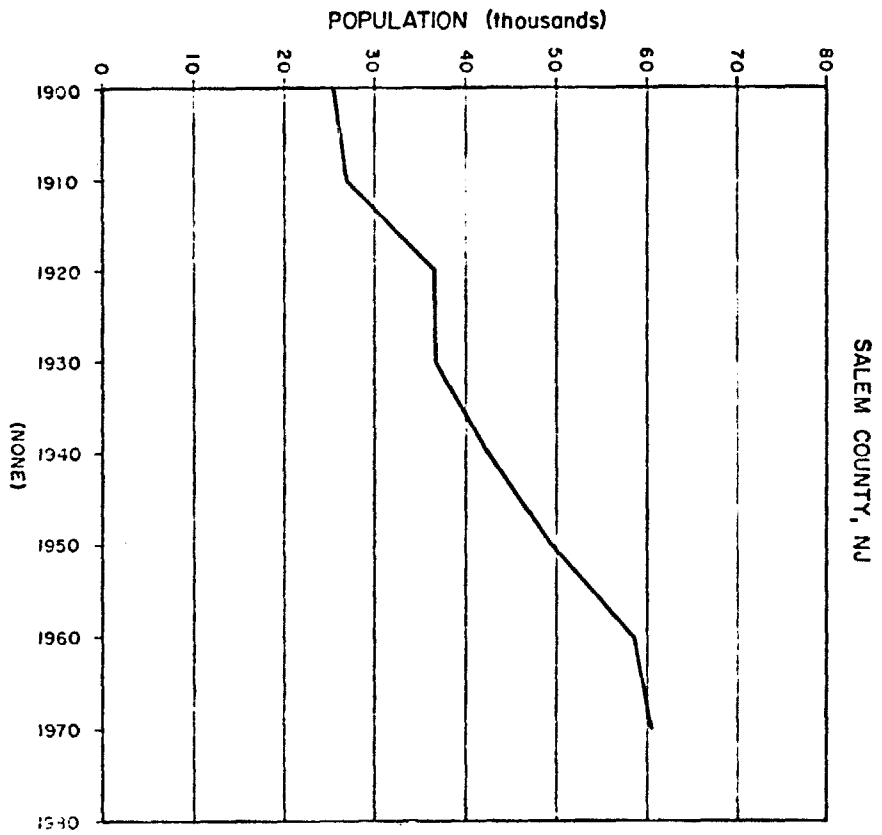
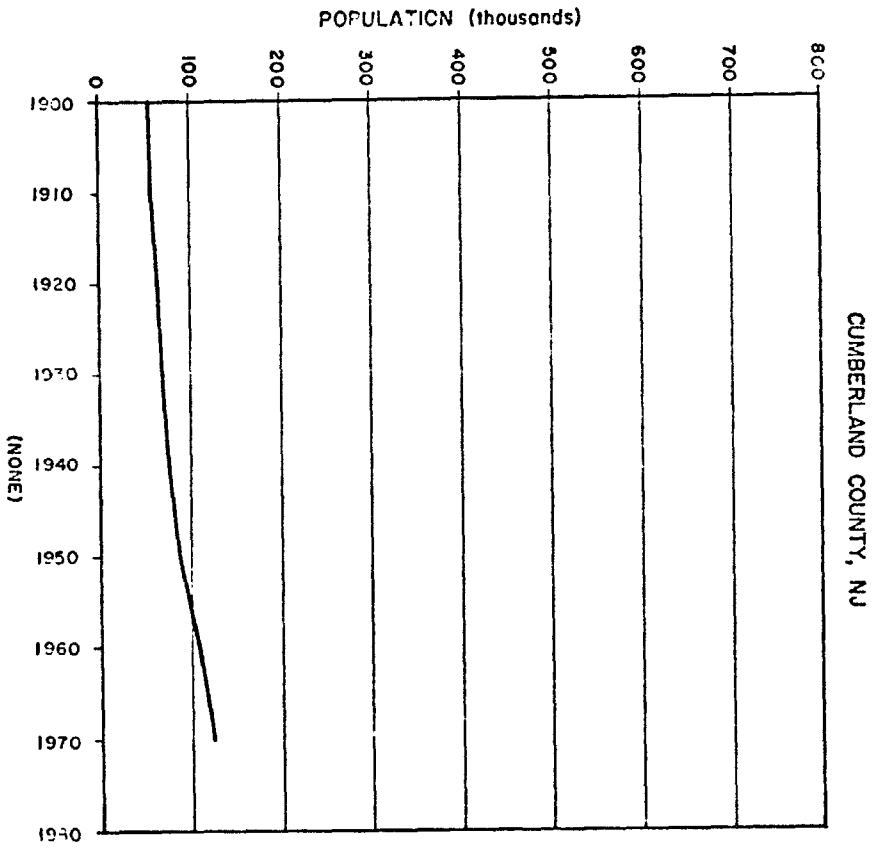
END OF MARYLAND COUNTIES

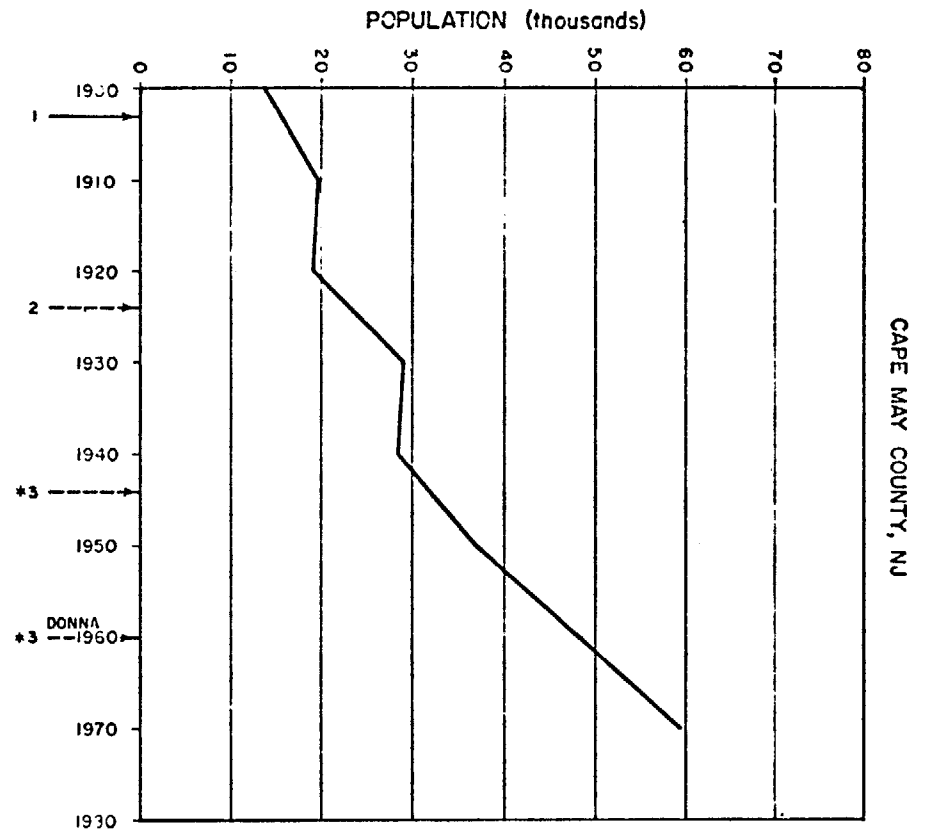
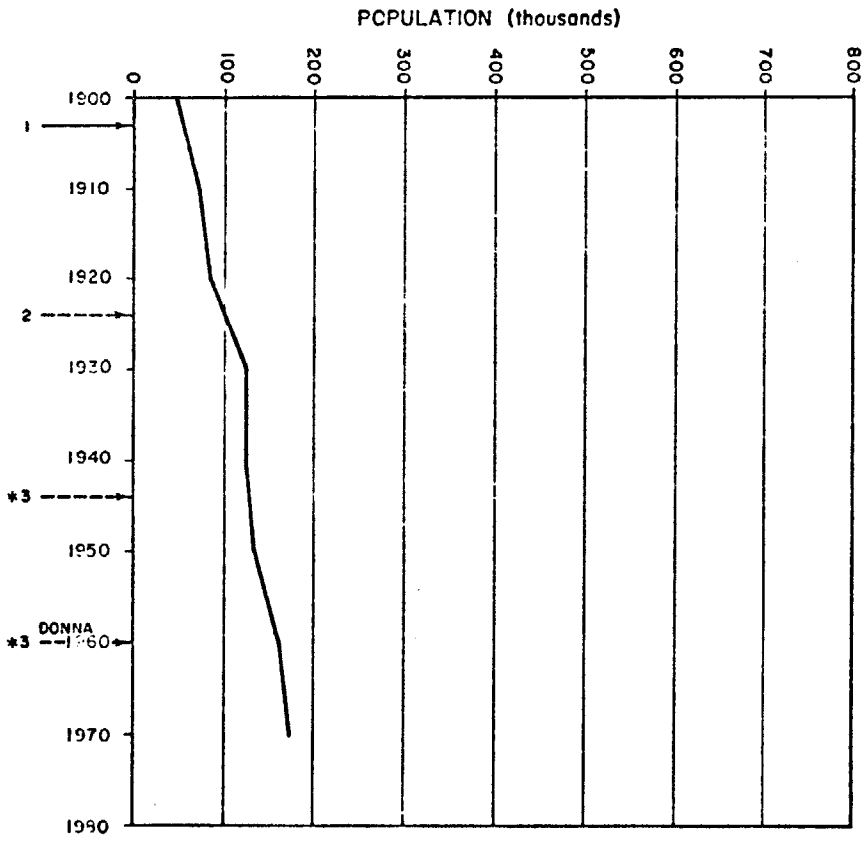


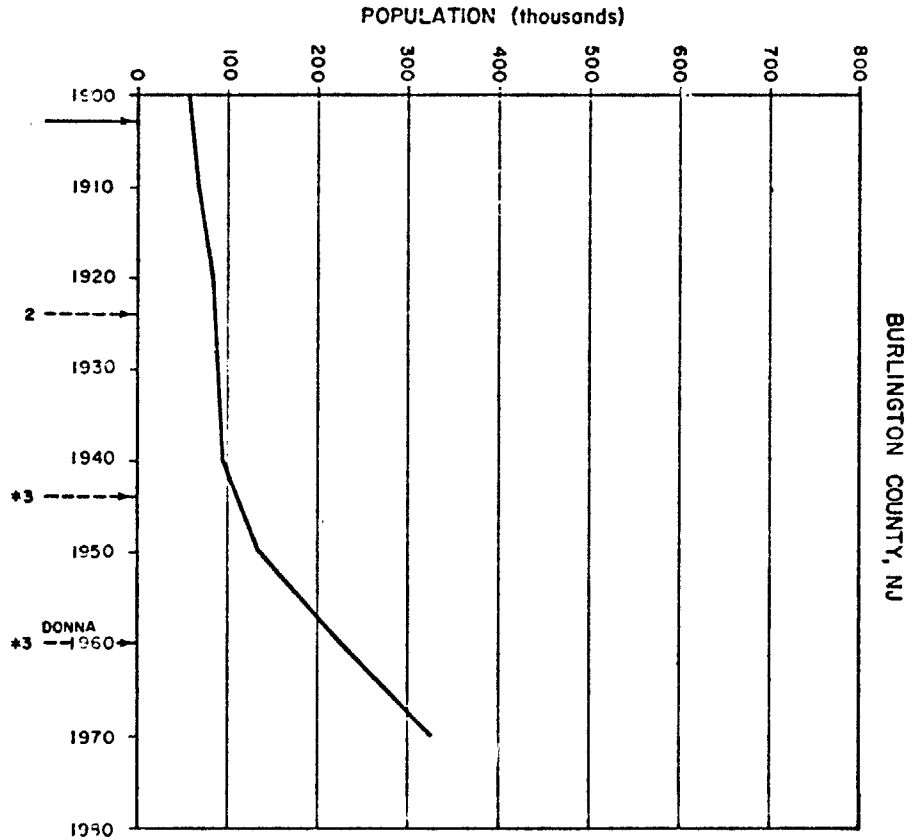
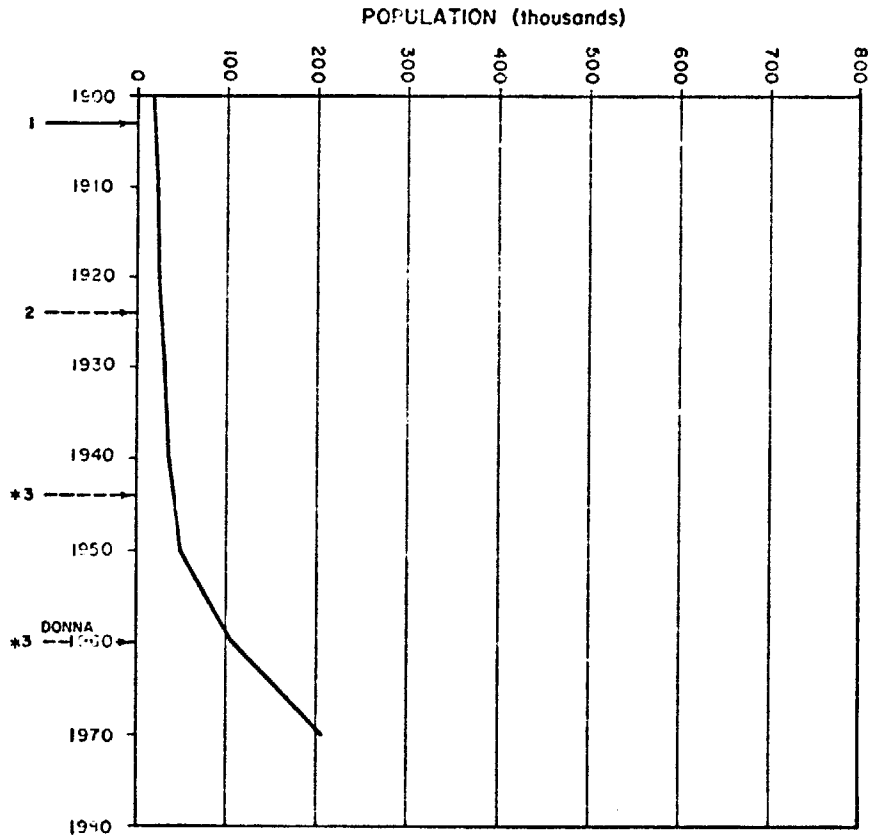
NEW CASTLE COUNTY; DE

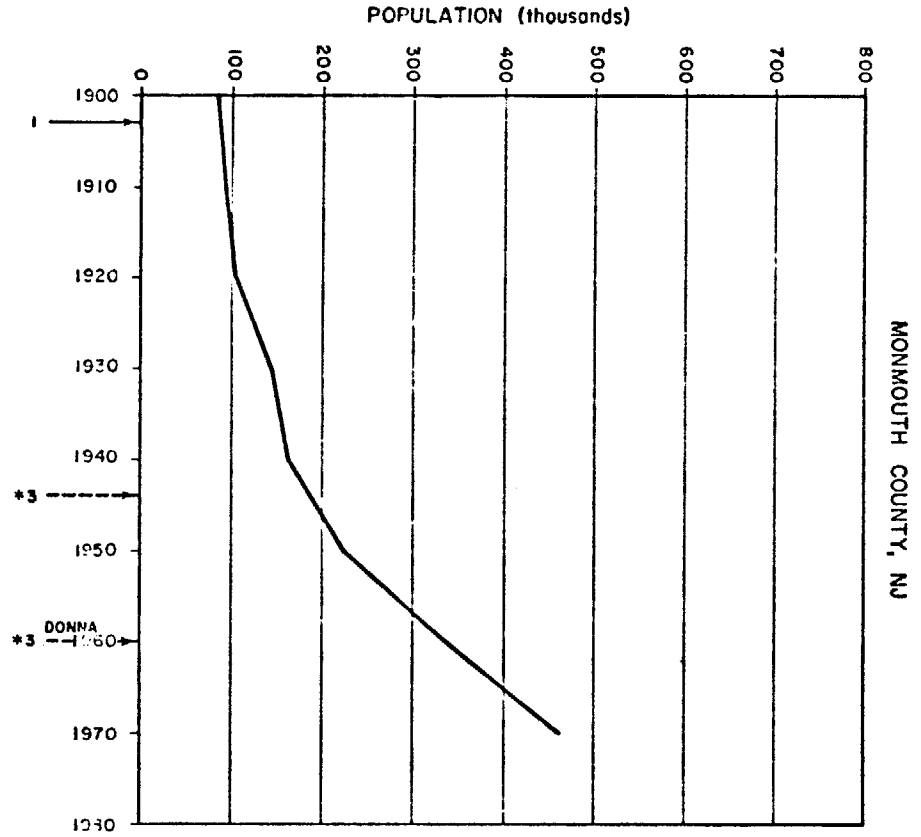
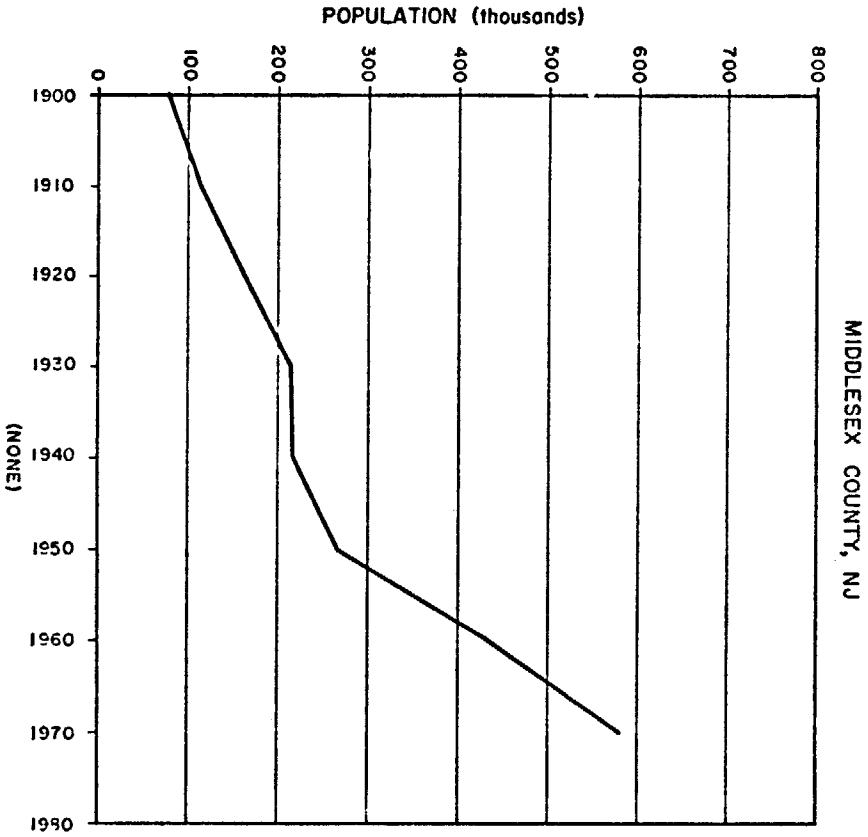


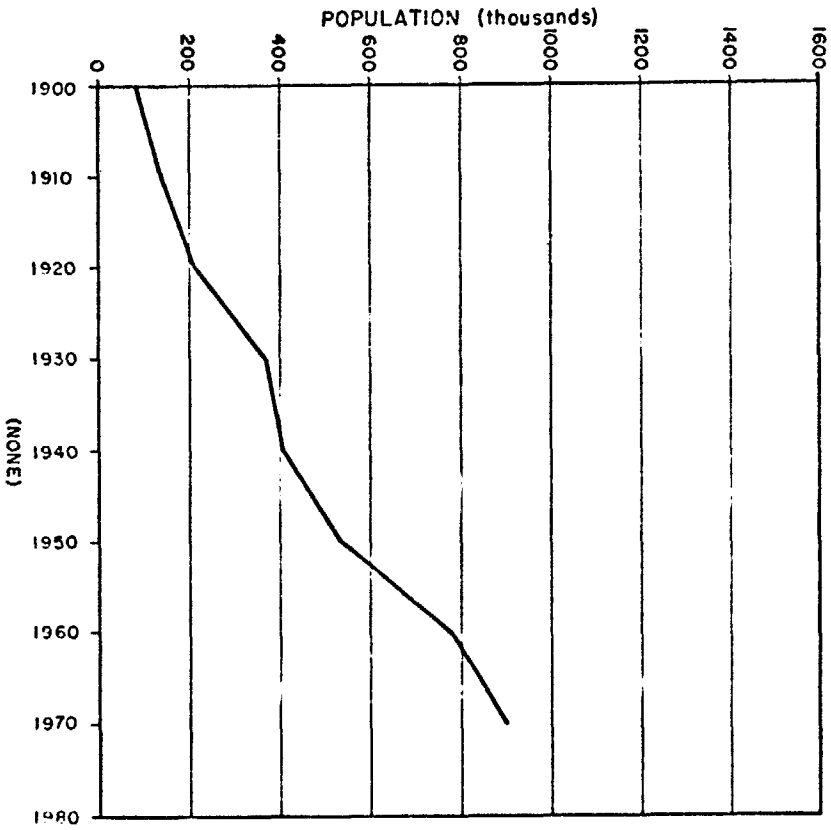
END OF DELAWARE COUNTIES



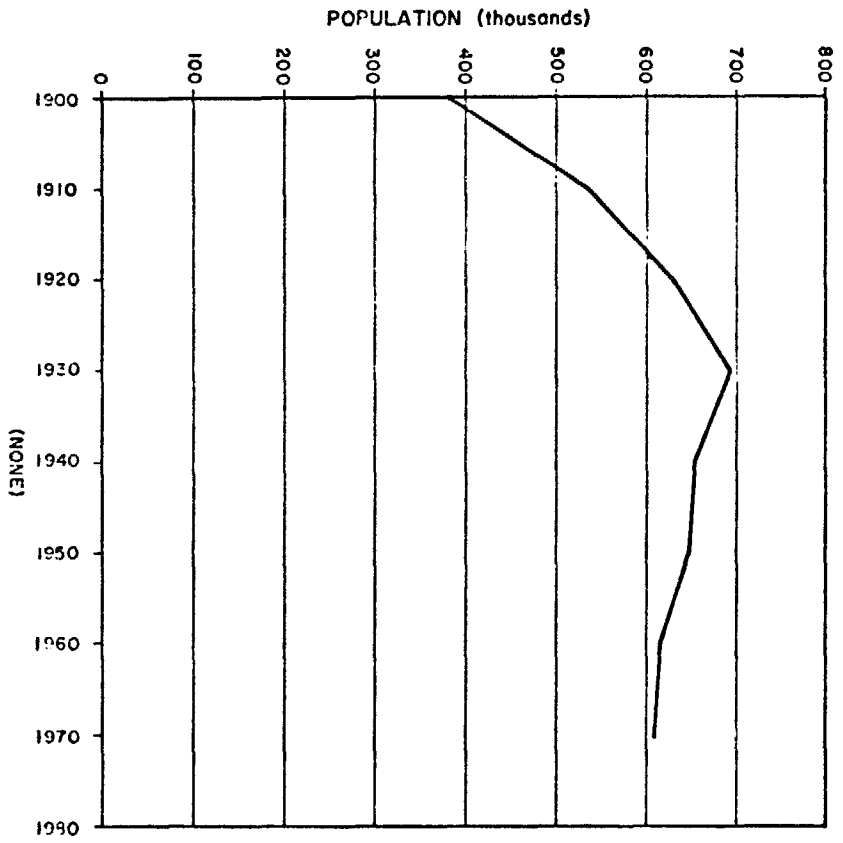




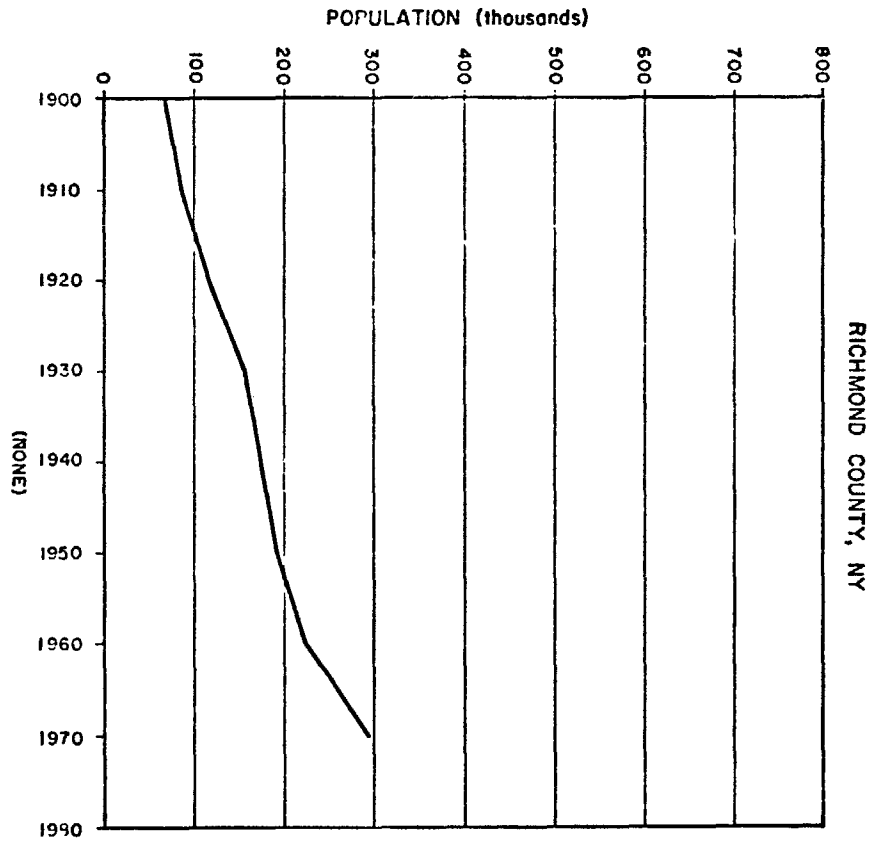
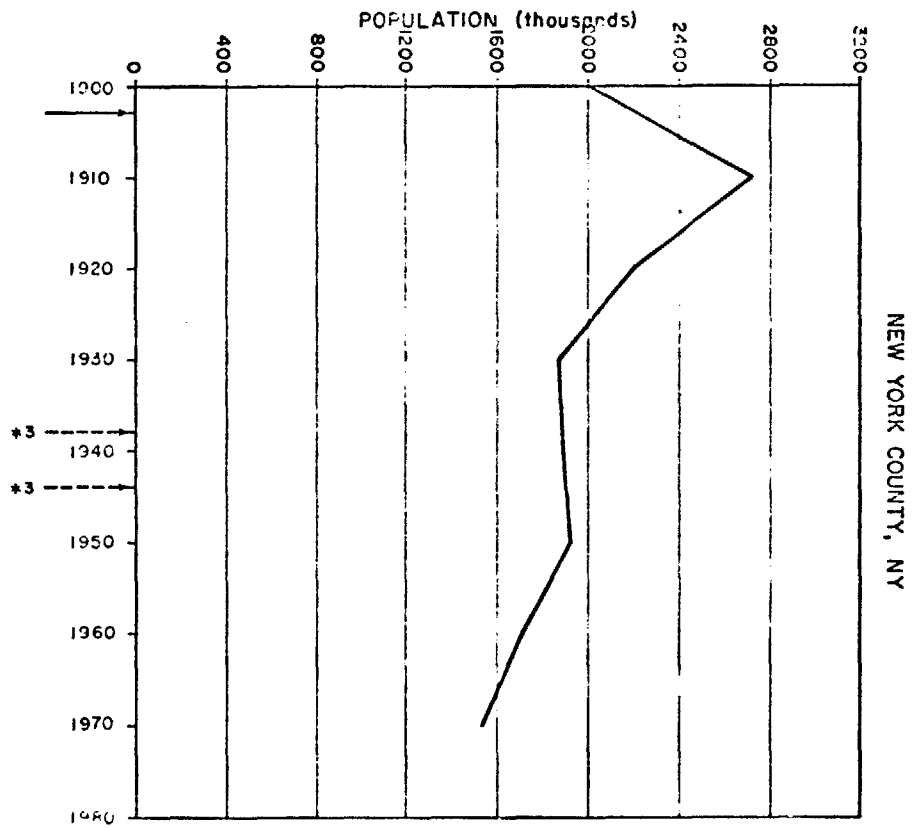


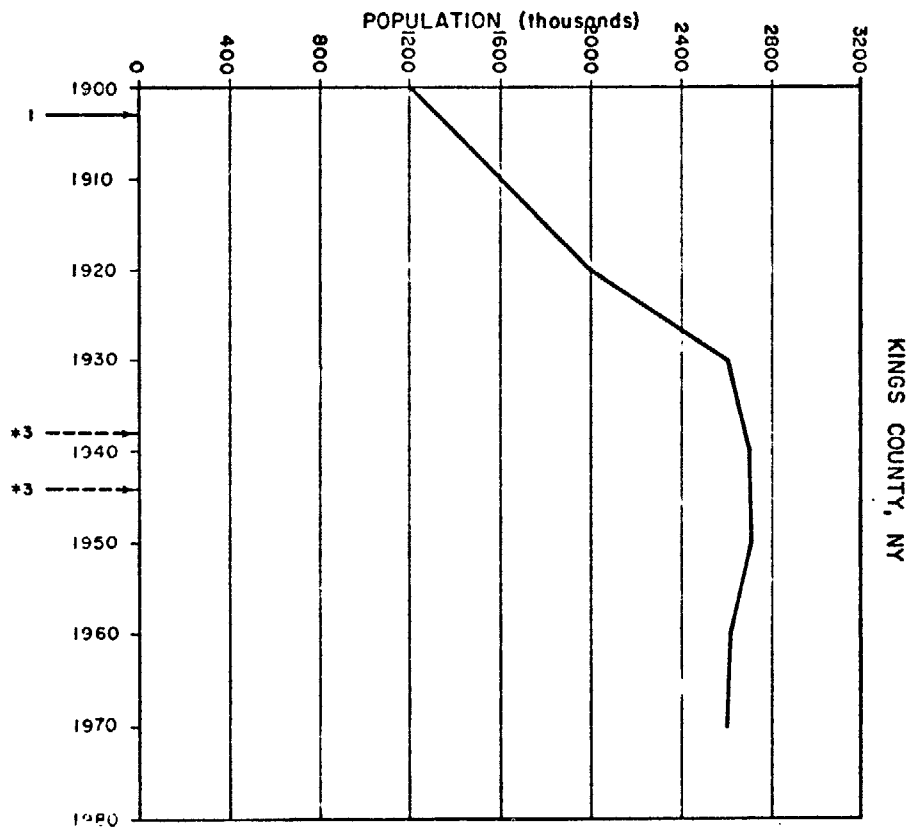
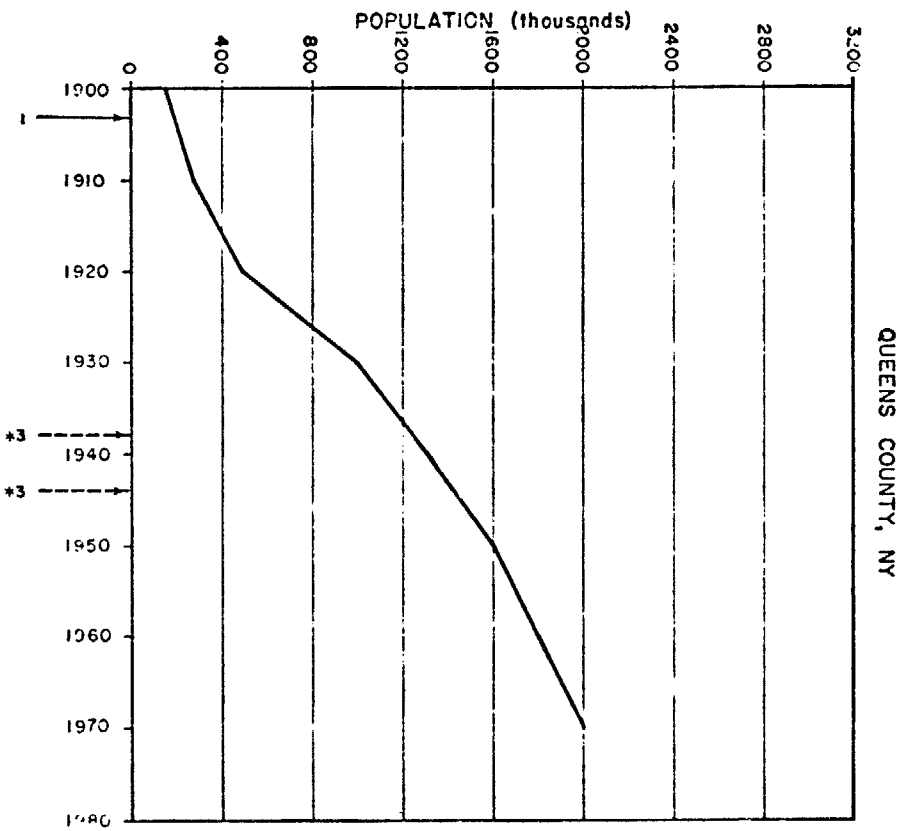


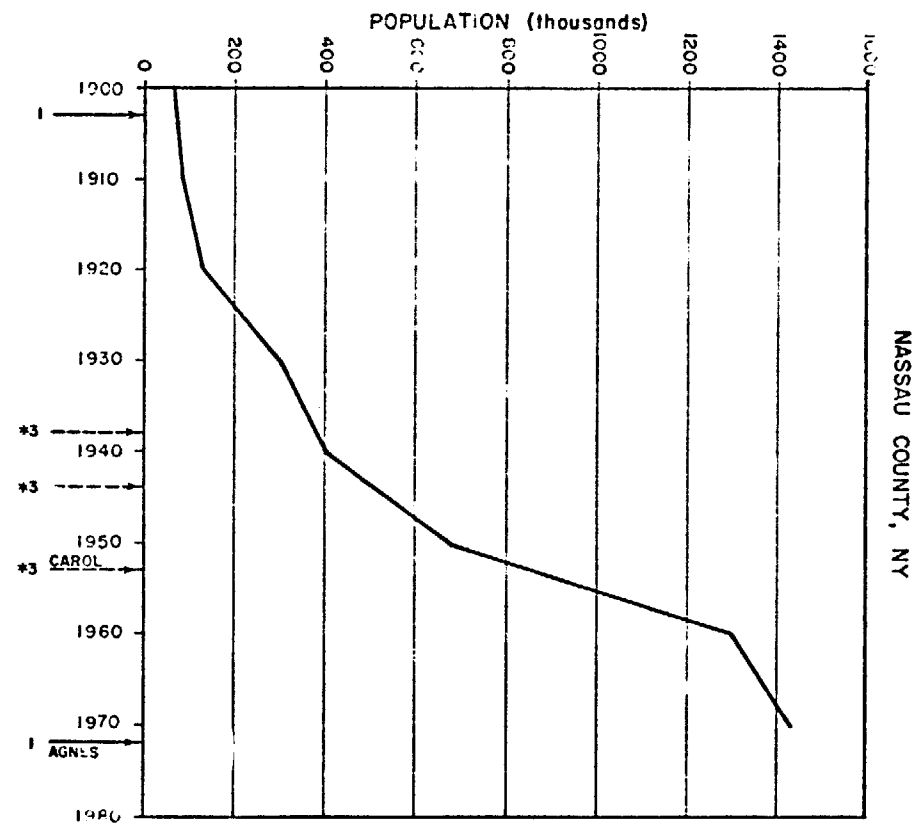
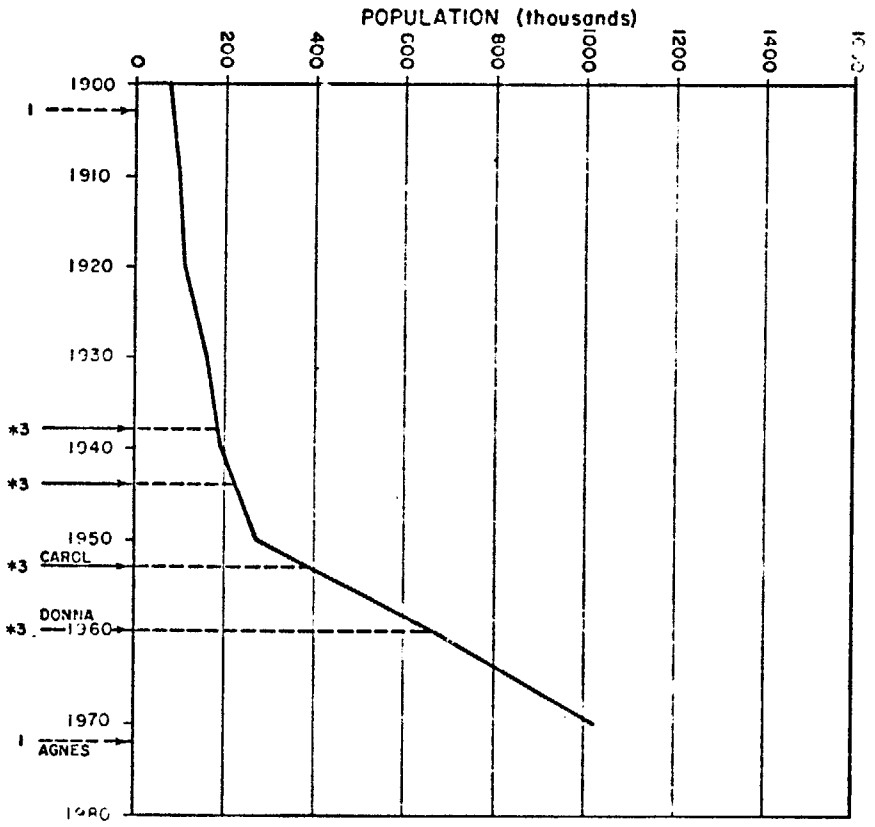
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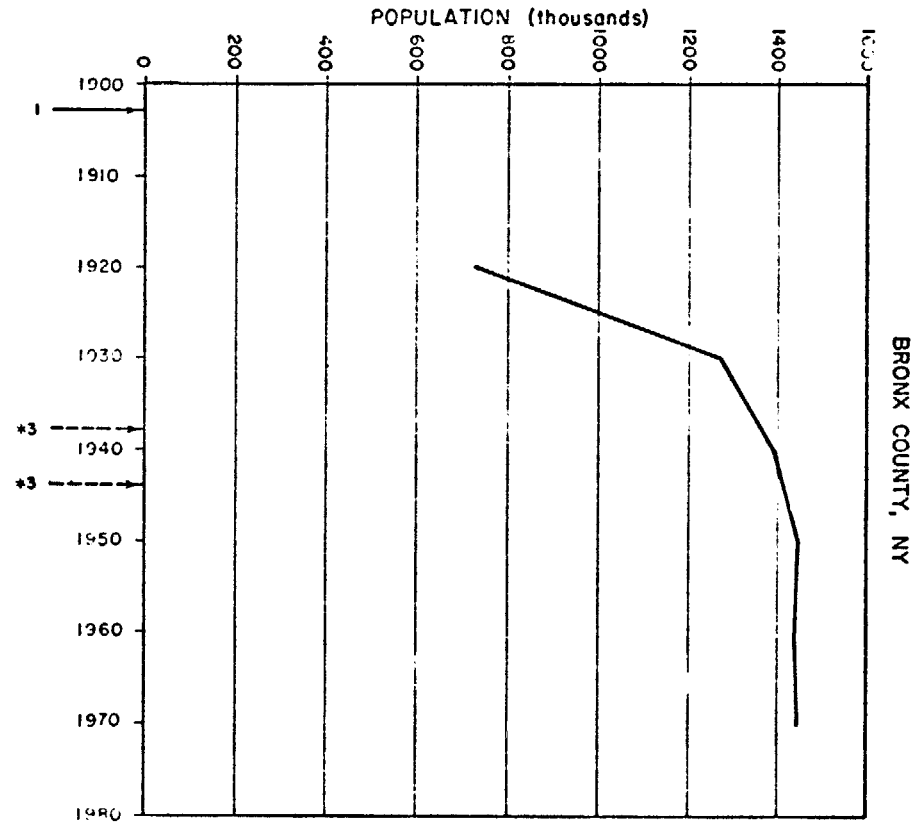
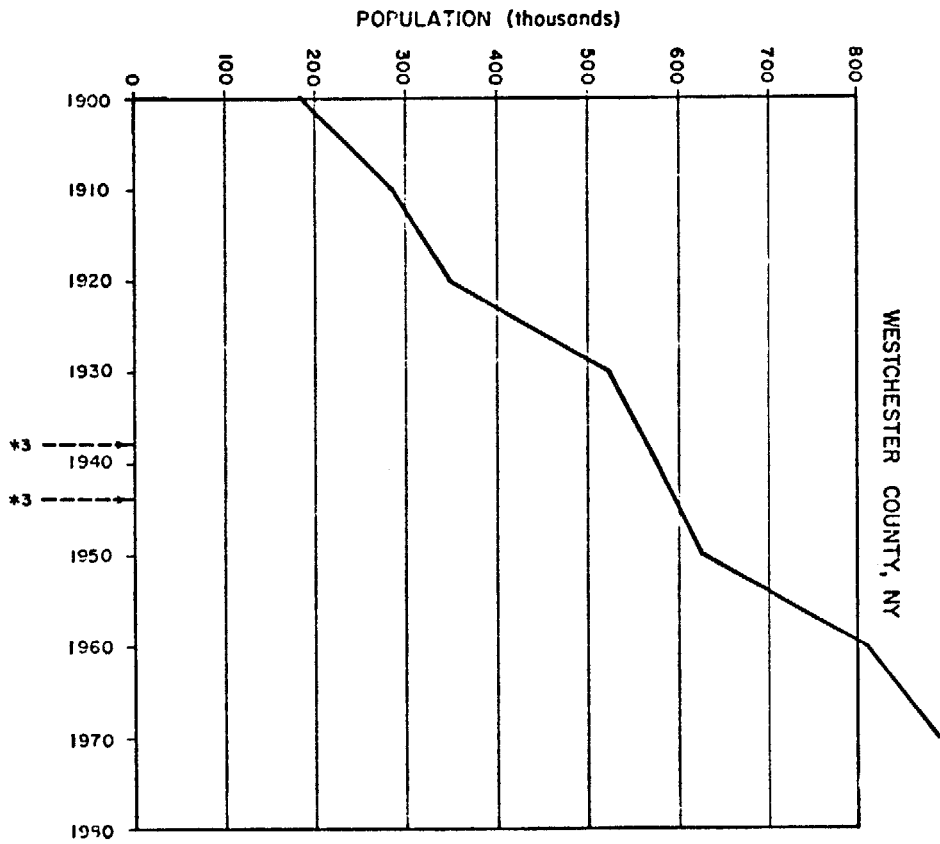


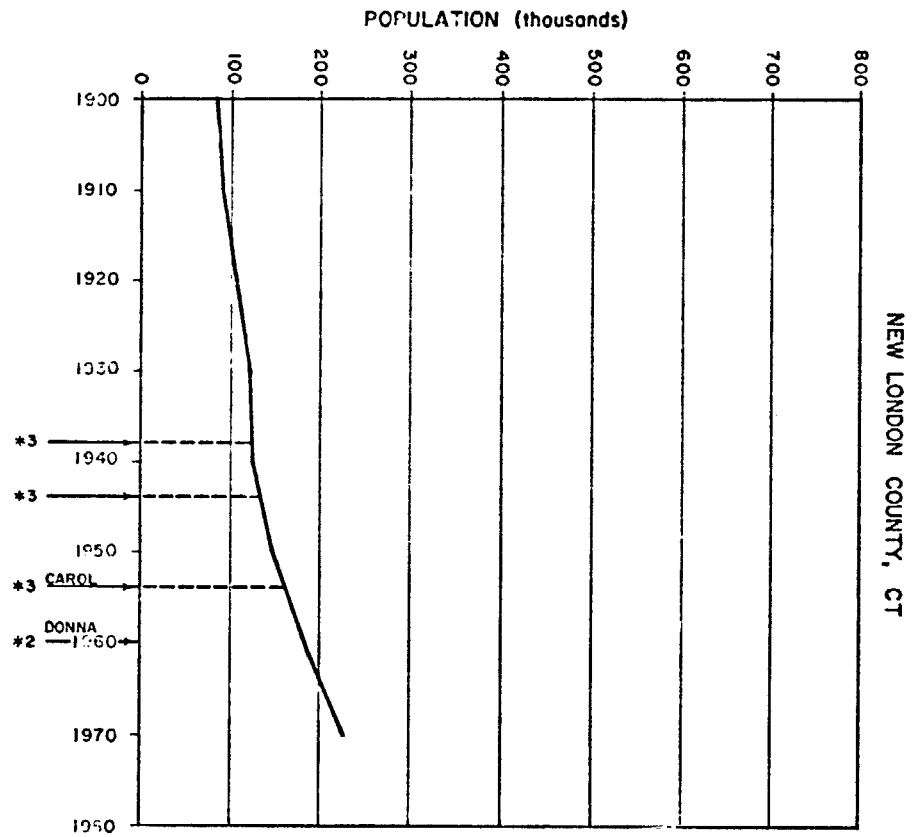
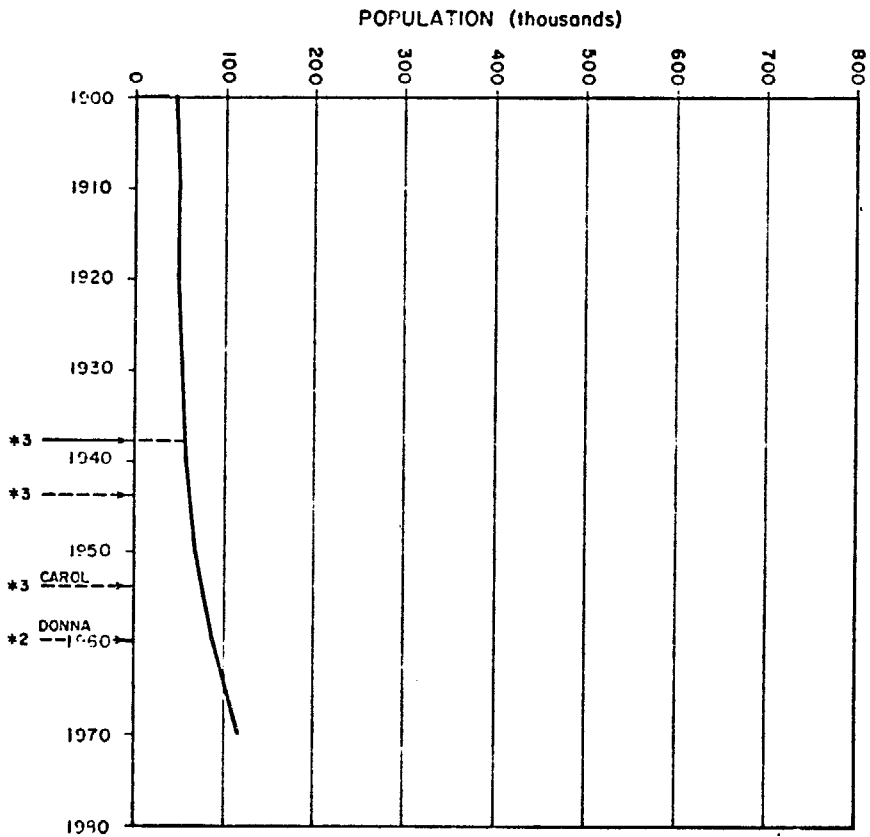
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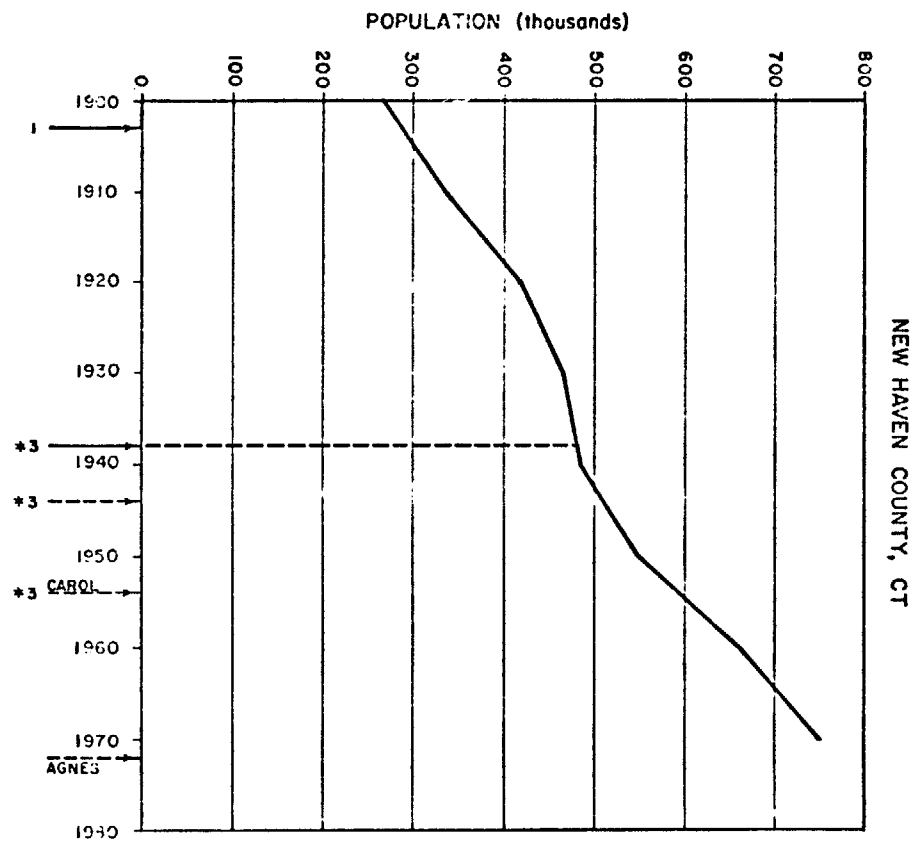
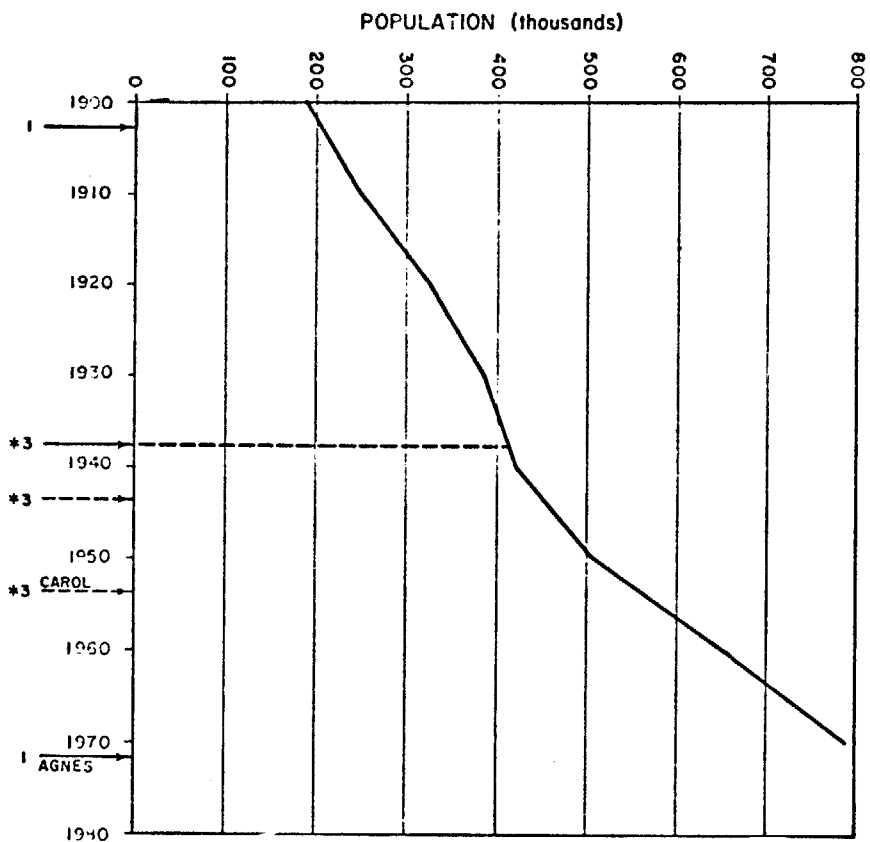




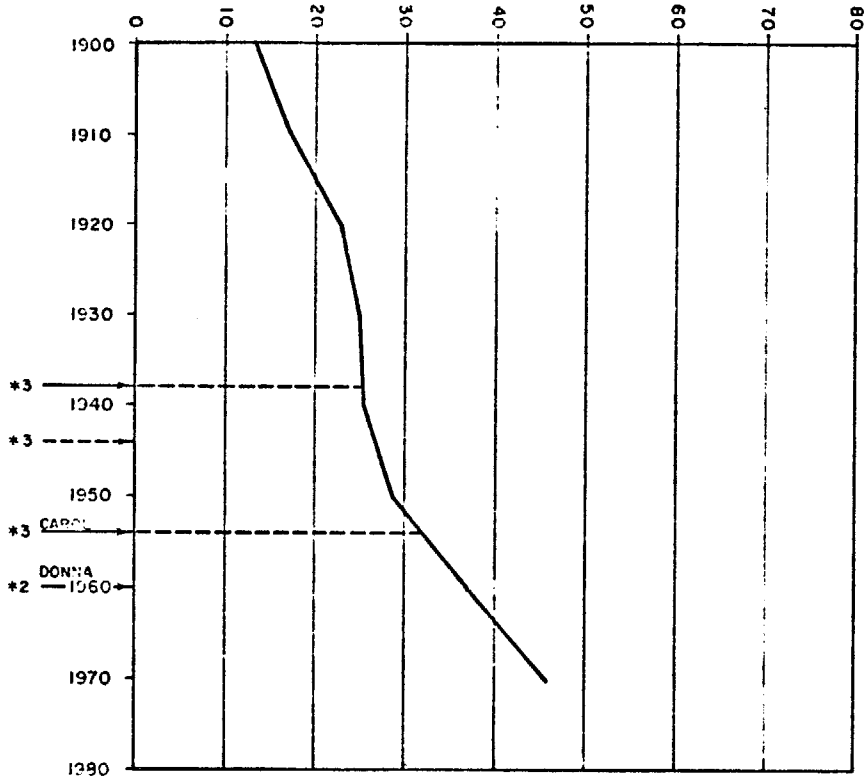






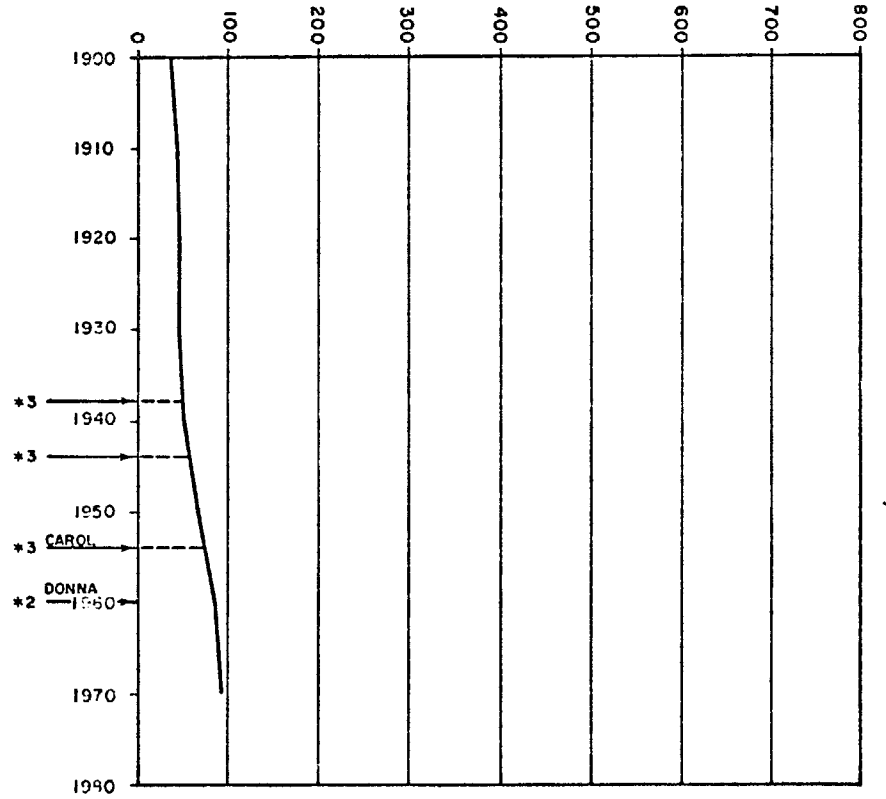


POPULATION (thousands)

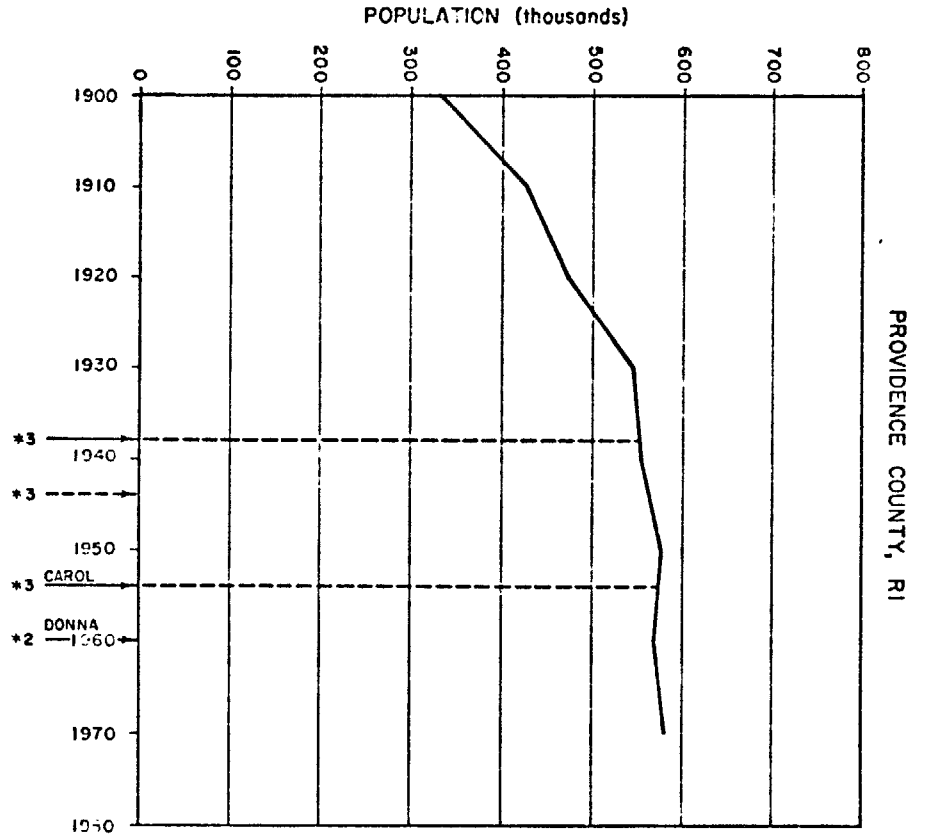
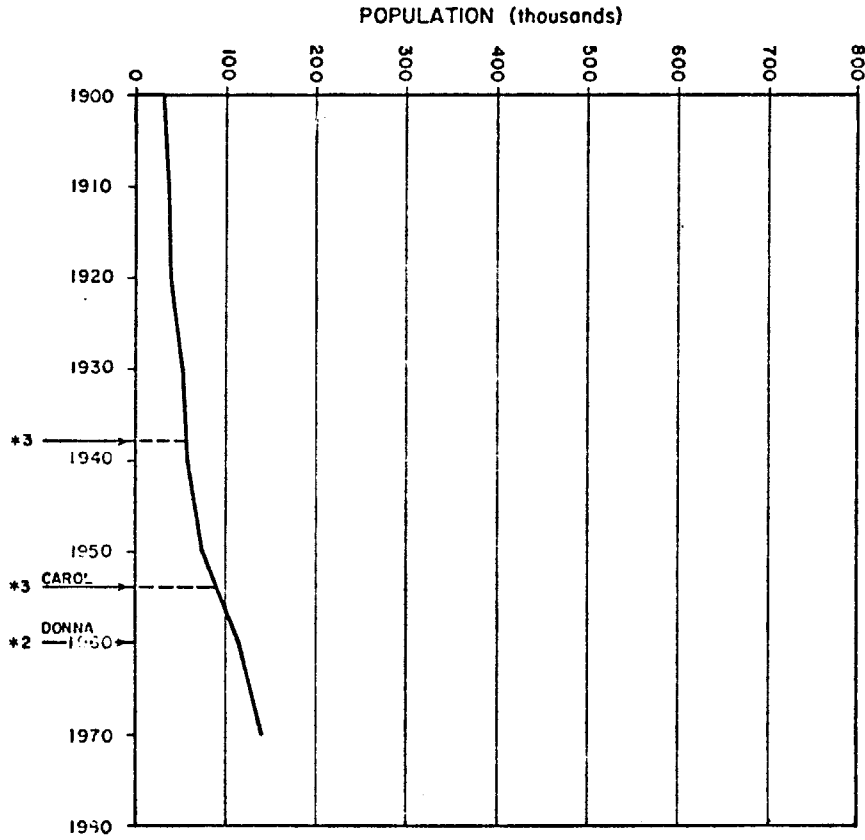


BRISTOL COUNTY, RI

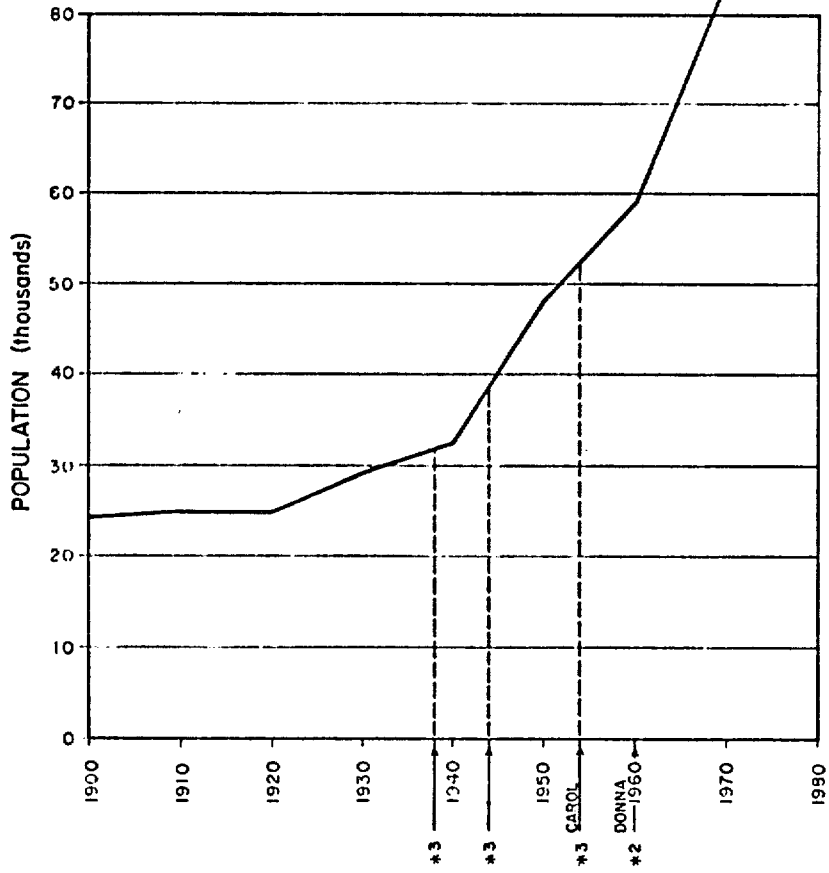
POPULATION (thousands)



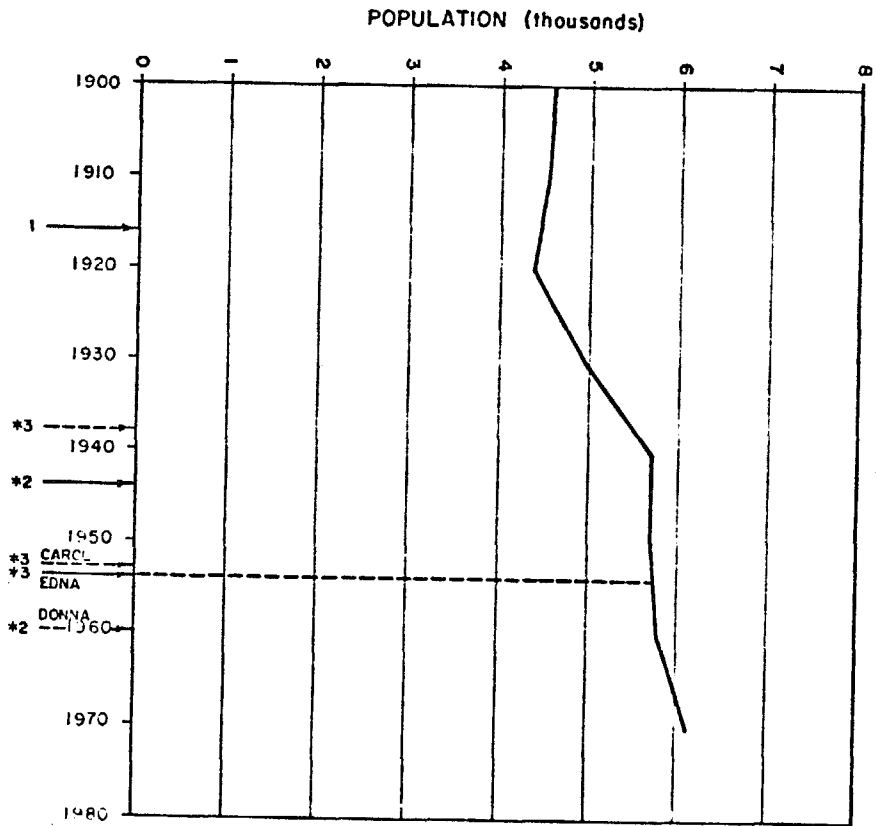
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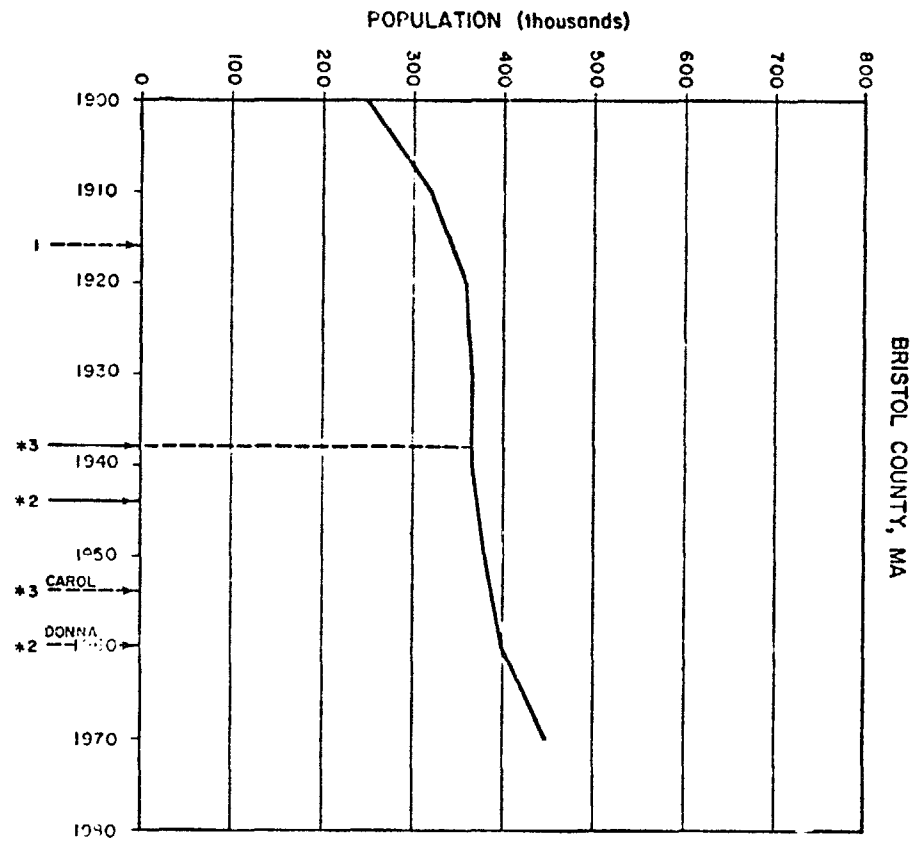
WASHINGTON COUNTY, RI



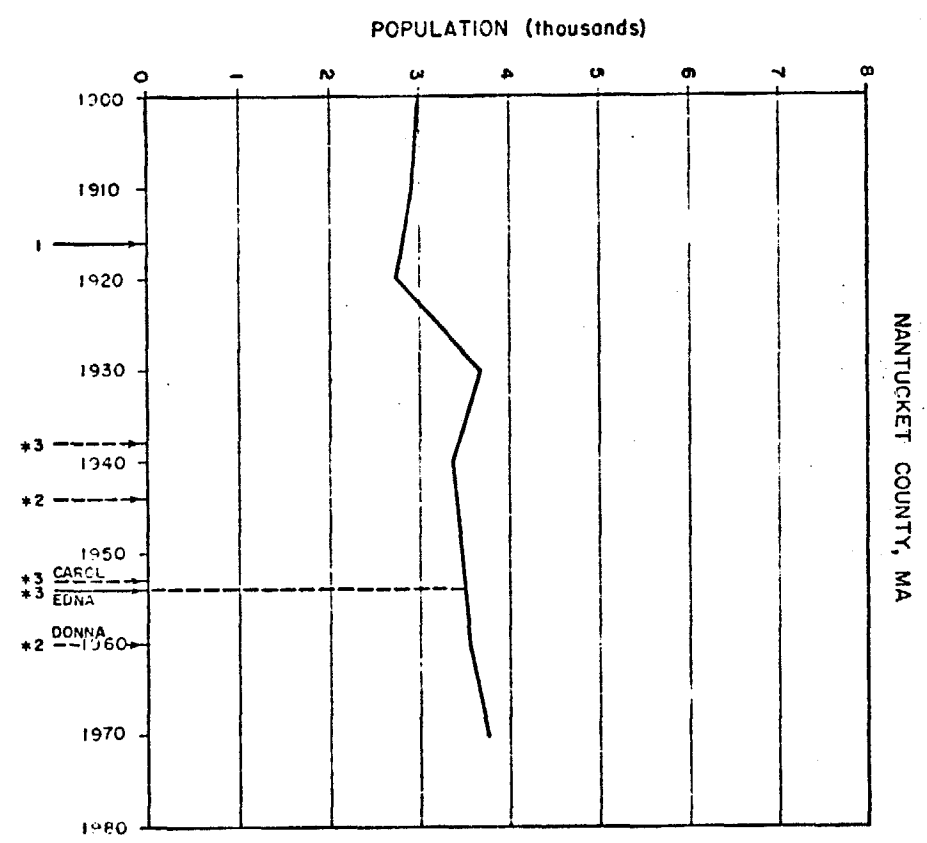
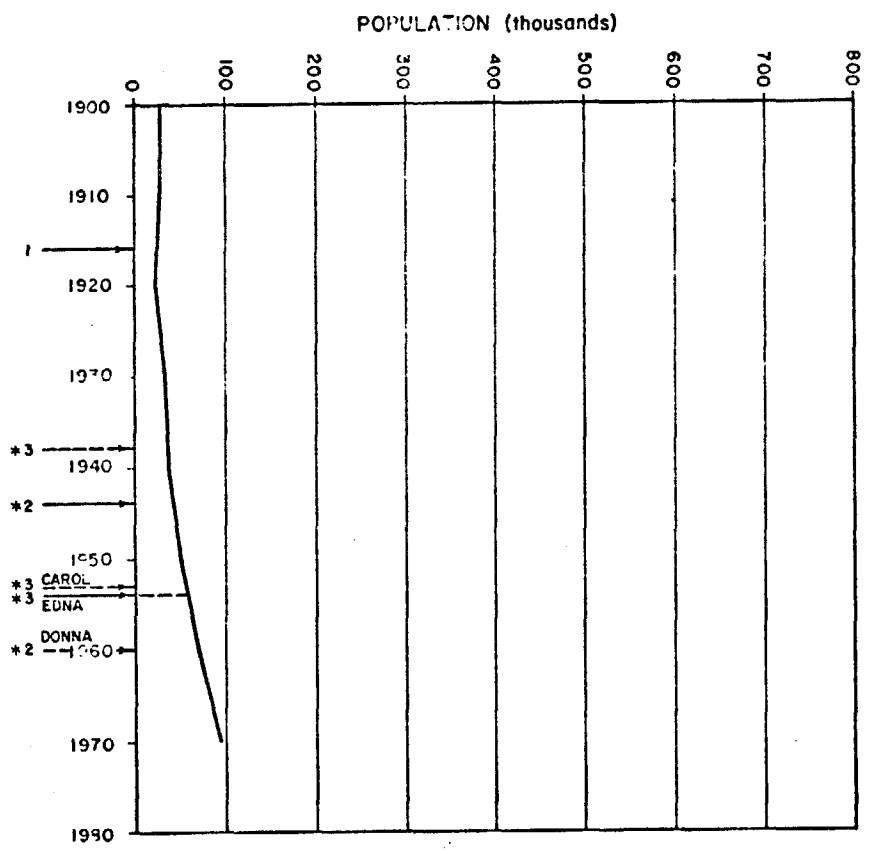
END OF RHODE ISLAND COUNTIES

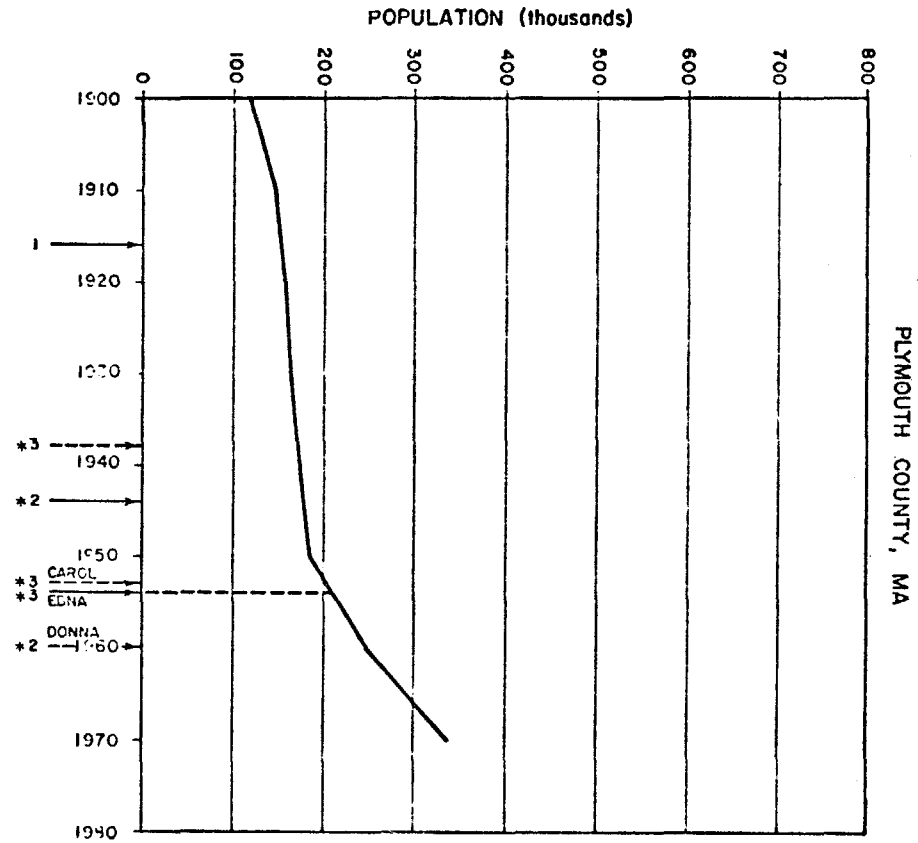
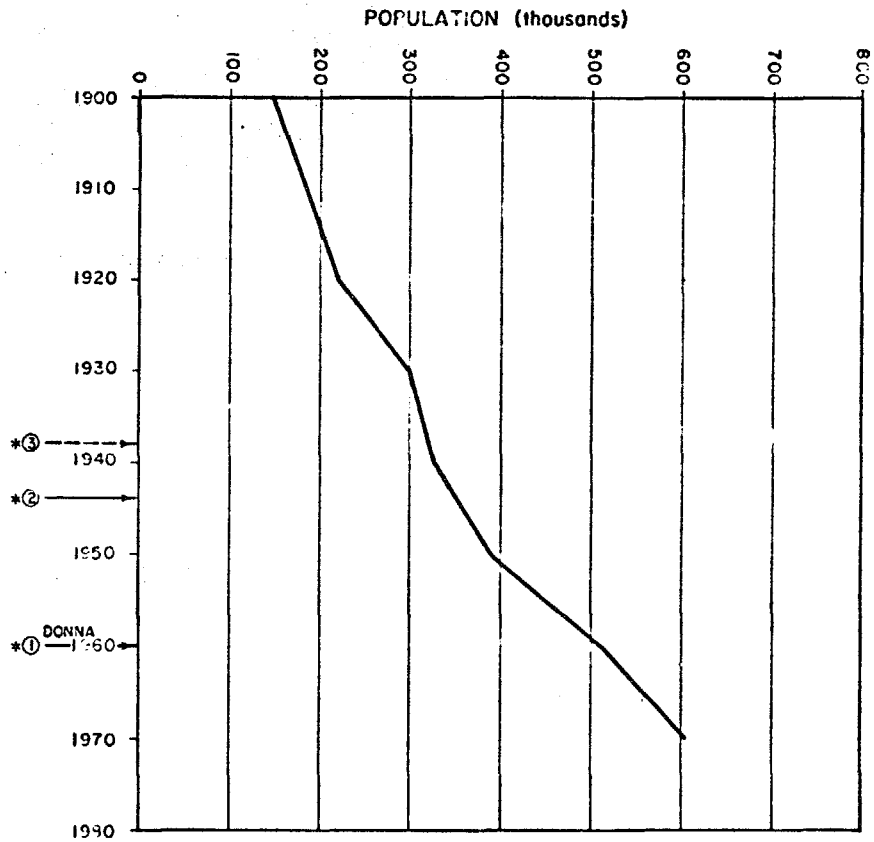


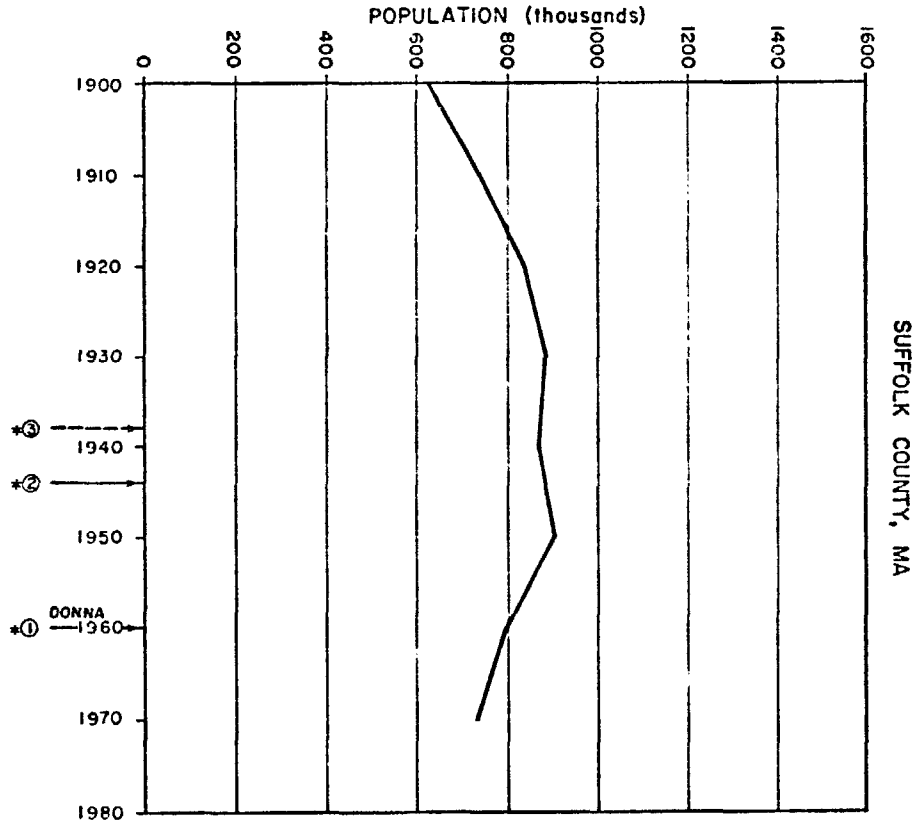
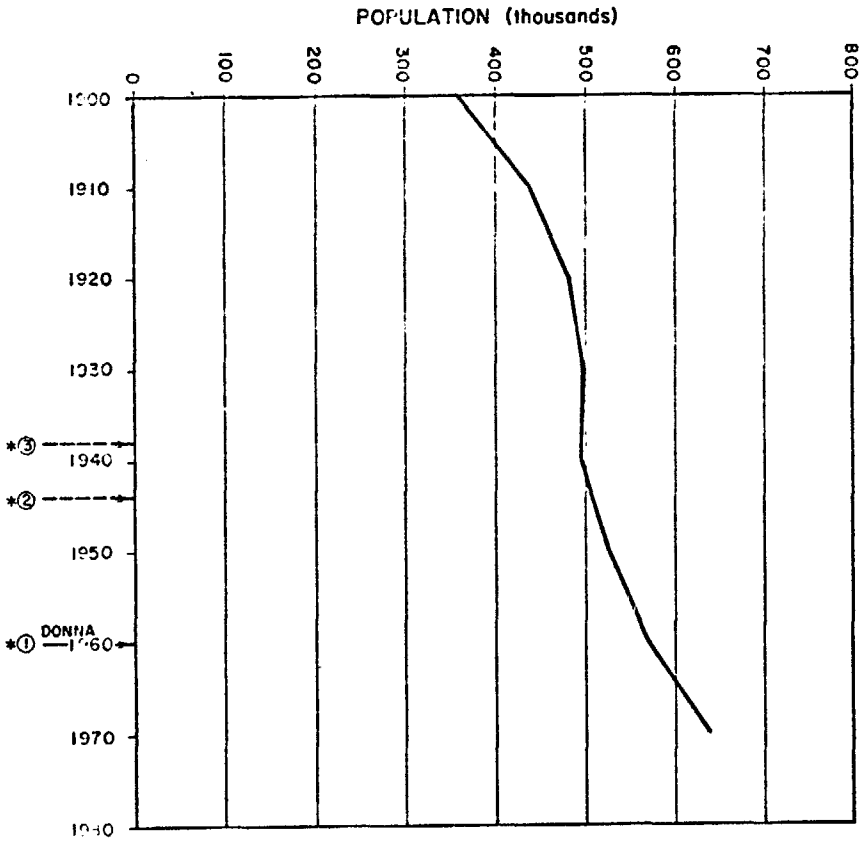
DUKES COUNTY, MA



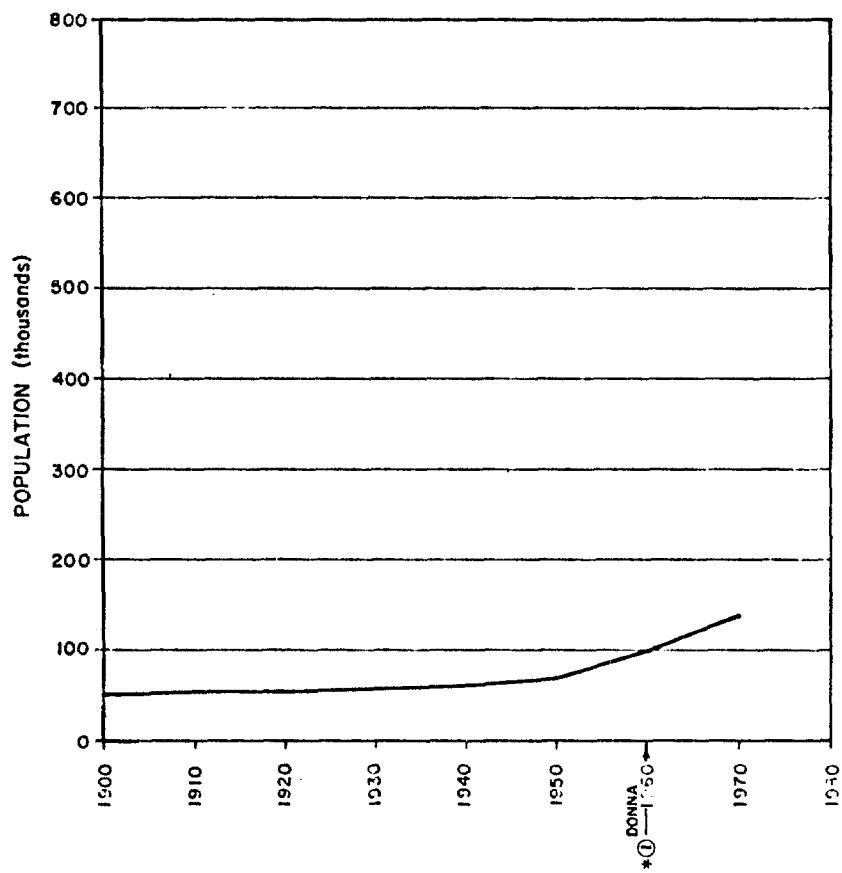
BRISTOL COUNTY, MA



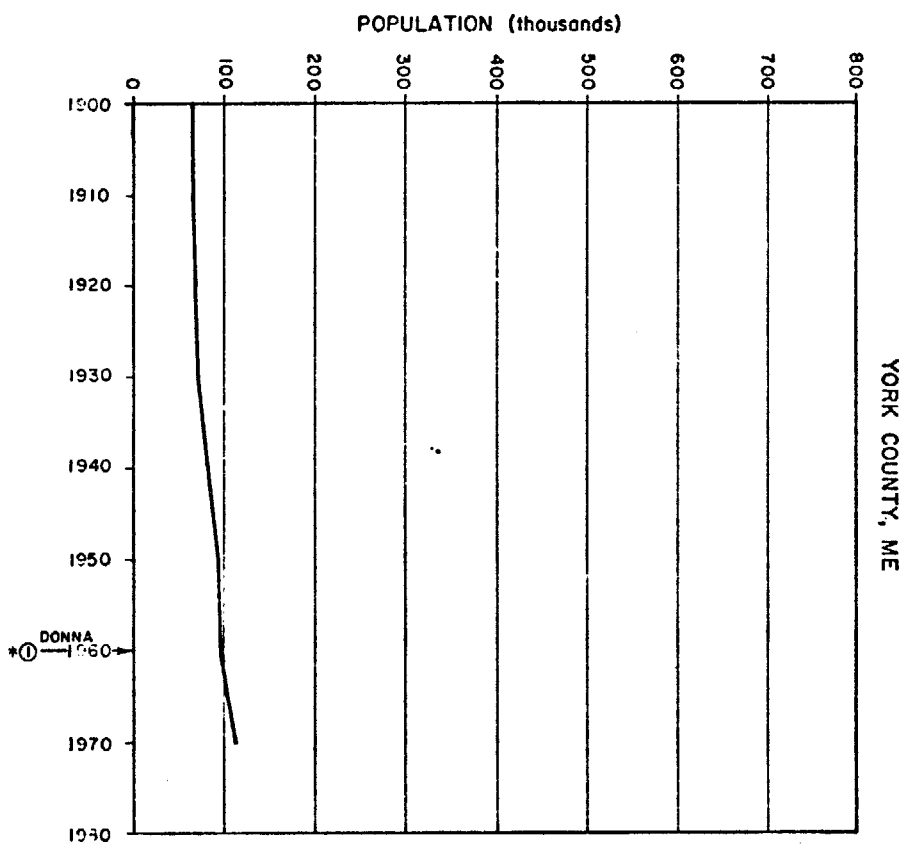
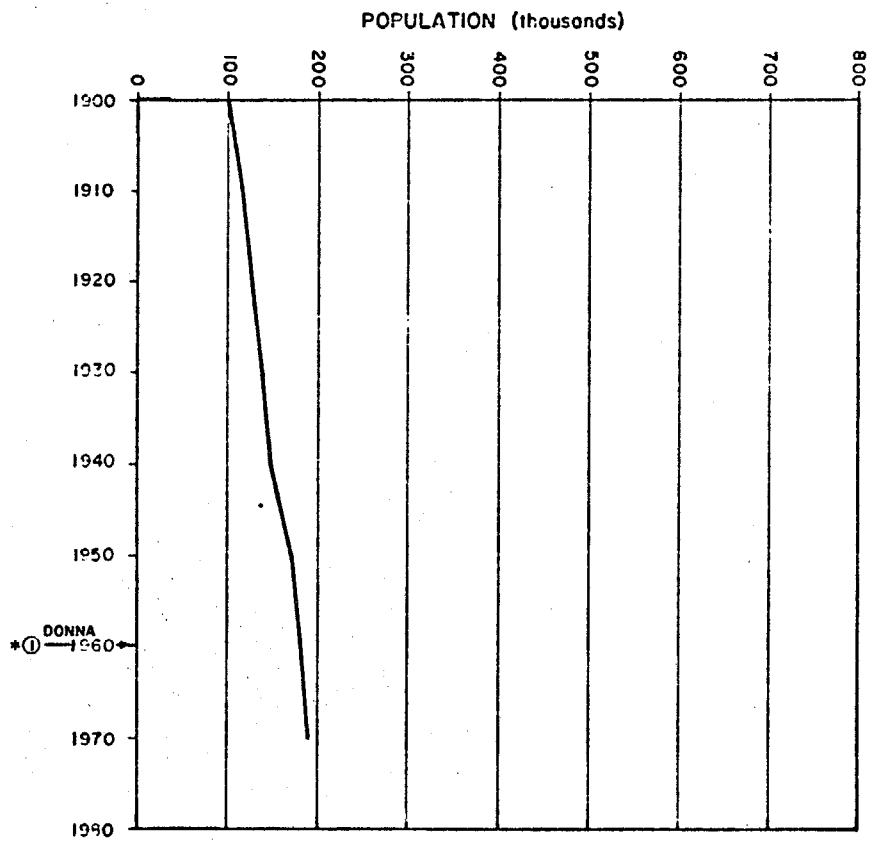


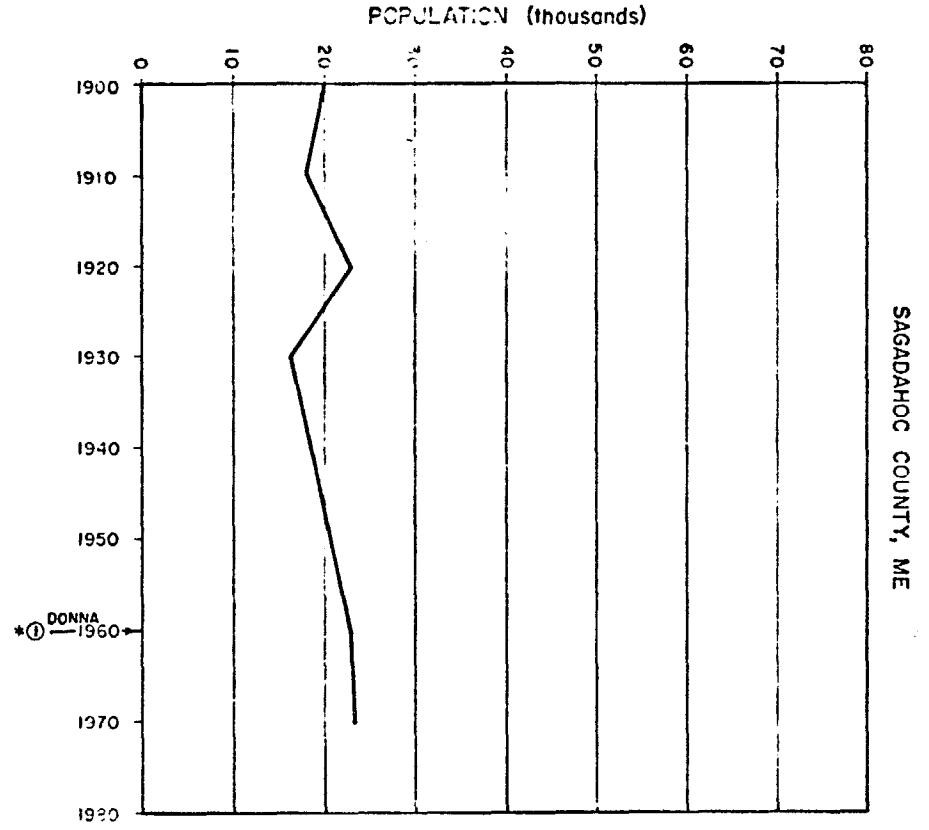
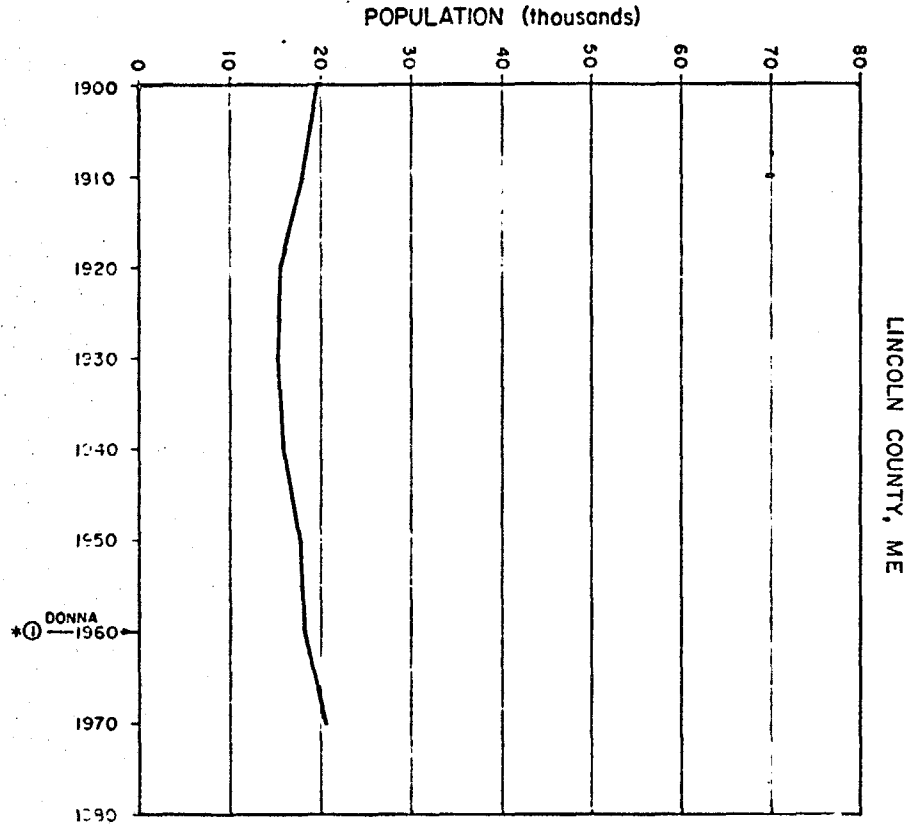


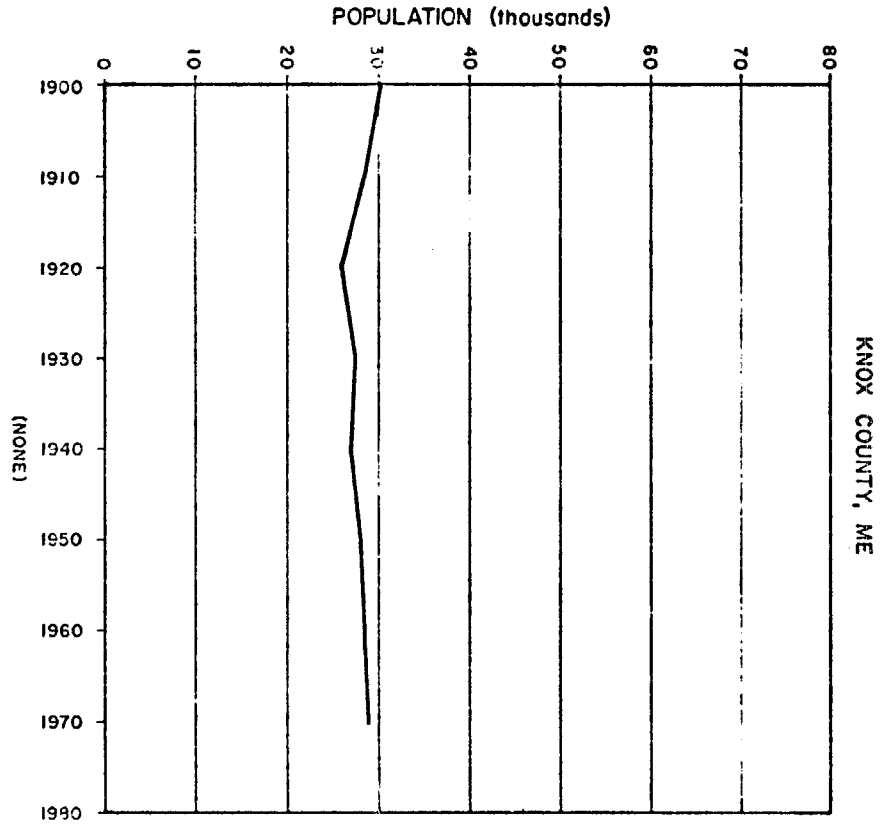
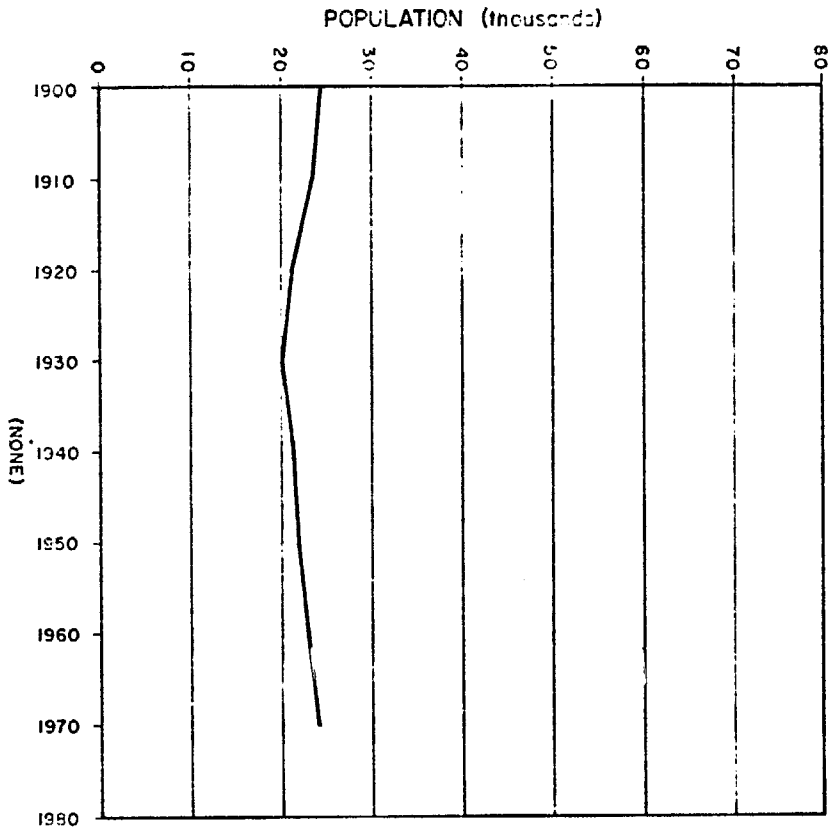
ROCKINGHAM COUNTY, NH

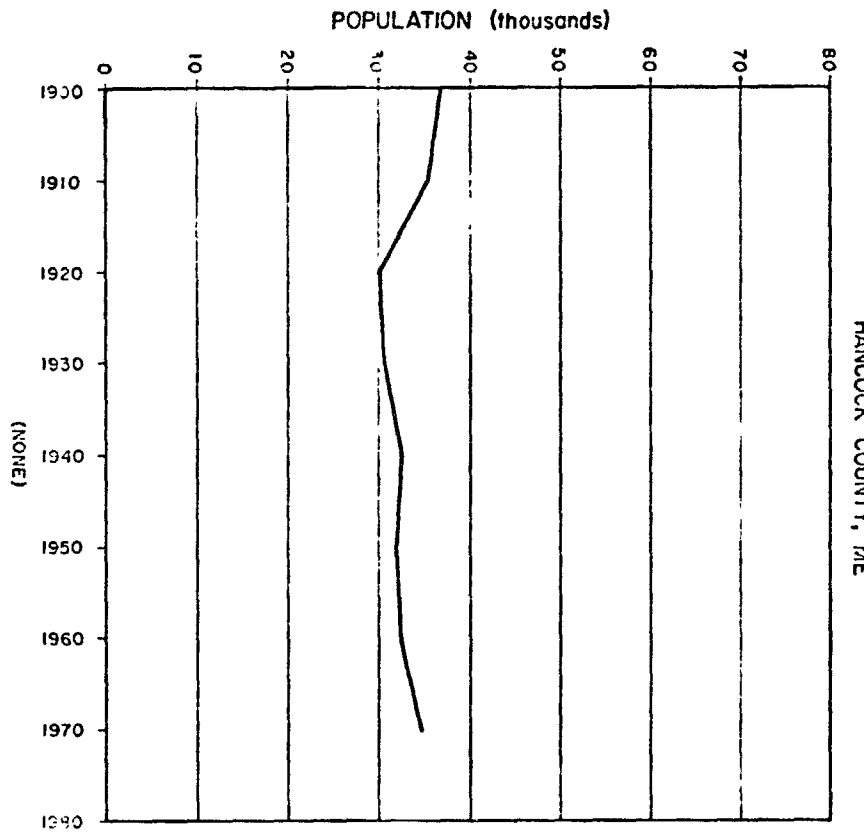
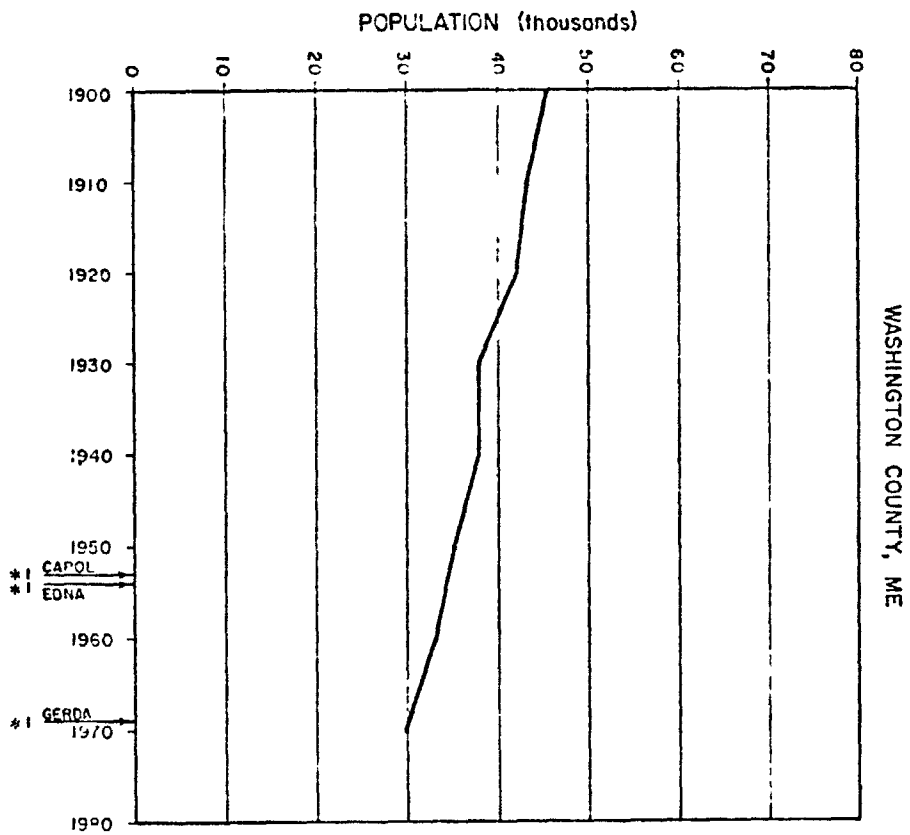


END OF NEW HAMPSHIRE COUNTIES









APPENDIX C

A TABULAR HURRICANE CLIMATOLOGY BY COUNTIES, TEXAS TO MAINE, 1900-1974

This climatology is a convenient reference for the hurricane history of individual coastal counties as well as for states. It is apparent at a glance when any particular county was last affected by a hurricane. Also, it can be determined whether a hurricane was large or small by the number of counties affected. The severity of a hurricane, of course, is indicated by its Saffir/Simpson Scale Number classification. Another useful feature of these tables is that the time between hurricane occurrences is readily apparent both for counties and states.

One point to keep in mind is that while some areas have not experienced a major hurricane during this century, severe hurricanes have been recorded prior to 1900. Examples of this include Savannah, New York City and Panama City, as indicated below:

Savannah: It is obvious at a glance that the Georgia coast has had very few direct hits in this century. However, Savannah was devastated by a severe hurricane (possibly a category 4) in 1893.

Panama City: Climatology indicates that Bay County, Florida (which includes Panama City), as well as six adjacent counties, has not received a direct hit by a major hurricane in this century. Here again, records indicate that severe hurricanes have affected that area prior to 1900. Excluding earlier hurricanes, such as in 1856, which probably moved inland very close to Panama City, four hurricanes moved to within 50 miles of Panama City during the 12-year period 1887-1898. One, in 1894, had winds of 120 mph - a Category 3. A total of nine hurricanes moved to within 100 miles of Panama City during the 13-year period 1886-1898.

New York City: Early records indicate that a major hurricane affected the New York City area in 1821. This hurricane possibly was as severe as the New England hurricane of 1938. However, New York City has not received a direct hit by a major hurricane during the 20th century. In fact, records indicate that the 1821 hurricane is the only major hurricane whose center passed over a part of New York City in the last 200 years.

The main point to be illustrated by the above examples of hurricanes prior to 1900 is that no particular area along the Gulf or Atlantic coast of the United States is immune to direct hits by major hurricanes, regardless of how the climatology appears to have been in recent years.

As indicated in Appendix B, dual symbols were necessary in illustrating the hurricane climatology. Arrows were used with the graphs in Appendix B, while arrows were not appropriate in a tabular presentation such as in this appendix. The key for symbols (non-arrows) is repeated below along with examples of Saffir/Simpson Scale Numbers as used in this appendix.

Key for Symbols

- Plain Number - Direct Hit
- () - Indirect Hit
- Exiting or Inland
- * - Forward Speed 30 mph or Greater

Examples

- 1 - Direct Hit by a Category 1 Hurricane
- (1) - Indirect Hit (or fringe hit) by a Category 1 Hurricane
- 2 - Direct Hit by an Inland or Exiting (moving from land to water) Category 2 Hurricane
- 3* - Direct Hit by a Category 3 Hurricane moving 30 mph or more
- (3*) - Indirect Hit by an exiting Category 3 Hurricane moving 30 mph or more
- 3,2 - Direct Hits by a Category 3 and a Category 2 Hurricane in the same year, with the Category 3 Hurricane occurring first
- (3,1,3) - Indirect Hits by Categories 3, 1 and 3 Hurricanes in the same year. Occurrences were in the order listed.
- E4 - Direct Hit by a Category 4 Hurricane in the eastern part of Monroe County, Florida. (See example in Appendix B)

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YEAR	MD.										DEL.				N.J.												
	WORCESTER	SOMERSET	ST. MARYS	CALVERT	ANNE ARUNDEL	BALTIMORE ##	HARFORD	CECIL	KENT	QUEEN ANNES	TALBOT	CAROL INE	DORCHESTER	WICOMICO	SUSSEX	KENT	NEW CASTLE	SALEN	CUMBERLAND	CAPE MAY	ATLANTIC	BURLINGTON	OCEAN	MONMOUTH	MIDDLESEX	HUDSON	BERGEN
1900																											
1901																											
1902																											
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1970																											
1971																											
1972																											
1973																											
1974																											
1975																											

INCLUDES THE INDEPENDENT CITY OF BALTIMORE.

1 1 1 1 1

(2) (2) (2) (2)

(3*)

(3*)

(3*) (3*) (3*) (3*) (3*)

2* (2*) (2*) (2*)

(3*)

(3*)

(3*) (3*) (3*) (3*) (3*)

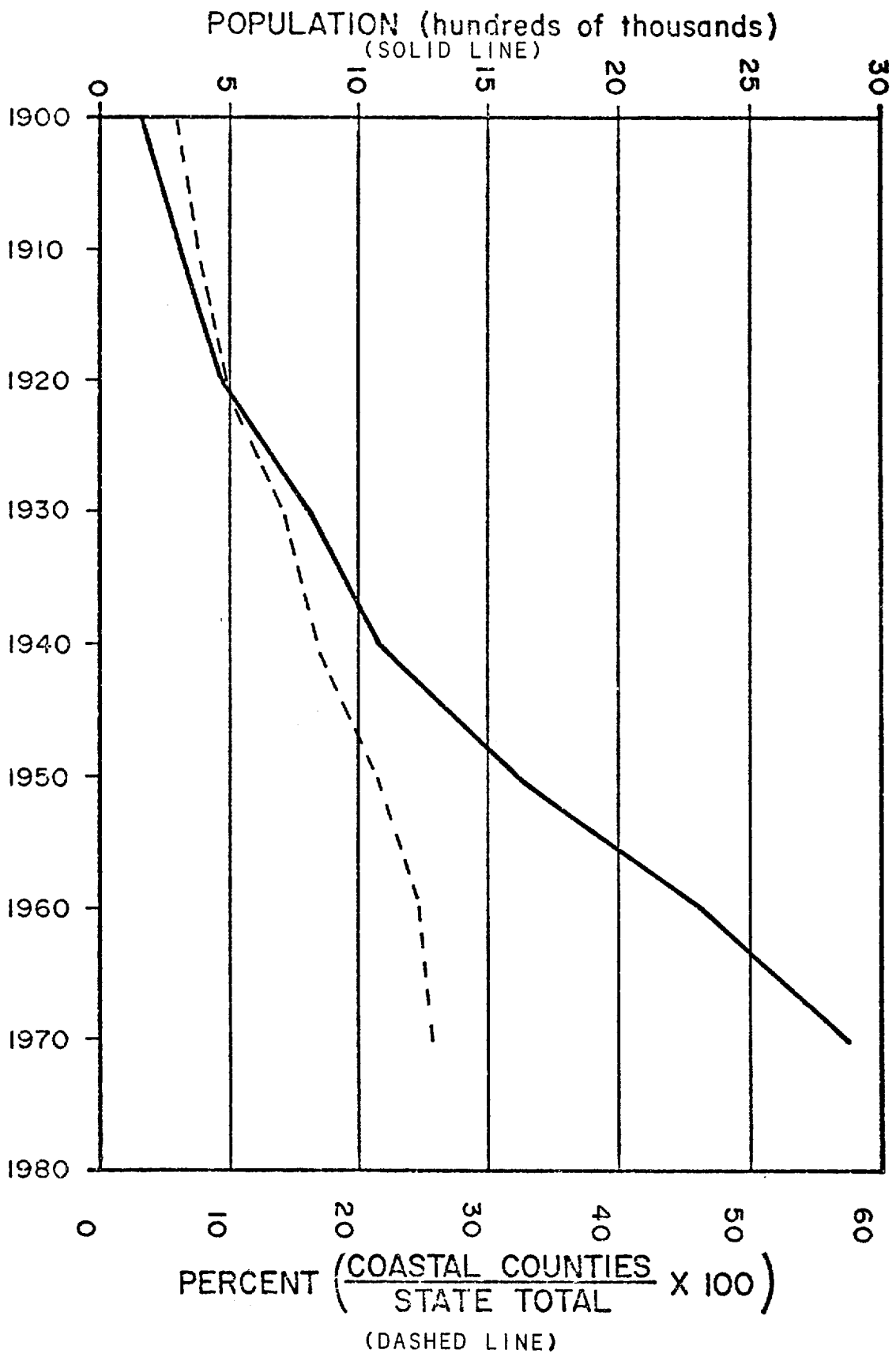
APPENDIX D

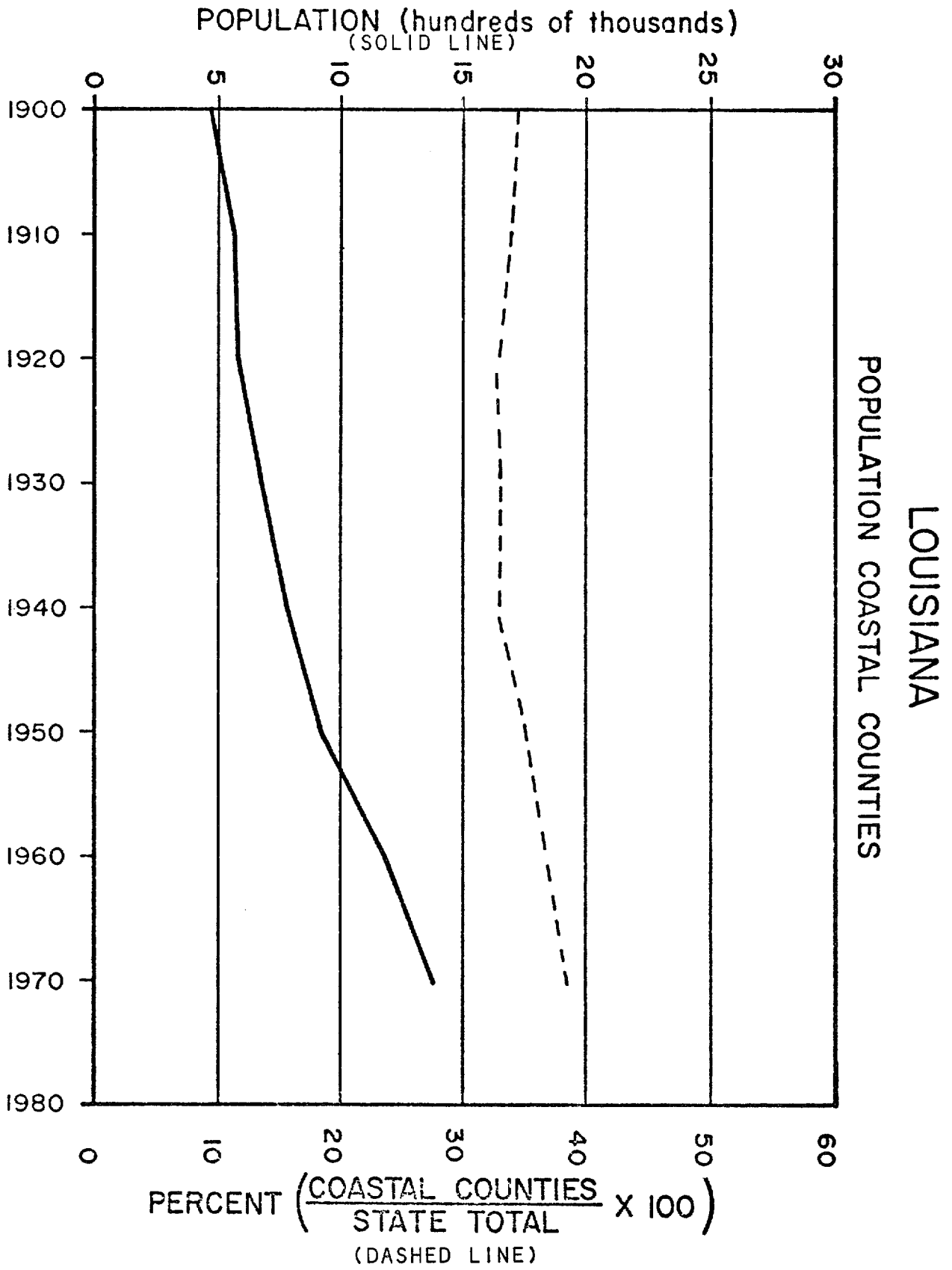
STATE COASTAL COUNTY POPULATIONS AND PERCENTAGE OF STATE POPULATIONS IN COASTAL COUNTIES, TEXAS TO MAINE

The main purpose of this set of graphs is to illustrate the growth rates of coastal populations by states and to indicate that a higher percentage of most state populations live along the coast now as compared to earlier years.

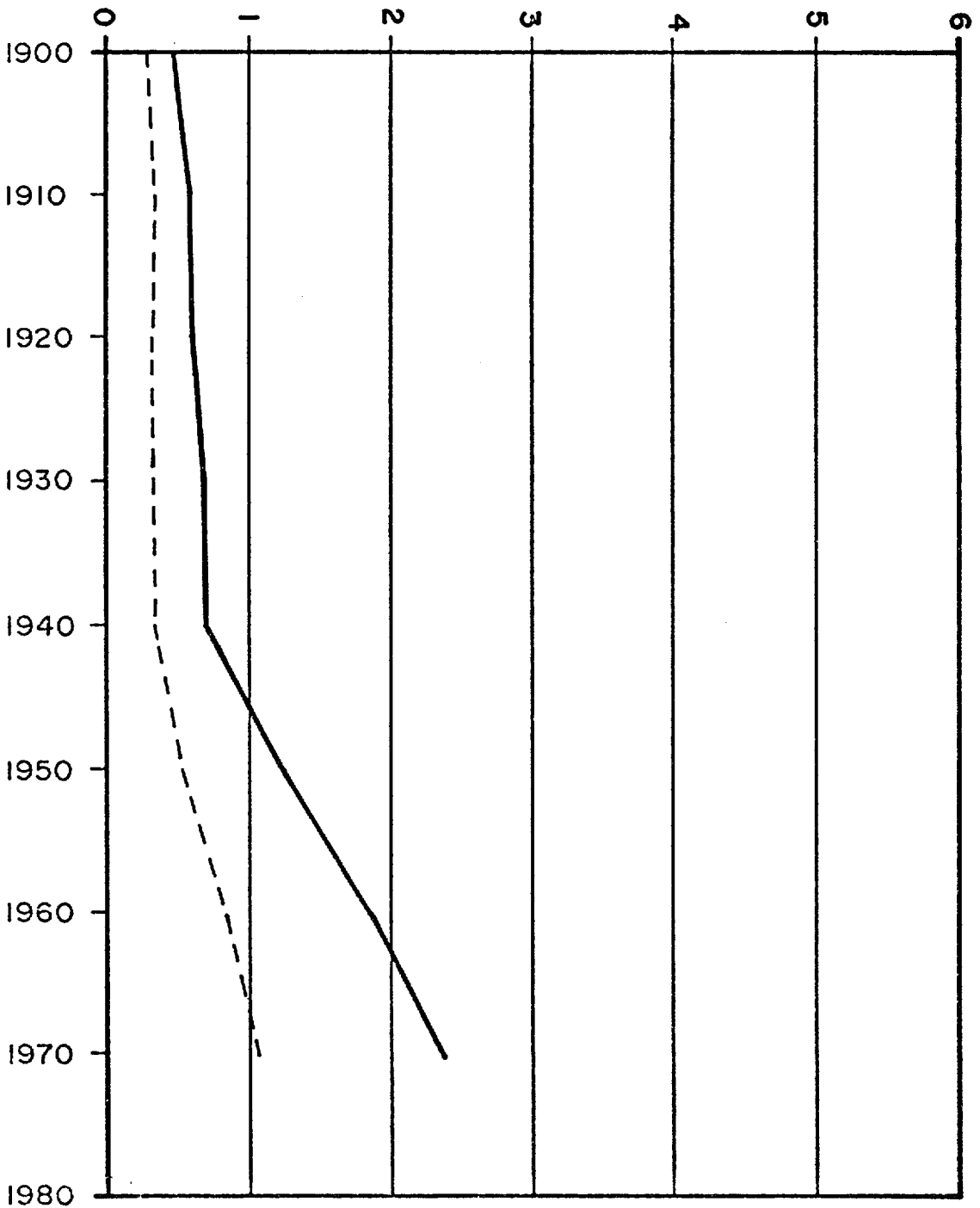
State population graphs (coastal counties only) are presented for each of the 18 Gulf and Atlantic coastal states for the period 1900-1970. Also shown is the percentage of each total state population in the coastal counties.

TEXAS
POPULATION COASTAL COUNTIES





POPULATION (hundreds of thousands)
(SOLID LINE)



MISSISSIPPI
POPULATION COASTAL COUNTIES

PERCENT $\left(\frac{\text{COASTAL COUNTIES}}{\text{STATE TOTAL}} \times 100 \right)$

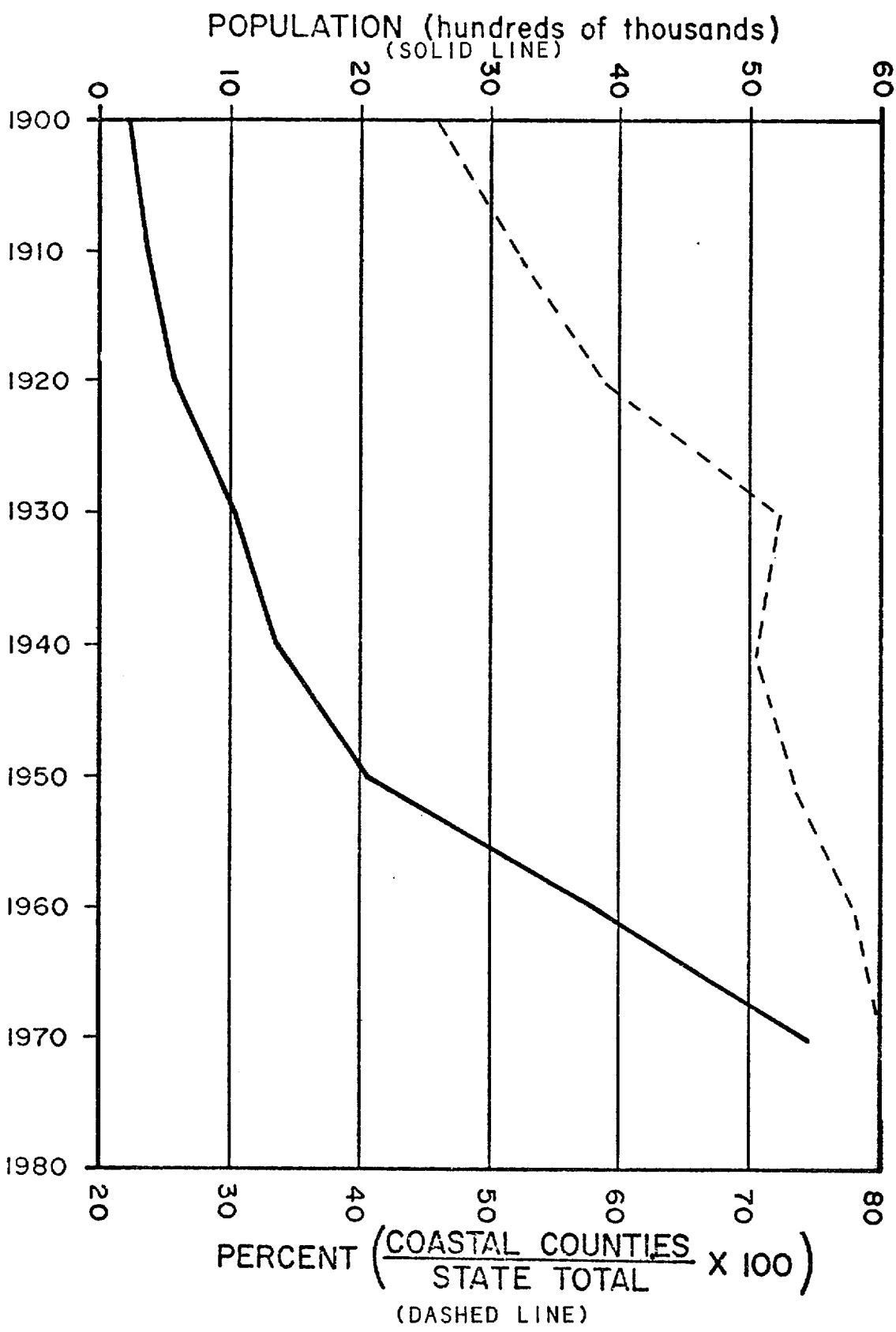
(DASHED LINE)

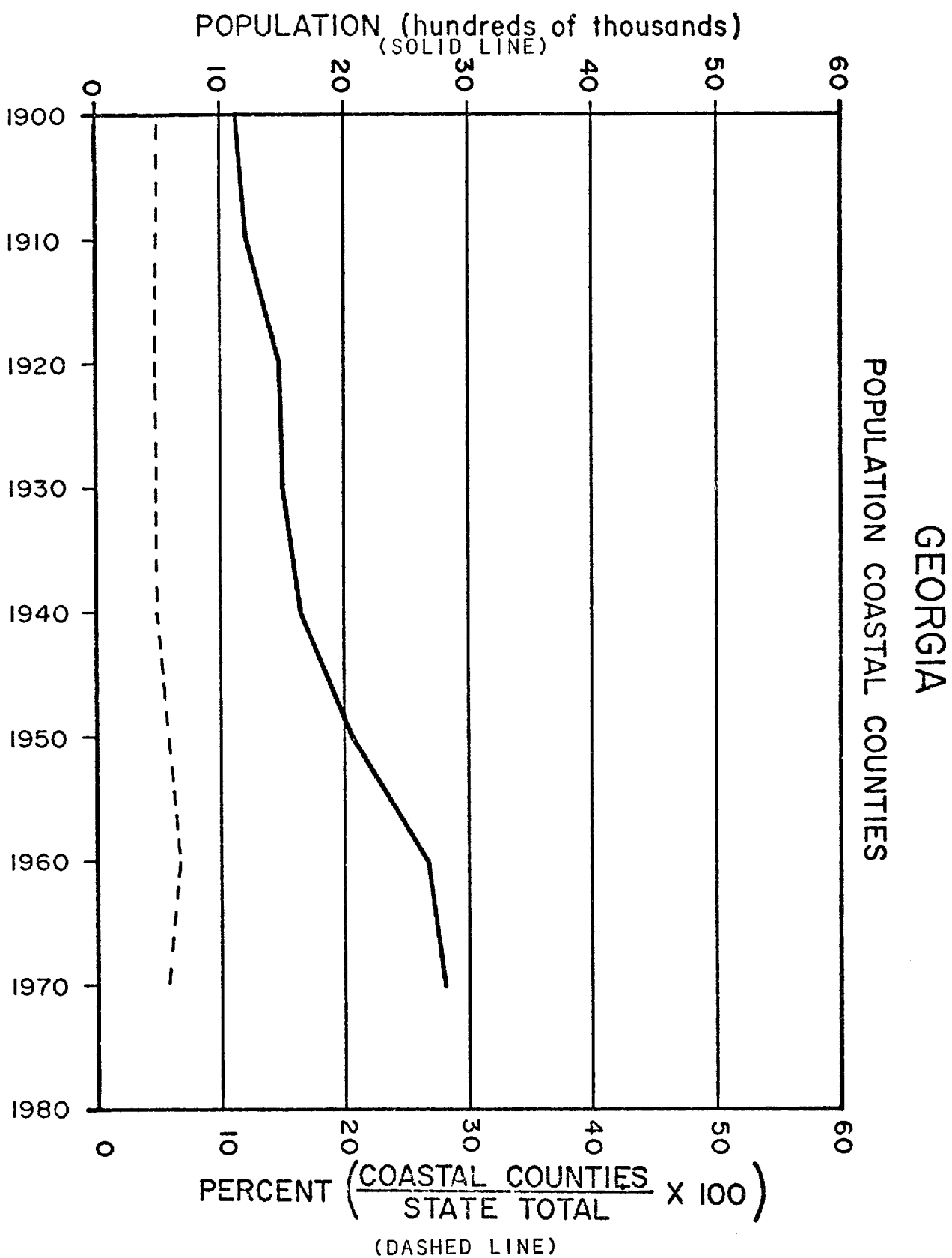
ALABAMA
POPULATION COASTAL COUNTIES



FLORIDA

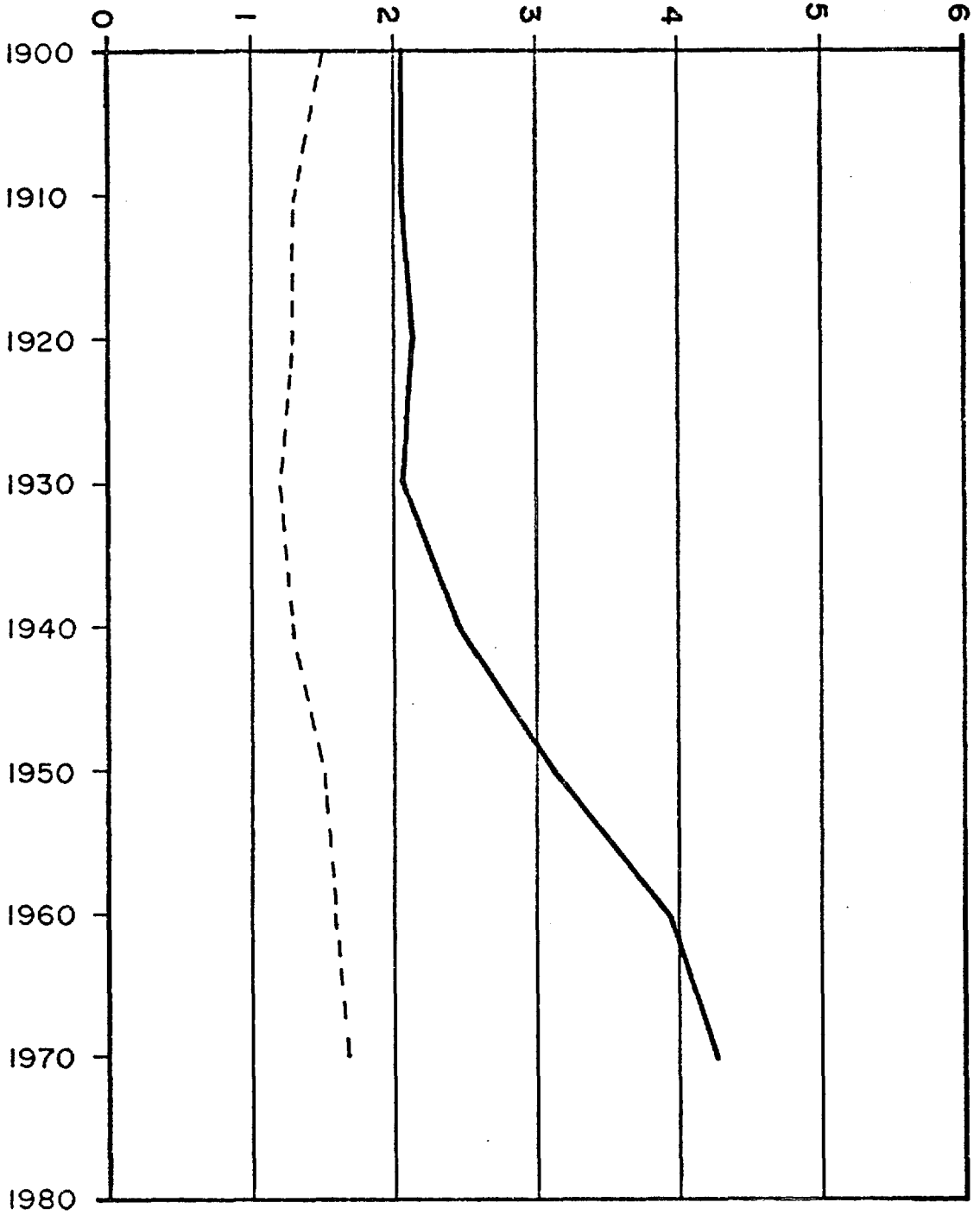
POPULATION COASTAL COUNTIES





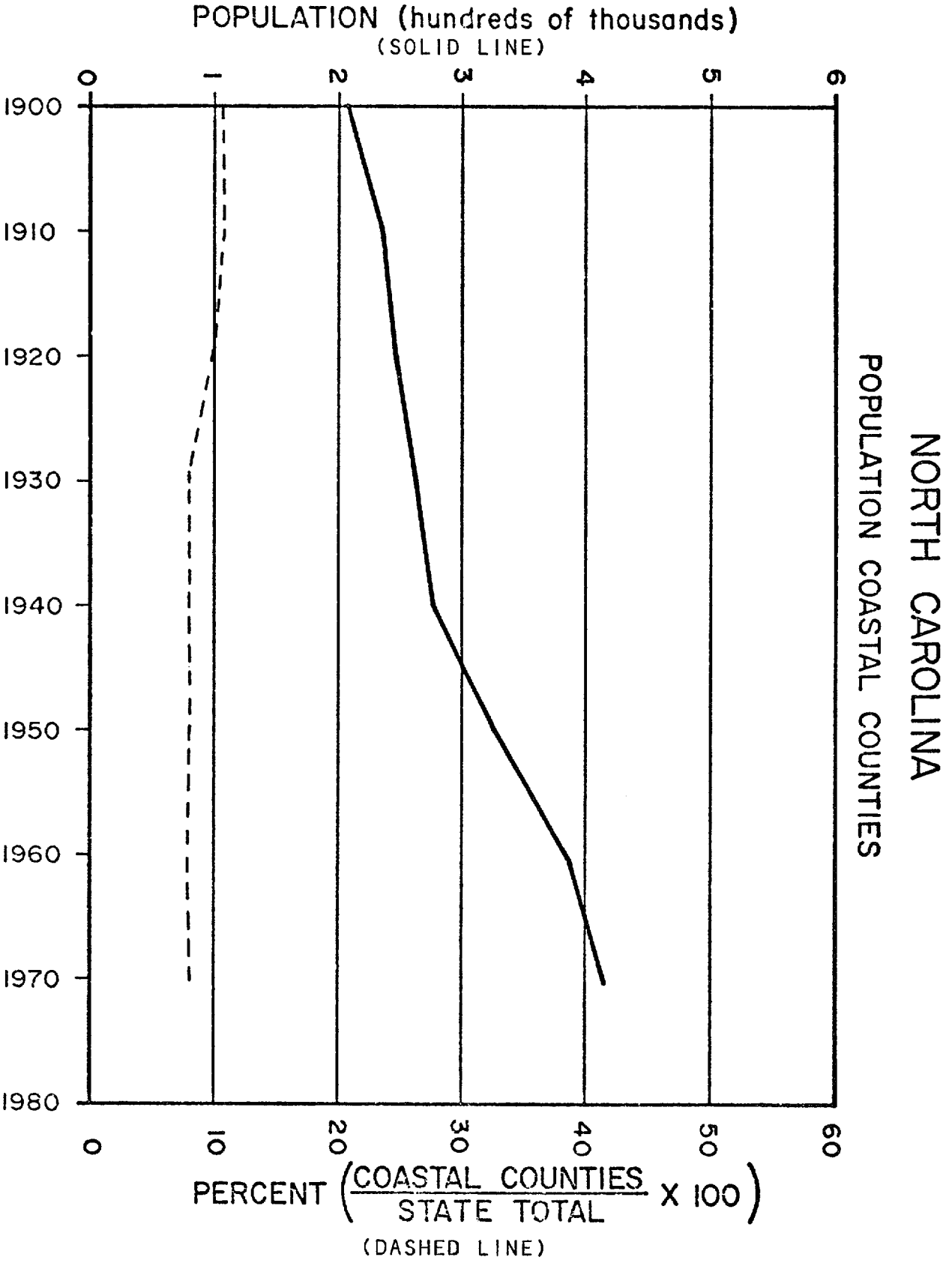
POPULATION (hundreds of thousands)
(SOLID LINE)

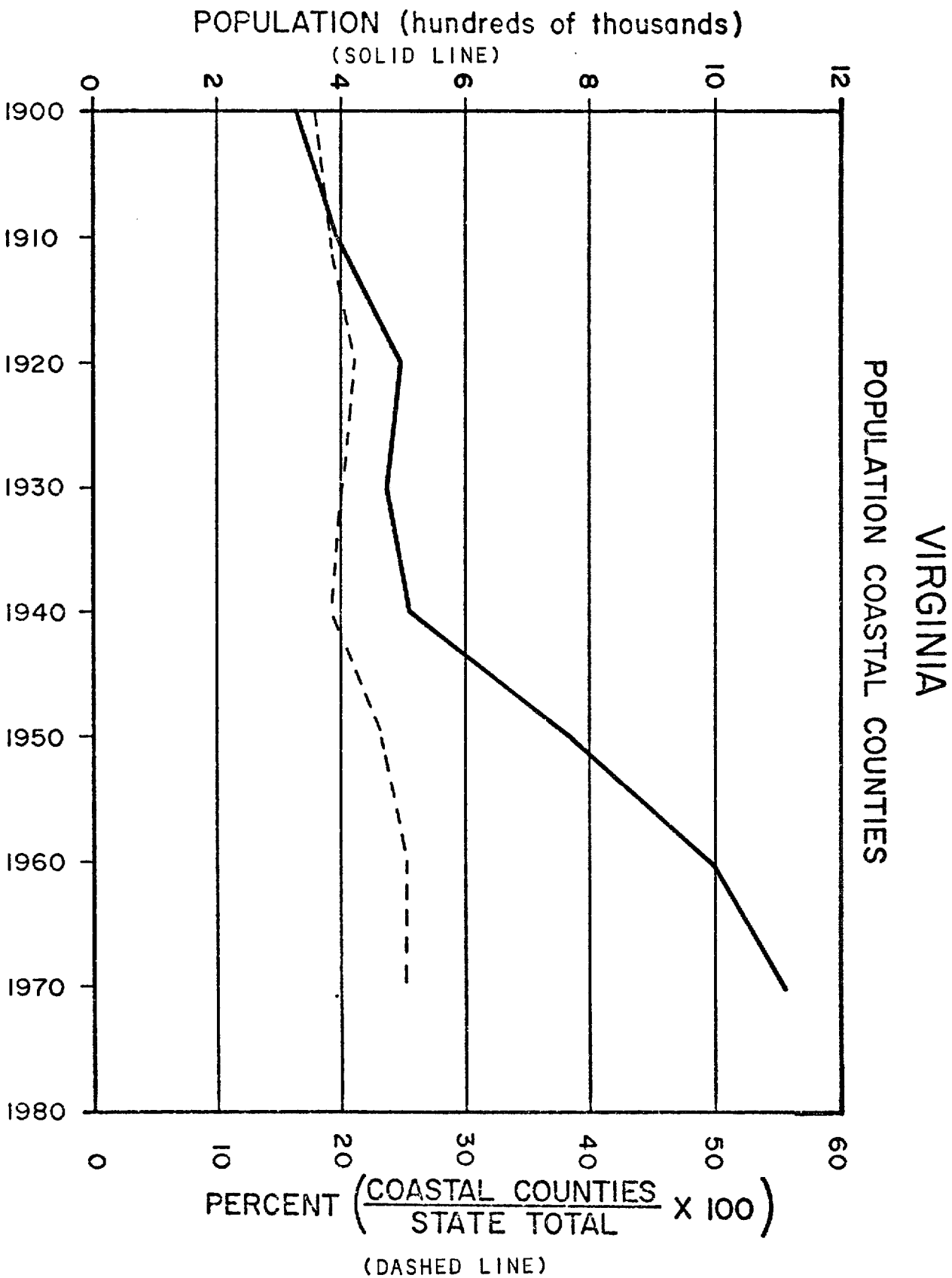
SOUTH CAROLINA
POPULATION COASTAL COUNTIES



PERCENT $\left(\frac{\text{COASTAL COUNTIES}}{\text{STATE TOTAL}} \times 100 \right)$

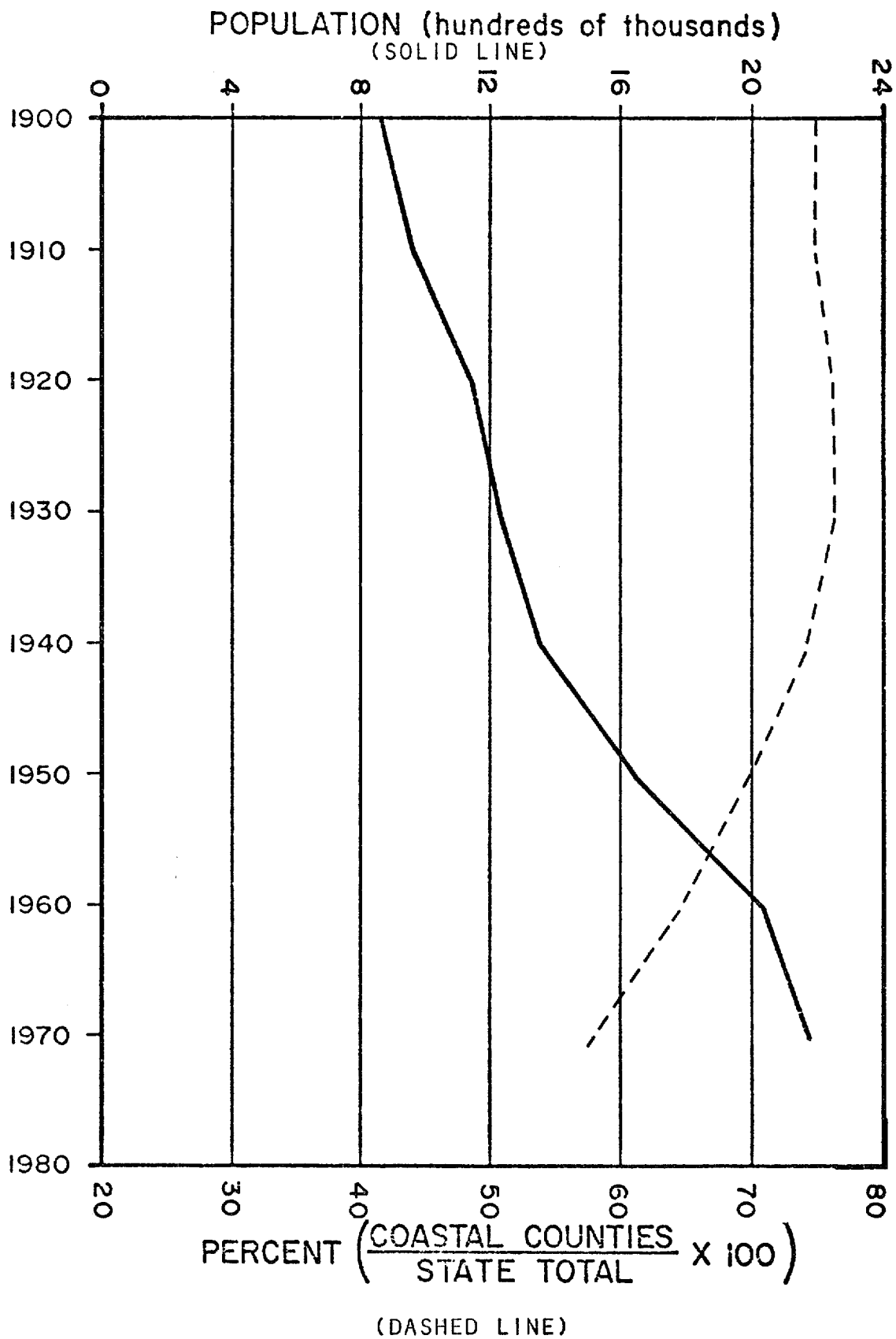
(DASHED LINE)





MARYLAND

POPULATION COASTAL COUNTIES

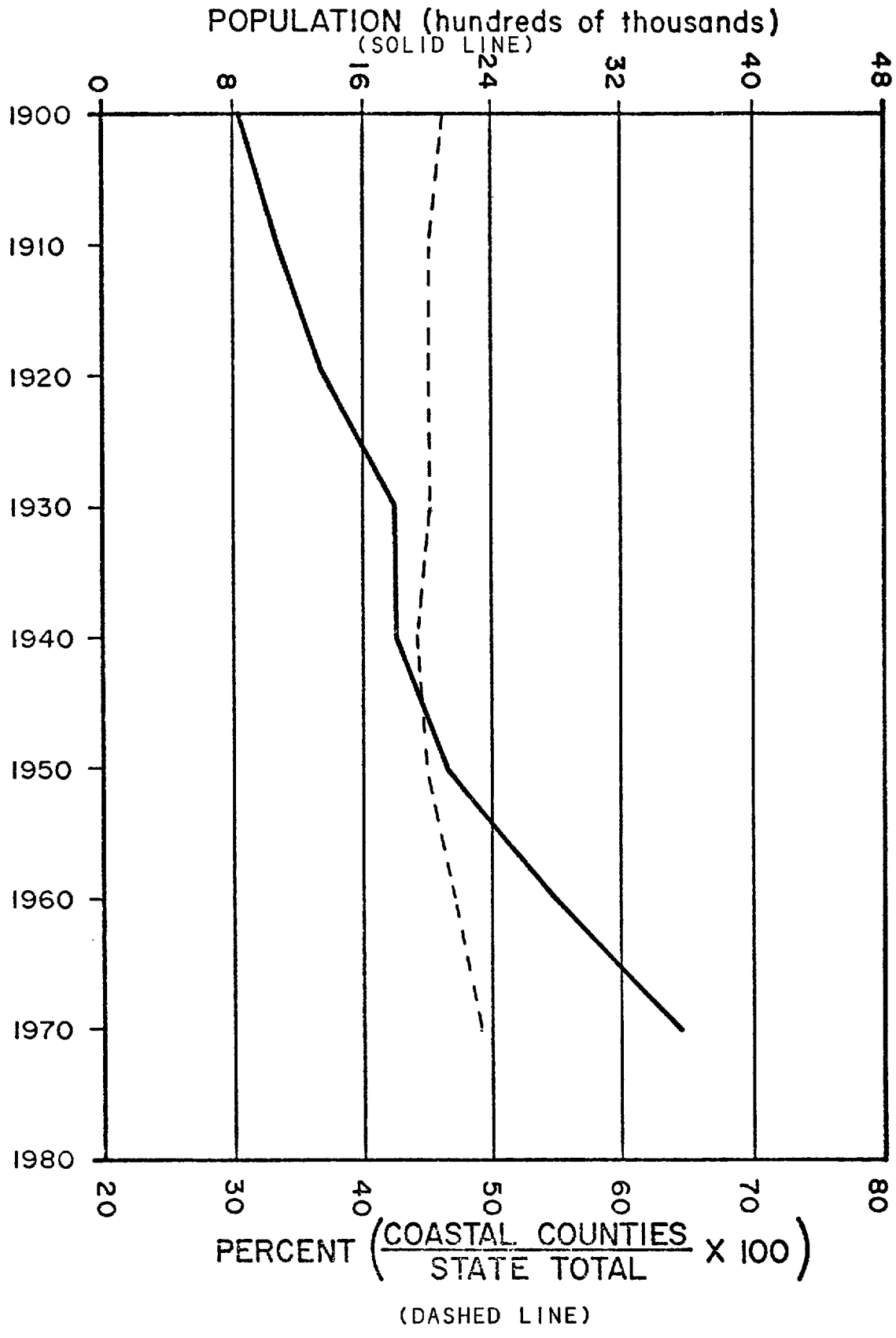


POPULATION (hundreds of thousands)

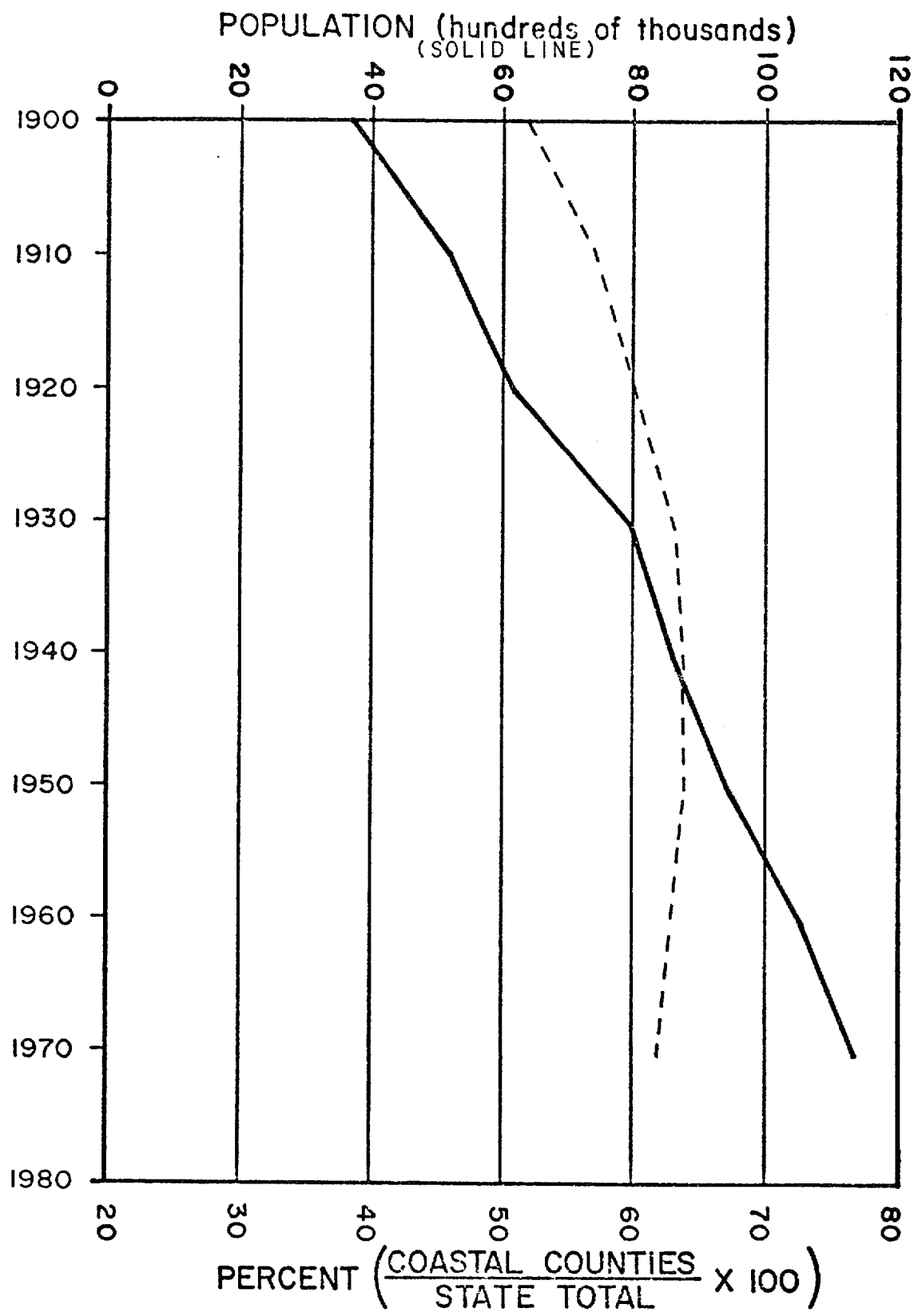


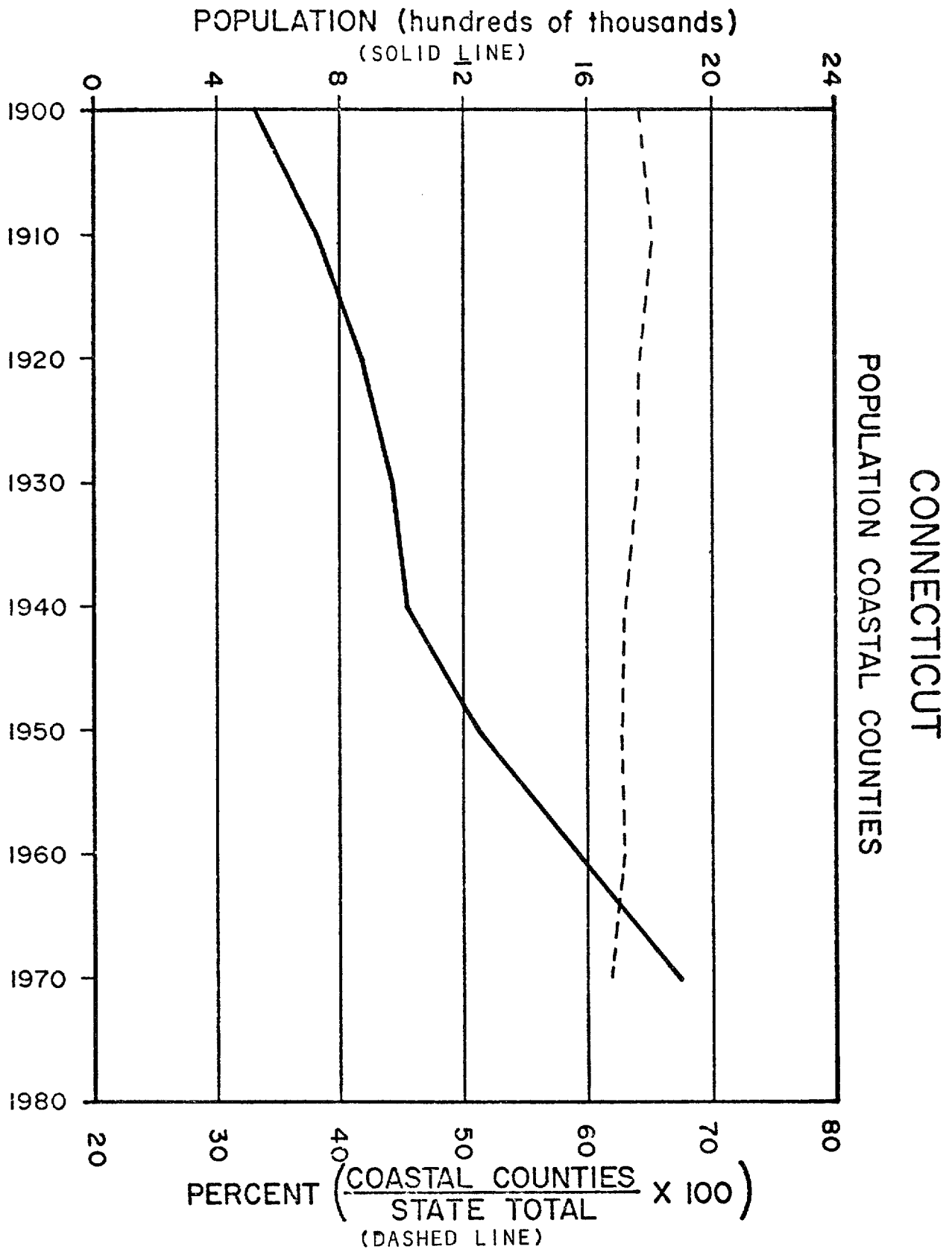
NEW JERSEY

POPULATION COASTAL COUNTIES

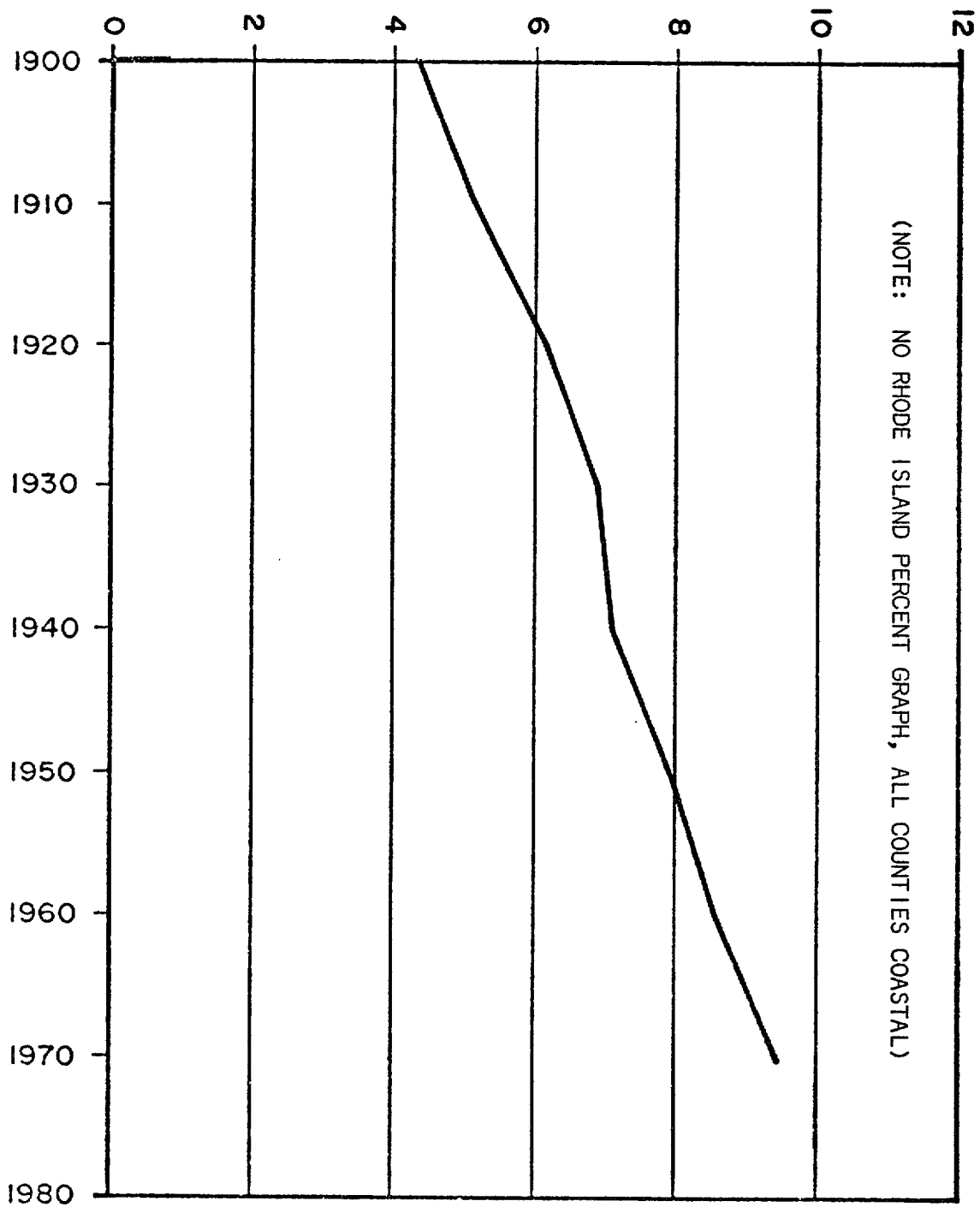


NEW YORK
POPULATION COASTAL COUNTIES

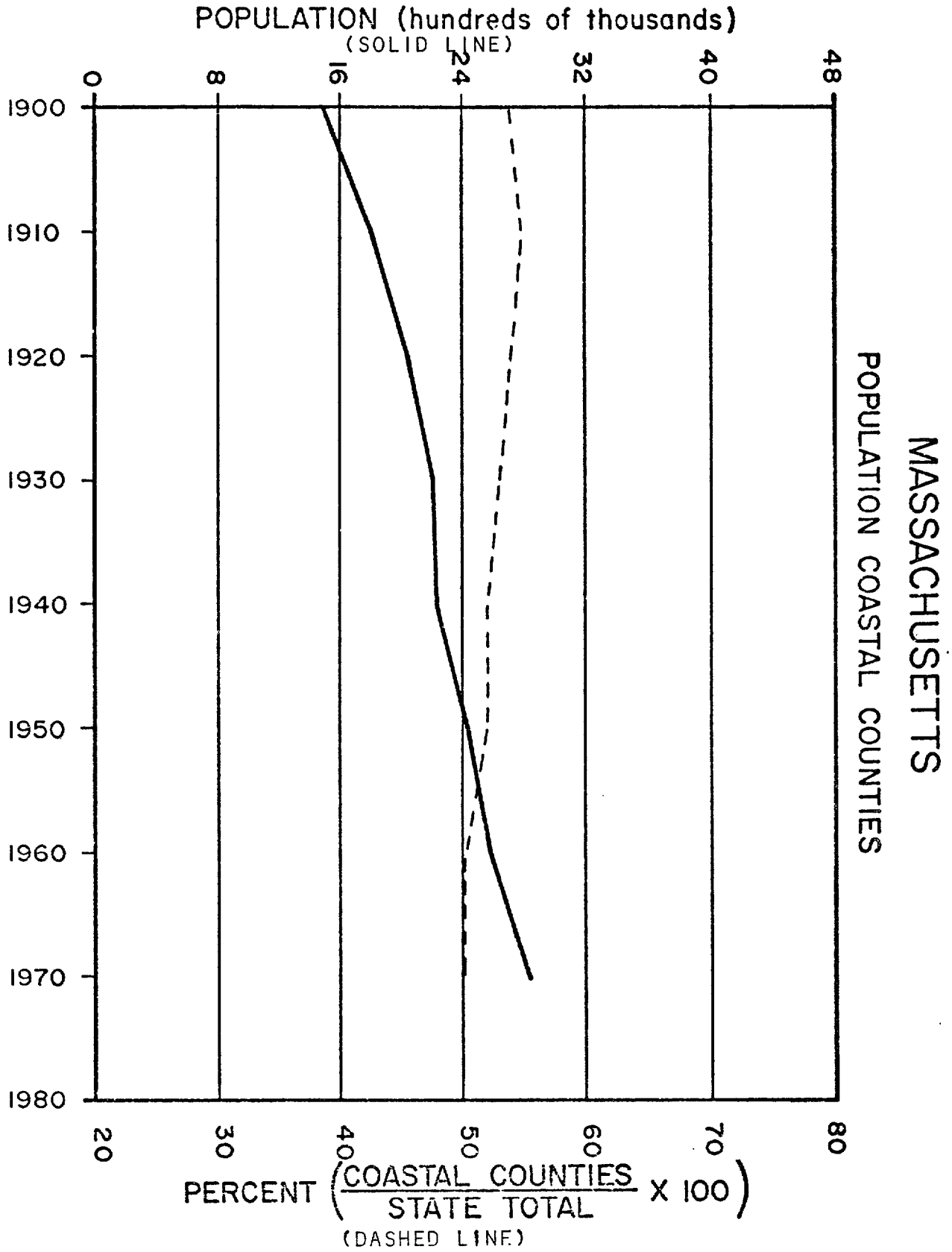




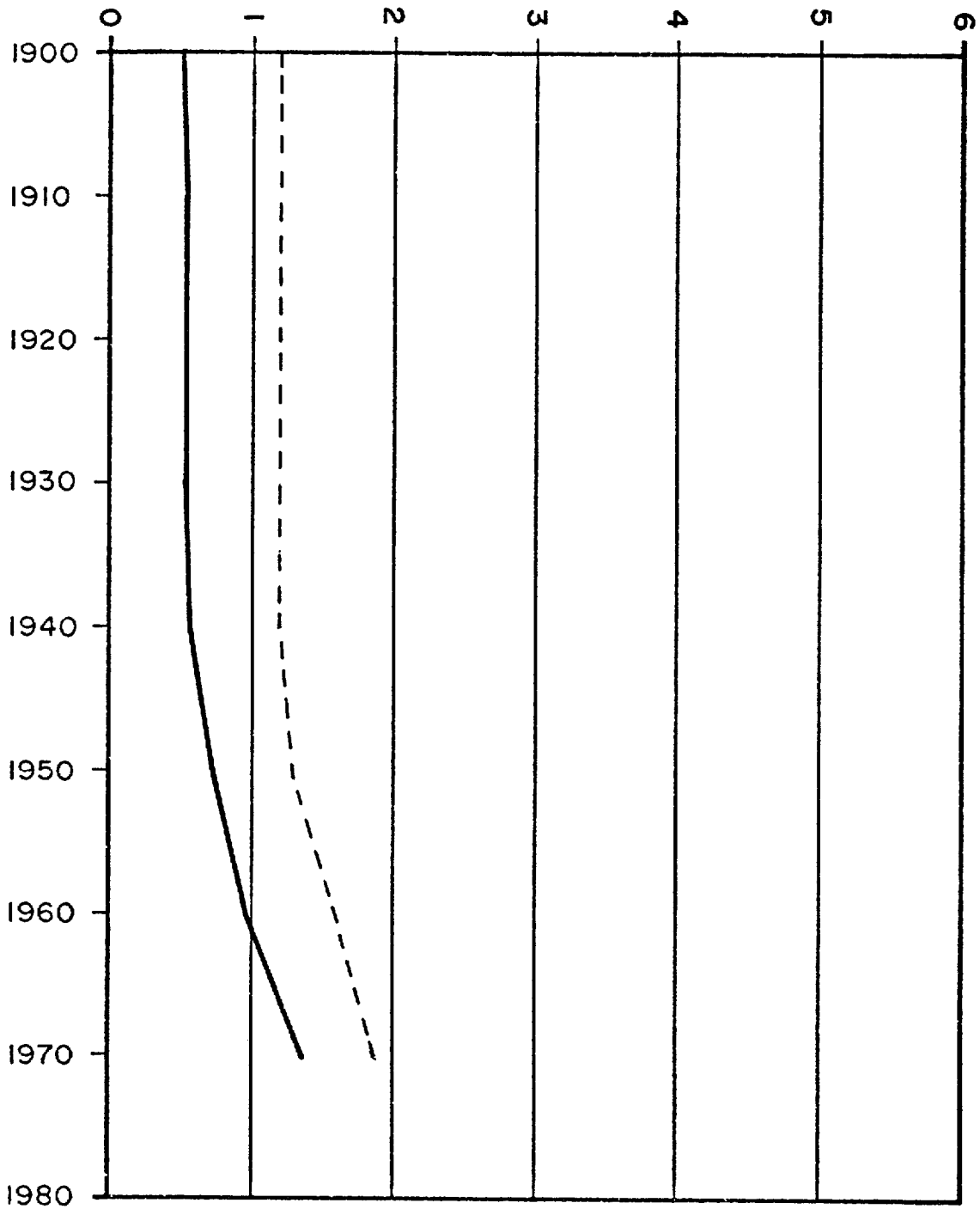
POPULATION (hundreds of thousands)



RHODE ISLAND
POPULATION COASTAL COUNTIES

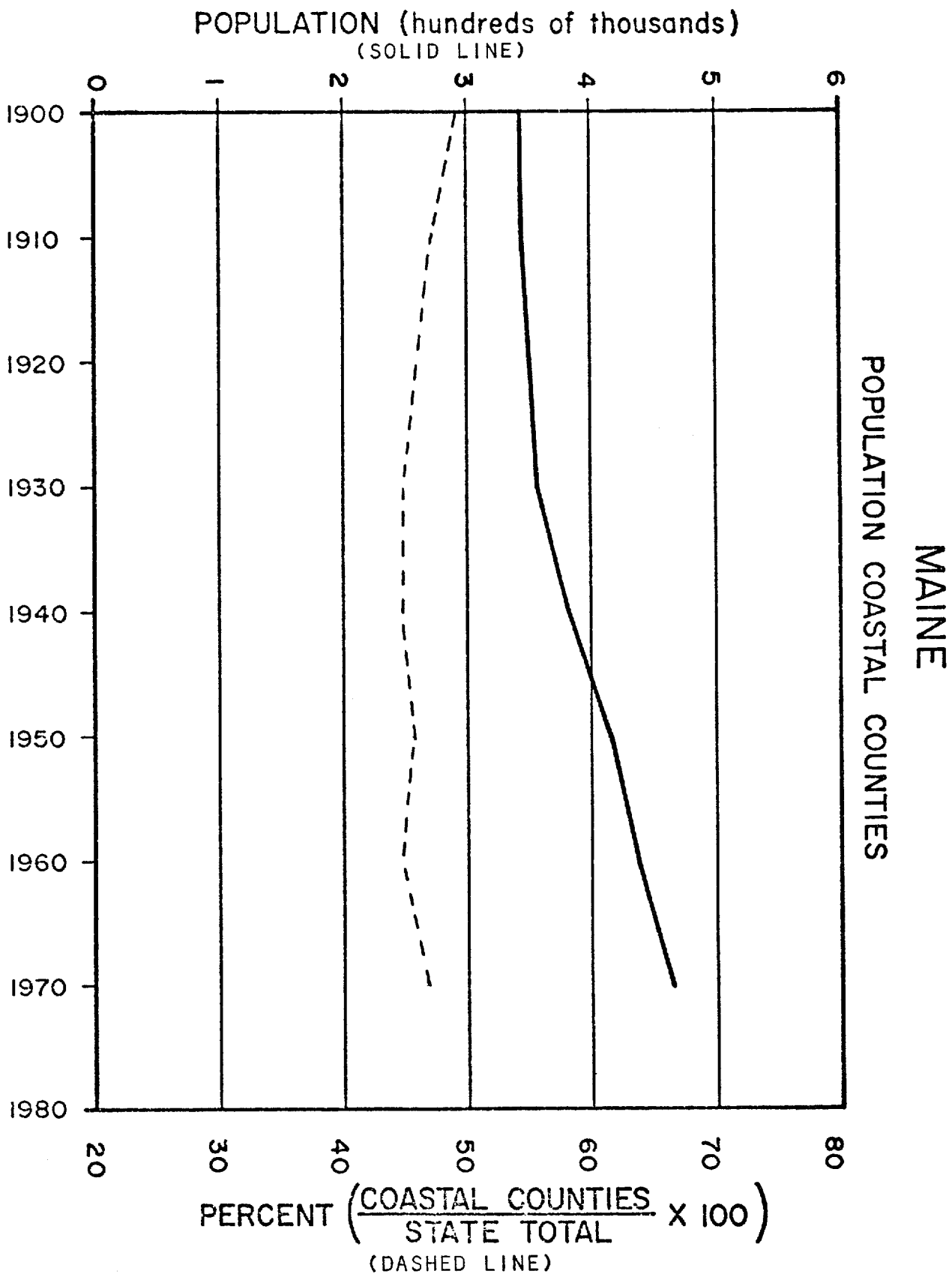


POPULATION (hundreds of thousands)
(SOLID LINE)



NEW HAMPSHIRE
POPULATION COASTAL COUNTIES

PERCENT $\left(\frac{\text{COASTAL COUNTIES}}{\text{STATE TOTAL}} \times 100 \right)$
(DASHED LINE)

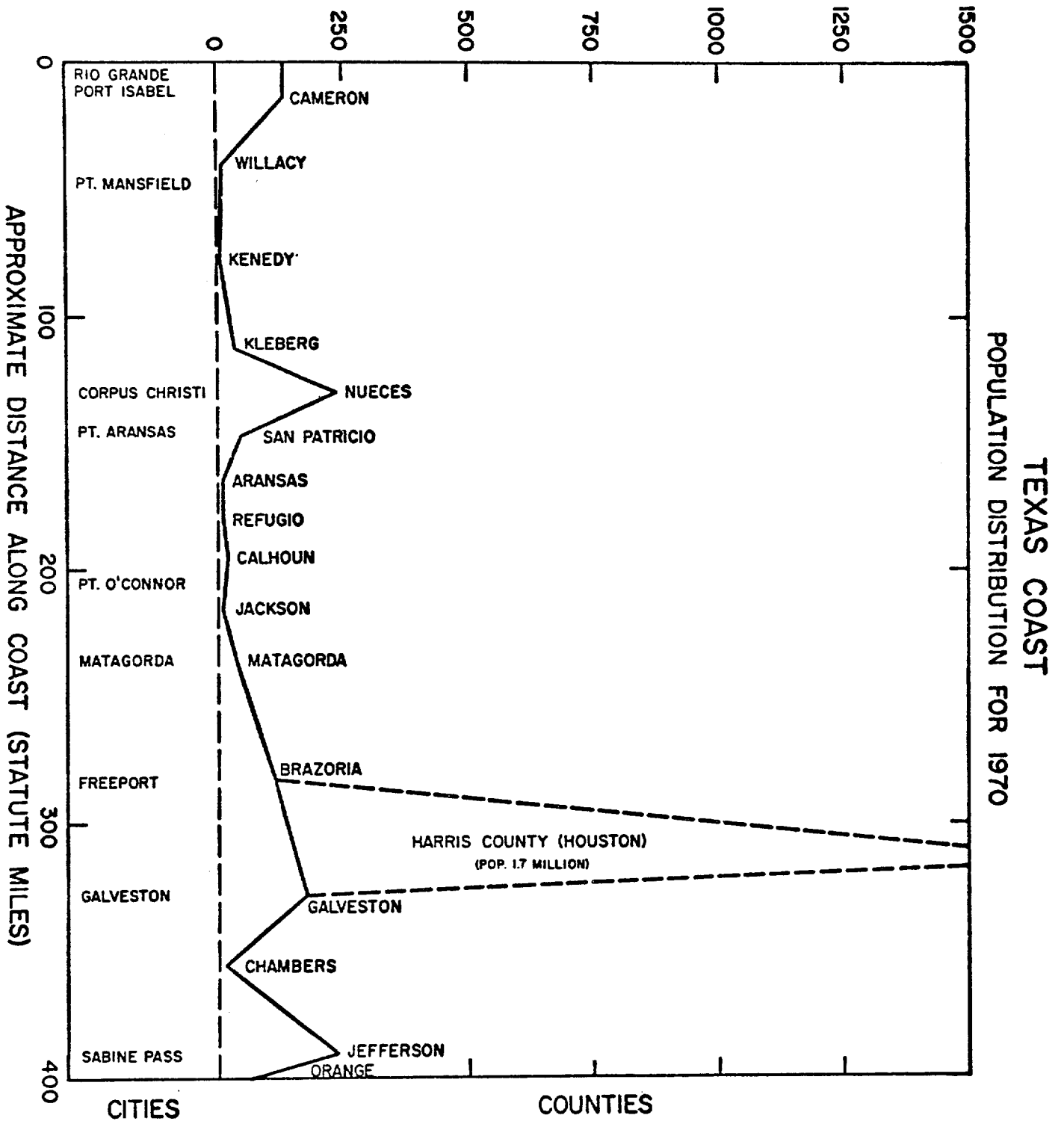


APPENDIX E

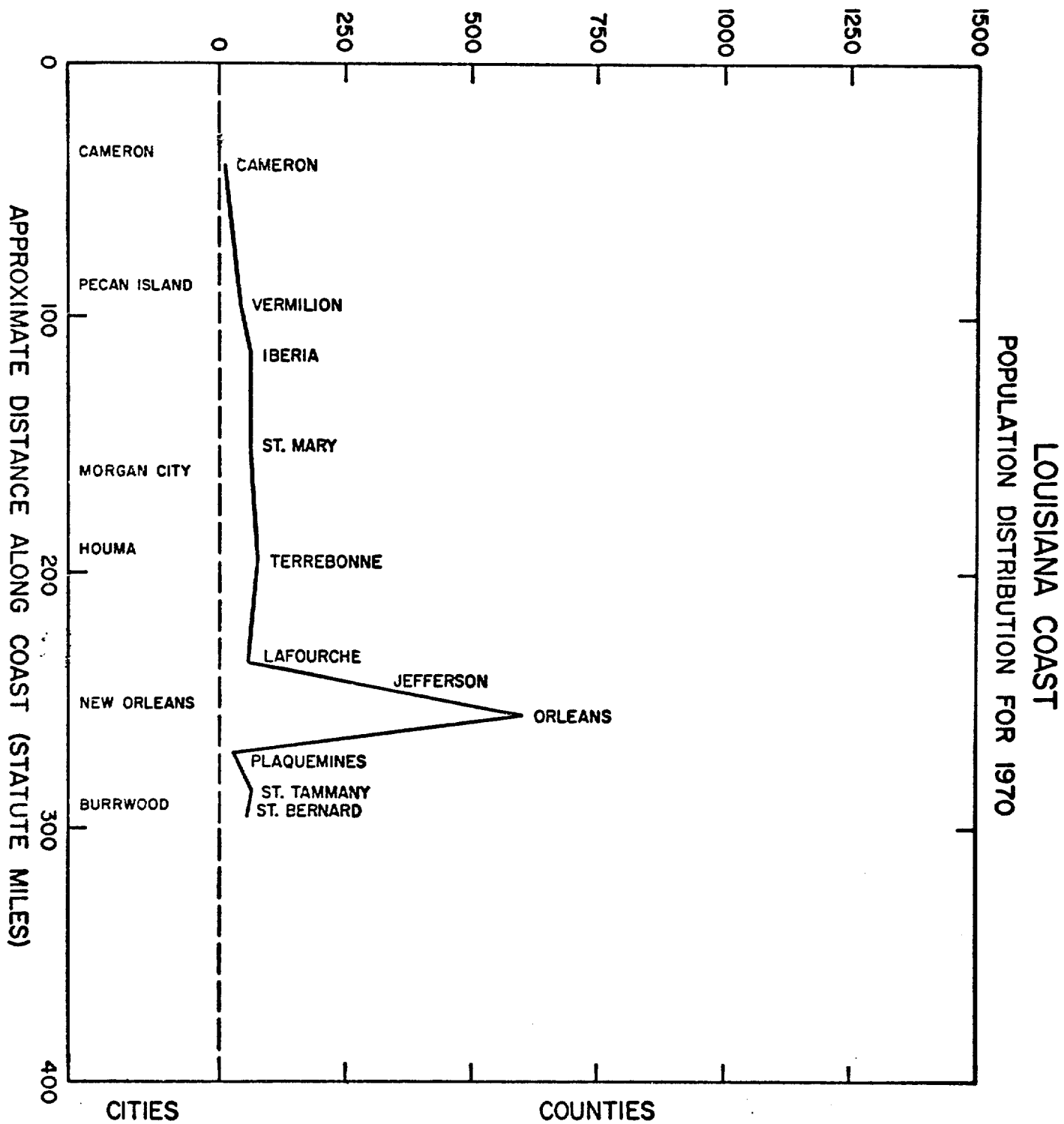
GULF AND ATLANTIC COASTAL POPULATION DISTRIBUTION - 1970

This set of nine graphs was designed as a rough guide to indicate approximately how many persons reside along any particular segment of coastline from Texas to Maine. The same distance scale was used for all states, so the graphs can be regarded as continuous when the appropriate end points are connected.

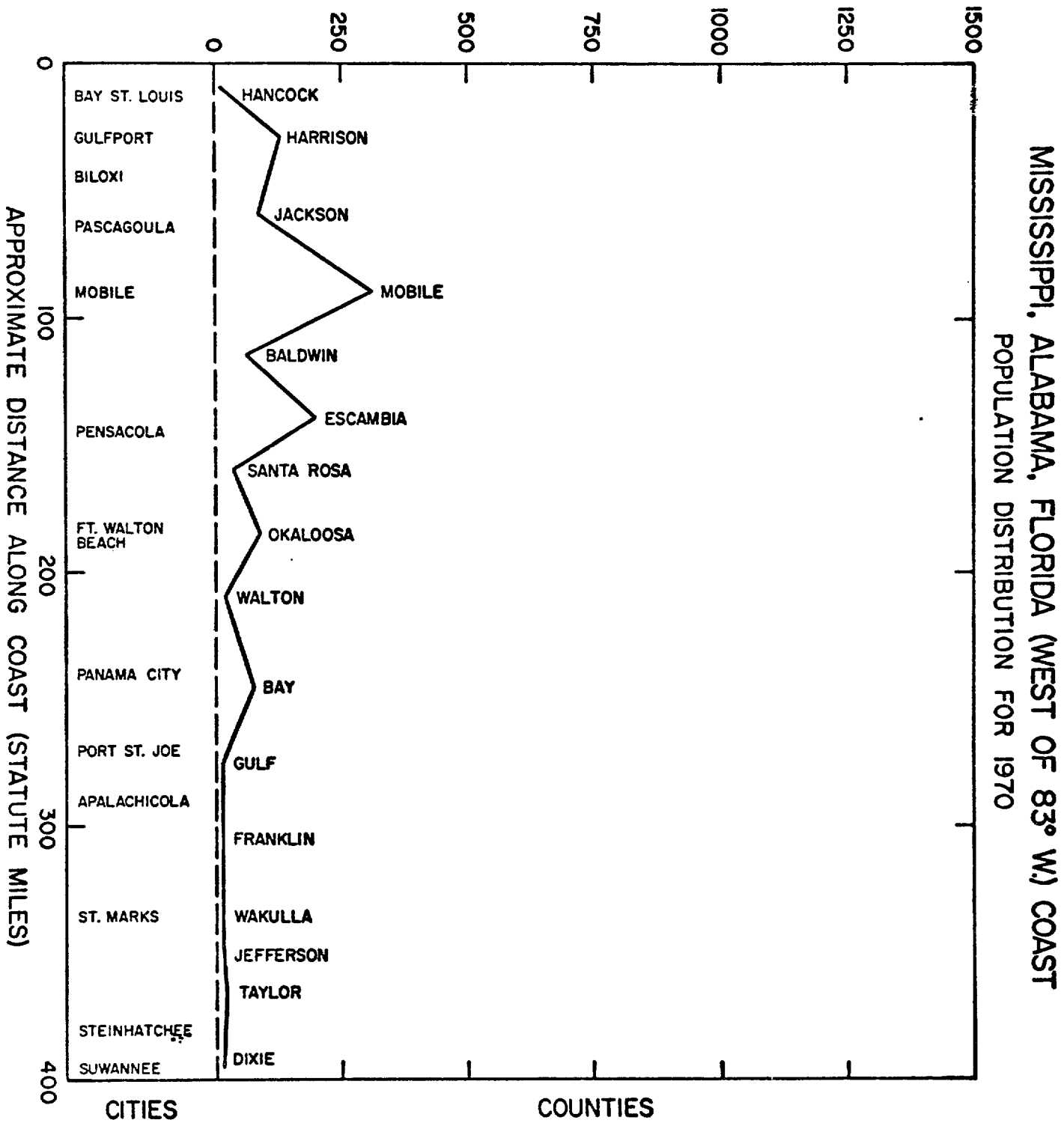
POPULATION OF COASTAL COUNTIES (THOUSANDS)



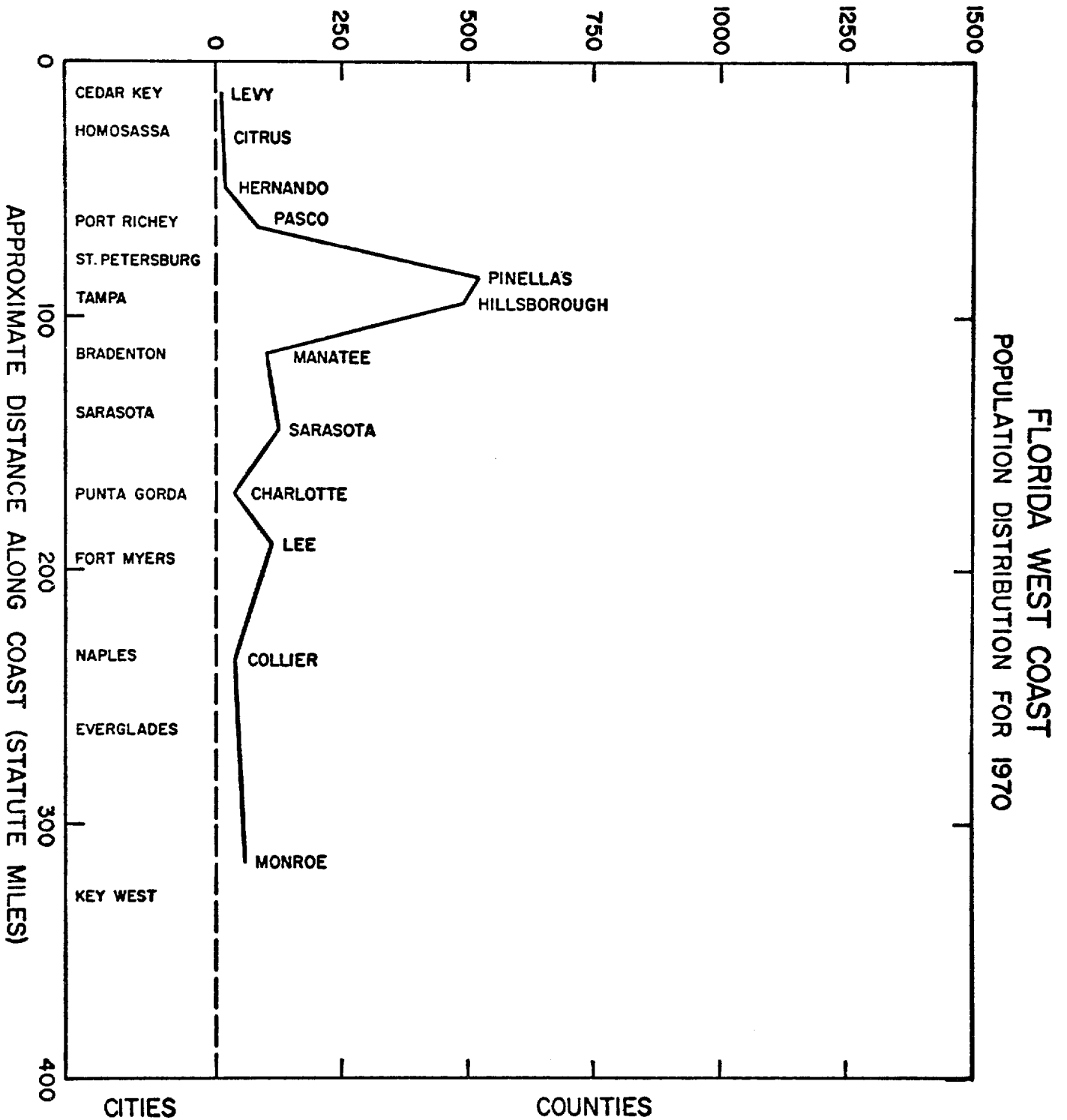
POPULATION OF COASTAL COUNTIES (THOUSANDS)



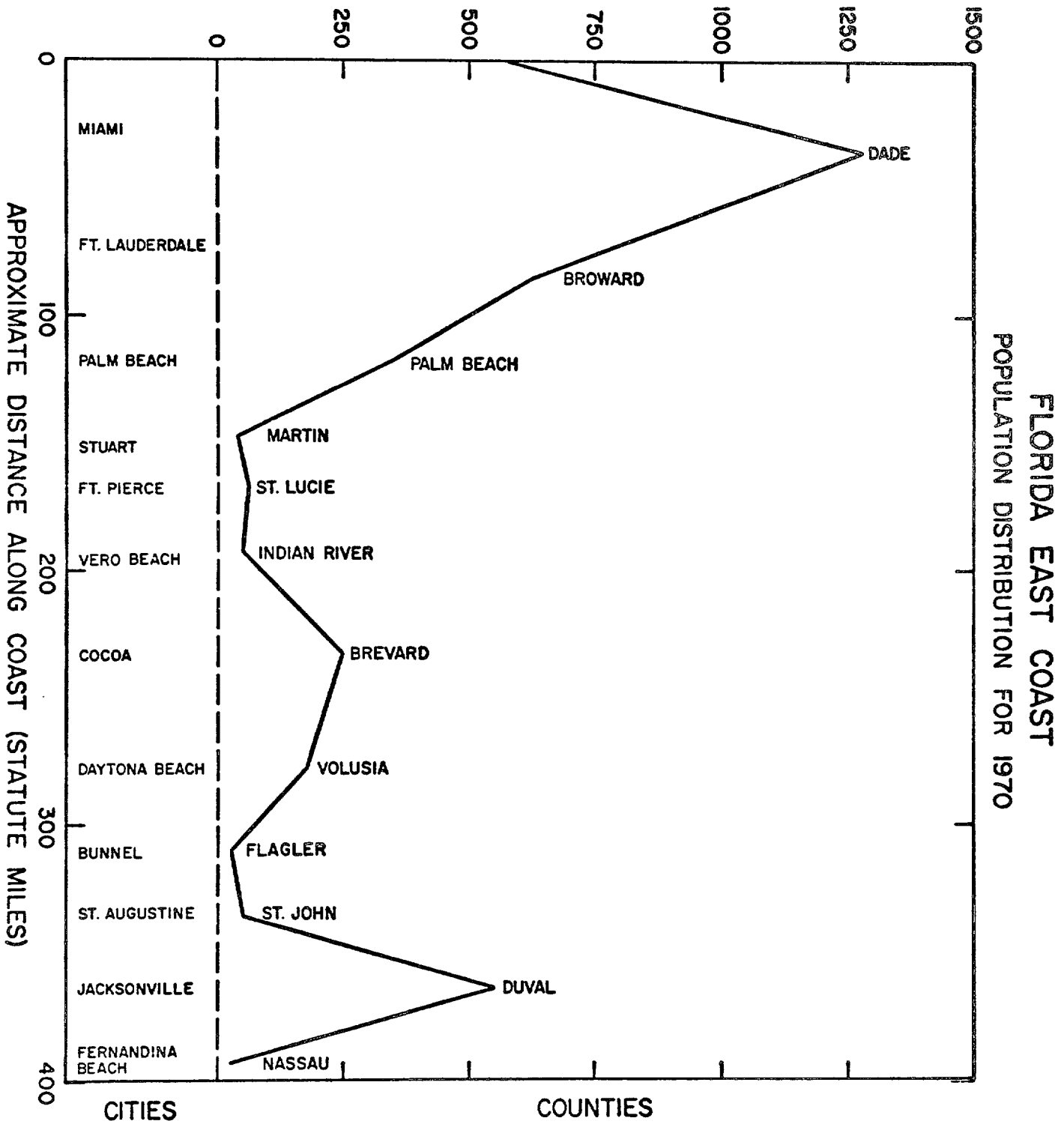
POPULATION OF COASTAL COUNTIES (THOUSANDS)



POPULATION OF COASTAL COUNTIES (THOUSANDS)

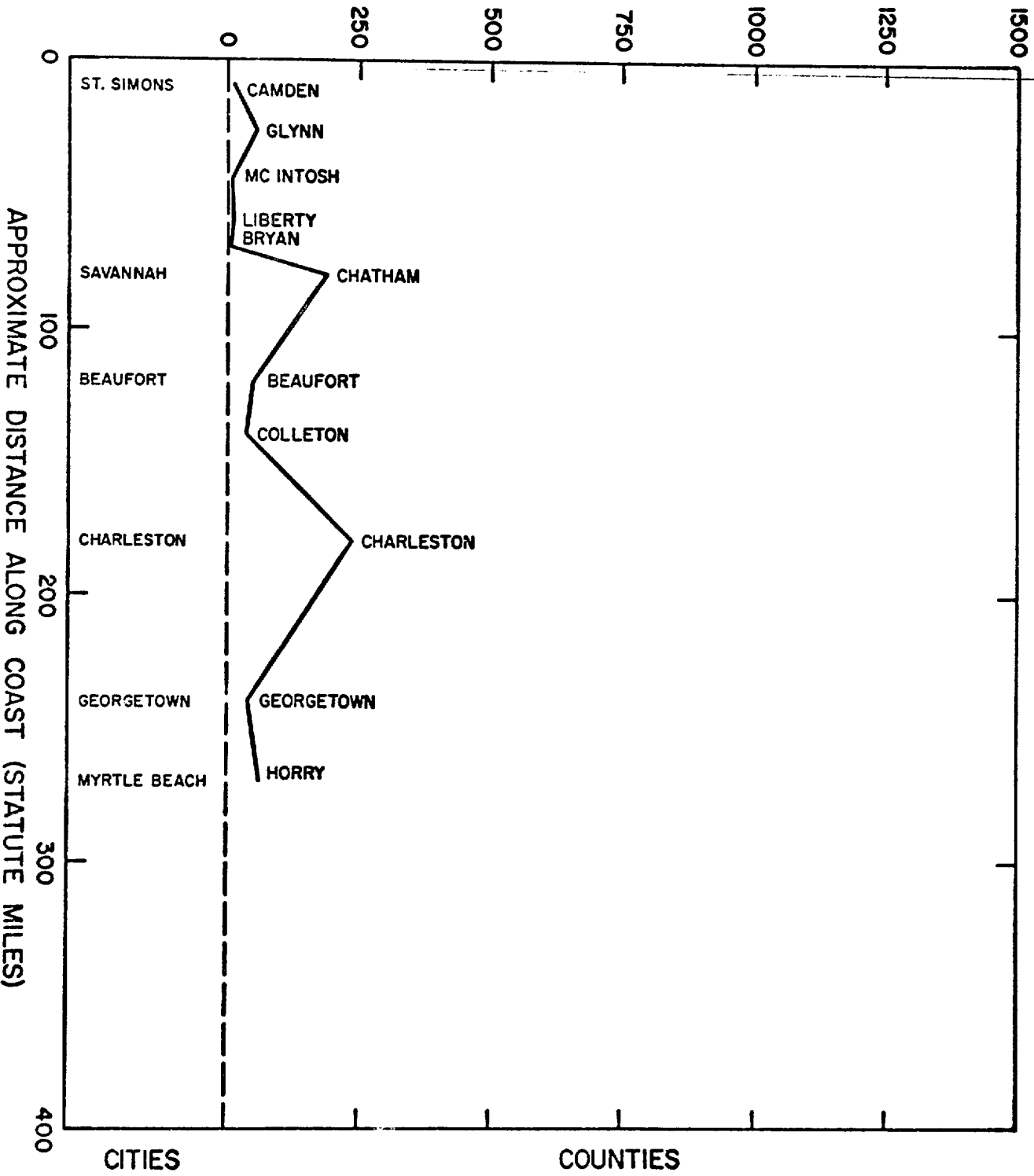


POPULATION OF COASTAL COUNTIES (THOUSANDS)

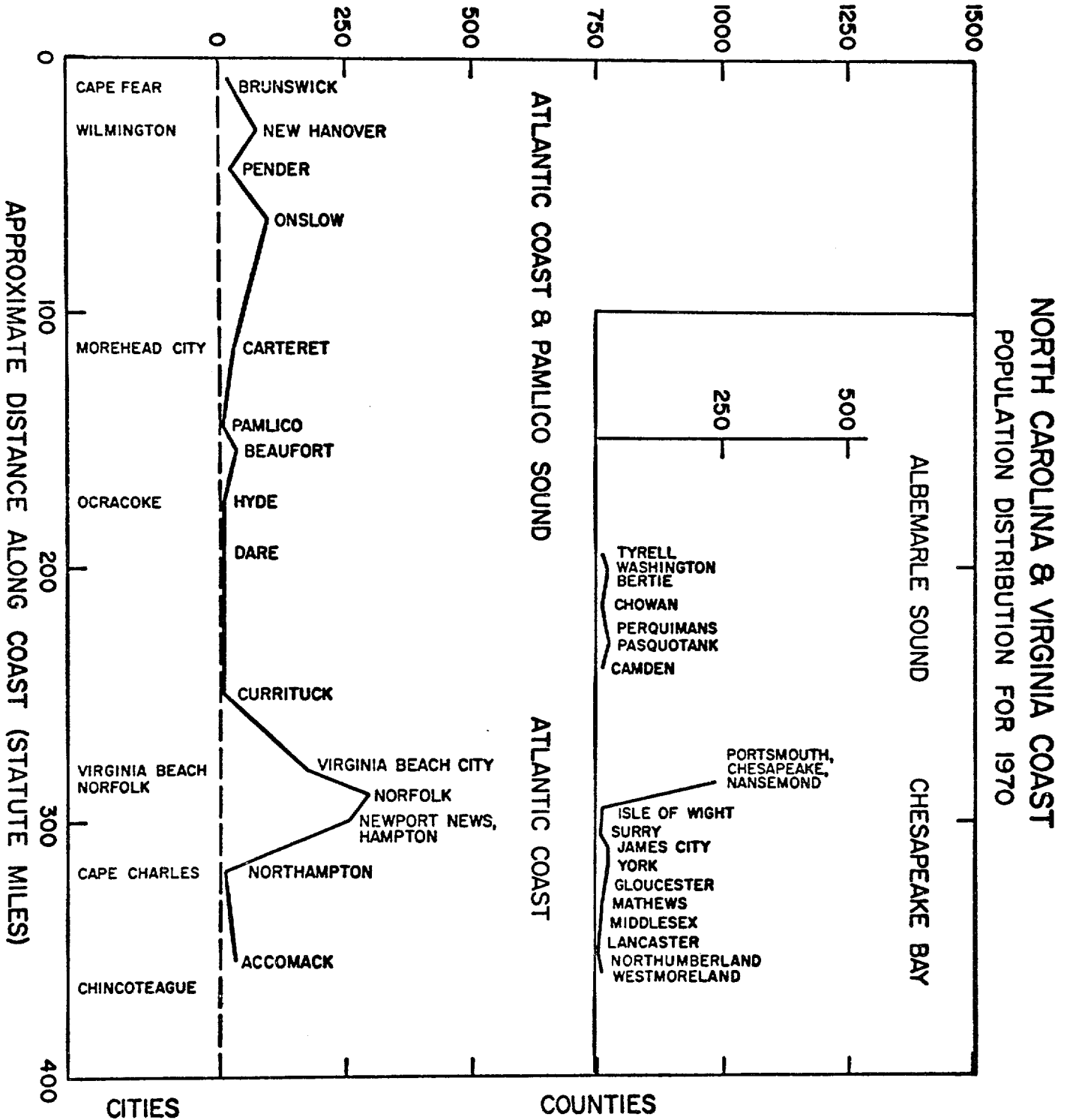


POPULATION OF COASTAL COUNTIES (THOUSANDS)

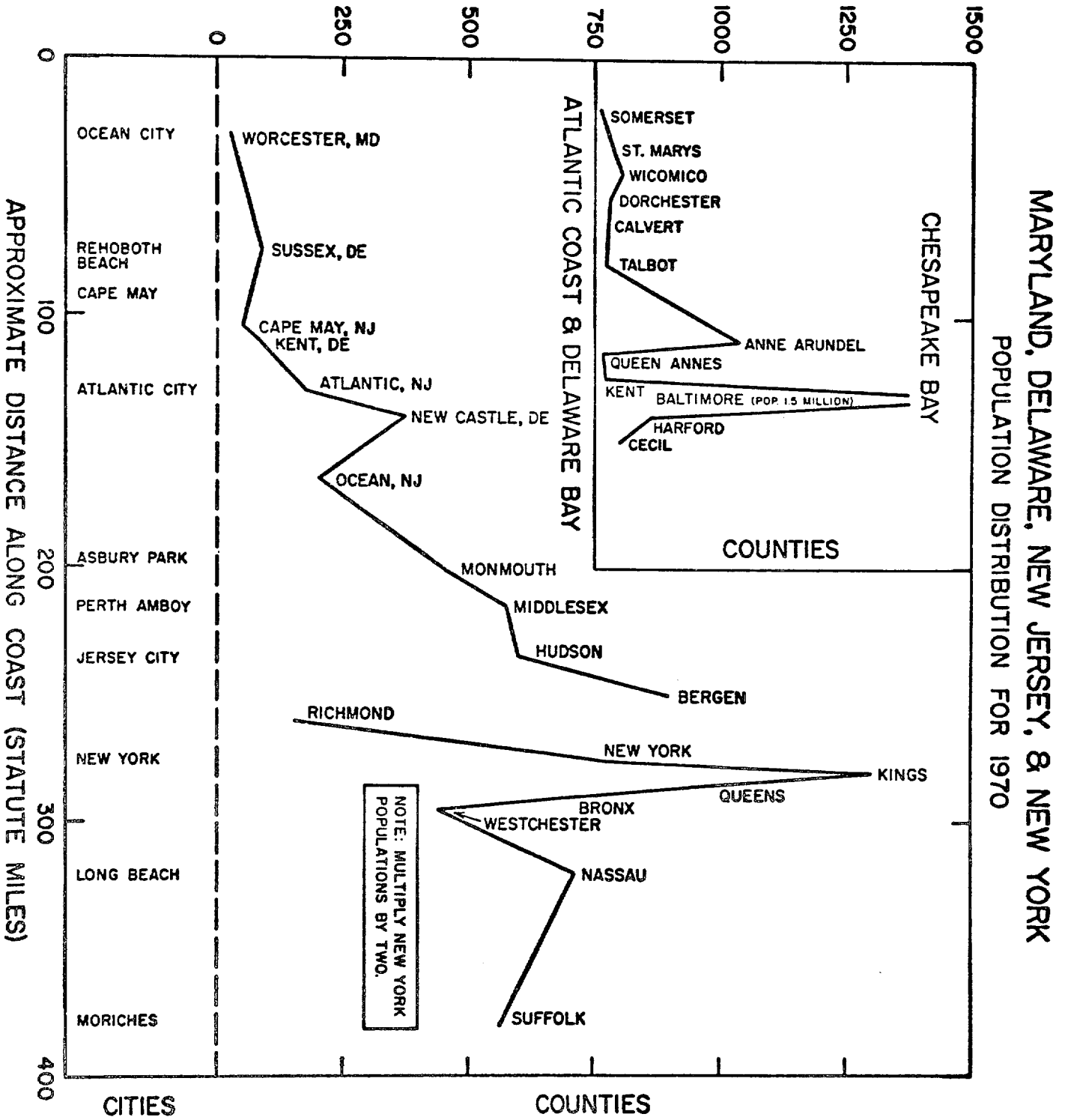
GEORGIA & SOUTH CAROLINA COAST
POPULATION DISTRIBUTION FOR 1970



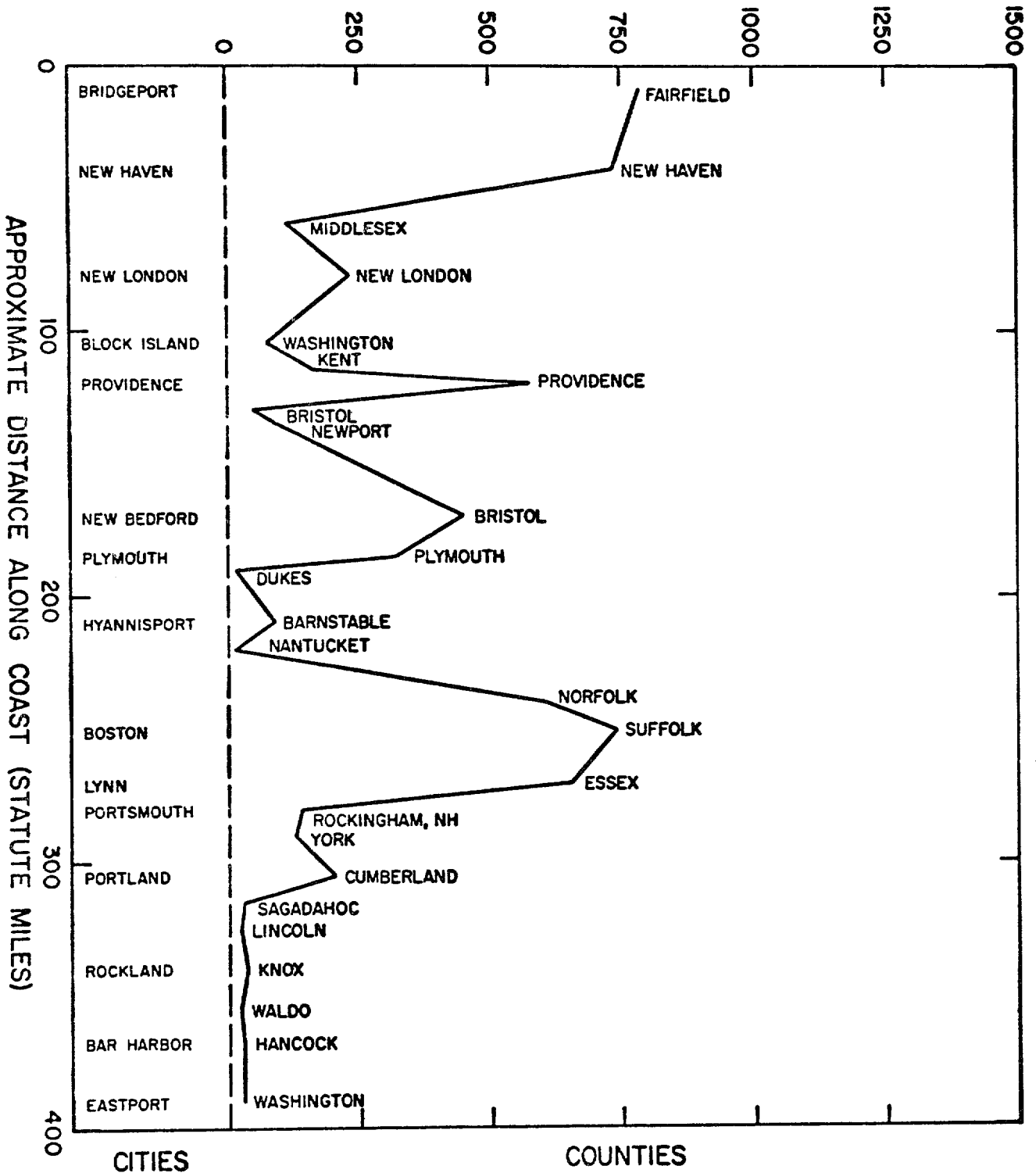
POPULATION OF COASTAL COUNTIES (THOUSANDS)



POPULATION OF COASTAL COUNTIES (THOUSANDS)



POPULATION OF COASTAL COUNTIES (THOUSANDS)



CONNECTICUT, RHODE ISLAND, MASSACHUSETTS,
NEW HAMPSHIRE & MAINE
POPULATION DISTRIBUTION FOR 1970