NOAA Technical Memorandum NWS NHC 24

HURRICANE EXPERIENCE LEVELS OF COASTAL COUNTY POPULATIONS - TEXAS TO MAINE

Paul J. Hebert, Glenn Taylor (Retired), and Robert A. Case
NHC, Miami, Florida

National Hurricane Center
Miami, Florida
June 1984

UNITED STATES
DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary

National Oceanic and
Atmospheric Administration
John V. Byrne, Administrator

National Weather
Service
Richard E. Hallgren, Director

CONTENTS

LIST OF TABLES

HURRICANE EXPERIENCE LEVELS OF COASTAL COUNTY POPULATIONS FROM TEXAS TO MAINE

by

Paul J. Hebert, Glenn Taylor (Retired), and Robert A. Case

(This publication updates the previous version by Hebert and Taylor, published in 1975.)

ABSTRACT

Population graphs for the period 1900-1980 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 Scale[1] (range 1-5) has been used to develop a hurricane climatology for each county for the period 1900-1982. The combined statistics graphically illustrate that nearly 80 percent of all Atlantic and Gulf coastal residents of the United States have never experienced the effects of a direct hit by a major[2] 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 continued 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 nearly 32 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 is 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 preparedness 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 1900-1980. 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 1982* 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 1980 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.

*No hurricanes hit the Gulf or Atlantic coastal counties during the years 1981 and 1982.

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	1980	AT LAST[1,2] MAJOR HURRICANE	INCREASE	% OF 1980 TOTAL
TEXAS	3,809,992	1,592,605	2,217,387	58.2%
LOUISIANA	1,575,591	1,145,440	430,151	27.3%
MISSISSIPPI	300,217	170,467	129,750	43.2%
ALABAMA	442,819	436,206	6,613	1.5%
FLORIDA	7,702,337	1,169,273	6,533,064	84.8%
GEORGIA	326,382		326,382	100.0%
S.CAROLINA	518,228	344,700	173,528	33.5%
N.CAROLINA	492,467	356,327	136,140	27.6%
VIRGINIA	1,274,579	28,901	1,245,678	97.7%
MARYLAND	2,350,248		2,350,248	100.0%
DELAWARE	595,225		595,225	100.0%
NEW JERSEY	3,683,930		3,683,930	100.0%
NEW YORK	10,543,442	666,784	9,876,658	93.7%
CONNECTICUT	1,935,906	1,108,374	827,532	42.7%
RHODE ISLAND	947,154	818,933	128,221	13.5%
MASSACHUSETTS	2,932,292	926,619	2,005,774	68.4%
NEW HAMPSHIRE	190,345		190,345	100.0%
MAINE	548,000		548,000	100.0%
ALL	40,169,295		31,404,666	78.2%

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

[2]Significant 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 83-year period 1900-1982 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 83-year period 1900-1982, 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... Female names were used for naming hurricanes from 1953 to 1978. Since 1979 alternating male/female names have been used.)

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. In addition to hurricanes which have occurred since 1974 (last year of the previous version), a few hurricanes have been added, or categories of others changed, based on additional information.

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

Category	Gulf Coast	Florida	Atlantic Coast
1	BOB 1979 (LA) BABE 1977 (LA) FERN 1971 (TX) CINDY 1963 (TX) ETHEL 1960 (MS)	AGNES 1972 (NW) INEZ 1966 (Keys) FLOSSY 1956 (NW) FLORENCE 1953 (NW) 1947 (Keys, SE)	BELLE 1976 (NY) AGNES 1972 (NY, CT) GINGER 1971 (NC) GERDA 1969 (ME) DONNA 1960 (MA,NH,ME)
2	EDITH 1971 (LA) FLOSSY 1956 (LA) 1949 (TX) 1945 (TX) 1943 (TX)	DAVID 1979 (SE,NE) GLADYS 1968 (NW) ALMA 1966 (NW) ISBELL 1964 (SW) CLEO 1964 (SE)	DAVID 1979 (GA,SC) DONNA 1960 (CT, RI) CAROL 1954 (NC) HAZEL 1954 (MD) 1947 (GA, SC)
3	ALLEN 1980 (TX) FREDERIC 1979 (AL,MS) CARMEN 1974 (LA) CELIA 1970 (TX) BEULAH 1967 (TX)	ELOISE 1975 (NW) BETSY 1965 (Keys) DONNA 1960 (SW) EASY 1950 (W-CNTRL) KING 1950 (SE)	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 (LA) 1915 (TX) 1909 (LA) 1900 (TX)	DONNA 1960 (Keys) 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 regions, 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≈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, 1900-1982, for all coastal counties from Texas to Maine is included in tabular form as Appendix C. It is comprised of a series of five pages 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) Appendix A illustrates the Saffir/Simpson Hurricane scale.

2) Tables 4a and 4b were prepared in the process of developing the Saffir/Simpson Hurricane scale climatology. Comments concerning all 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, 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 31 million people along the Gulf and Atlantic coasts have never experienced a direct hit by a major hurricane. This is over 78% 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 85% of the coastal population of Florida - the most hurricane prone state - have never experienced a direct hit by a major hurricane

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, 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 eight years since 1975, the three major hurricanes to strike the U. S. (Eloise 1975, Frederic 1979, Allen 1980) hit in areas containing relatively few people.

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 136 hurricanes have affected the U. S. coast during the period 1900-1982. Of this total, 55 or about 40% 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 nearly once every six years.

This table gives a quick reference to the hurricane climatology of individual states. The table reveals that 38% of all hurricanes hit Florida. A few other noteworthy statistics are that Florida and Texas combined have been hit by nearly 75% 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 136 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 Table 5. This table gives the coastal county population in exact numbers (1980) rather than having to extract the figure from the graphs in Appendix B.

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 - 1982 according to Saffir/Simpson Hurricane Scale.

AREA	CATEGORY NUMBER 1	2	3	4	5	ALL	MAJOR HURRICANES (≥3)
U.S. (Texas to Maine)	48	33	40	13	2	136	55
Texas	9	9	8	6	0	32	14
(North)	4	3	2	4	0	13	6
(Central)	2	2	1	1	0	6	2
(South)	3	4	5	1	0	13	6
Louisiana	5	5	7	3	1	21	11
Mississippi	1	1	4	0	1	7	5
Alabama	4	1	4	0	0	9	4
Florida	16	14	15	5	1	51	21
(Northwest)	9	6	5	0	0	20	5
(Northeast)	1	7	0	0	0	8	0
(Southwest)	5	3	5	2	1	16	8
(Southeast)	4	10	7	3	0	24	10
Georgia	1	4	0	0	0	5	0
South Carolina	5	4	2	1*	0	12	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	3	0	4*	0	0	7	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.

Note: State totals will not equal U. S. totals and Texas and Florida sectional totals will not equal state totals.

Table 4b. - Chronological List of All Hurricanes Which Affected the U. S. 1900 - 1982 Including Category by States.

Year	Month	States Affected and Category by States	Highest Category U. S.	Minimum Sea Level Pressure (Mb.
1900	Sep	TX, 4N	4	931
1901	Jul	NC, 1	1	-
1901	Aug	LA, MS 2	2	972
1903	Sep	FL, 2SE, 1NW	2	976
1903	Sep	NJ, NY, CT, 1	1	990
1904	Sep	SC, 1	1	-
1906	Jun	FL, 1SE	1	-
1906	Sep	SC, NC, 3	3	947
1906	Sep	MS, AL, 3	3	958
1906	Oct	FL, 2SE	2	967
1908	Jul	NC, 1	1	-
1909	Jul	TX, 3N	3	958
1909	Aug	TX, 2S	2	-
1909	Sep	LA, 4	4	931
1909	Oct	FL, 3SE (Keys)	3	957
1910	Sep	TX, 2S	2	965
1910	Oct	FL, 3SW	3	955
1911	Aug	FL, 1NW; AL, 1	1	-
1911	Aug	GA, SC, 2	2	-
1912	Sep	AL, 1	1	-
1912	Oct	TX, 1S	1	-
1913	Jun	TX, 1S	1	-
1913	Sep	NC, 1	1	-
1915	Aug	TX, 4N	4	945
1915	Sep	FL, 1NW	1	988
1915	Sep	LA, 4	4	931
1916	Jul	MS, AL, 3	3	948
1916	Jul	MA, 1	1	-
1916	Jul	SC, 1	1	980
1916	Aug	TX, 3S	3	948
1916	Oct	AL, 2; FL, 2NW	2	972
1916	Nov	FL, 1SW (Keys)	1	-
1917	Sep	FL, 3NW	3	958
1918	Aug	LA, 3	3	955
1919	Sep	FL, 4SW (Keys); TX, 4S	4	927
1920	Sep	LA, 2	2	975
1920	Sep	NC, 1	1	-
1921	Jun	TX, 2C	2	979
1921	Oct	FL, 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	Sep	FL, 1NW	1	985
1924	Oct	FL, 1SW	1	980
1925	Nov	FL, 1SW	1	-
1926	Jul	FL, 2NE	2	967
1926	Aug	LA, 3	3	955
1926	Sep	FL, 4SE, 3SW, 3NW AL, 3	4	935
1928	Aug	FL, 2SE	2	-
1928	Sep	FL, 4SE, 2NE GA, SC, 1	4	929
1929	Jun	TX, 1C	1	982
1929	Sep	FL, 3SE, 2NW	3	948
1932	Aug	TX, 4N	4	941
1932	Sep	AL, 1	1	979
1933	Jul/ Aug	FL, 1SE; TX, 2S	2	975
1933	Aug	NC, VA, 2	2	971
1933	Sep	TX, 3S	3	949
1933	Sep	FL, 3SE	3	948
1933	Sep	NC, 3	3	957
1934	Jun	LA, 3	3	962
1934	Jul	TX, 2S	2	975
1935	Sep	FL, 5SW (Keys), 2NW	5	892
1935	Nov	FL, 2SE	2	973
1936	Jun	TX, 1S	1	987
1936	Jul	FL, 3NW	3	964
1936	Sep	NC, 2	2	-
1938	Aug	LA, 1	1	985
1938	Sep	NY, CT, RI, MA, 3*	3*	946
1939	Aug	FL, 1SE, 1NW	1	985
1940	Aug	TX, 2N, LA, 2	2	972
1940	Aug	GA, SC, 2	2	970
1941	Sep	TX, 3N	3	958
1941	Oct	FL, 2SE, 2SW, 2NW	2	975
1942	Aug	TX, 1N	1	992
1942	Aug	TX, 3C	3	950
1943	Jul	TX, 2N	2	969
1944	Aug	NC, 1	1	990
1944	Sep	NC, VA, NY, CT, RI, MA, 2*	3*	947
1944	Oct	FL, 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	Jun	FL, 1NW	1	985
1945	Aug	TX, 2C	2	967
1945	Sep	FL, 3SE	3	951
1946	Oct	FL, 1SW	1	980
1947	Aug	TX, 1N	1	992
1947	Sep	FL, 4SE, 2SW; MS, LA, 3	4	940
1947	Oct	FL, 1SE; GA, SC, 2	2	974
1948	Sep	LA, 1	1	987
1948	Sep	FL, 3SW, 2SE	3	963
1948	Oct	FL, 2SE	2	975
1949	Aug	NC, 1	1	980
1949	Aug	FL, 3SE	3	954
1949	Oct	TX, 2N	2	972
1950	Aug	AL, 1	1	980
1950	Sep	FL, 3NW	3	958
1950	Oct	FL, 3SE	3	955
1952	Aug	SC, 1	1	985
1953	Aug	NC, 1	1	987
1953	Sep	ME, 1*	1*	-
1953	Sep	FL, 1NW	1	985
1954	Aug	NC, 2; NY, CT, RI, 3*	3*	960
1954	Sep	MA, 3*; ME, 1*	3*	954
1954	Oct	SC, NC, 4*; MD, 2*	4*	938
1955	Aug	NC, 3; VA, 1	3	962
1955	Aug	NC, 1	1	987
1955	Sep	NC, 3	3	960
1956	Sep	LA, 2; FL, 1NW	2	975
1957	Jun	TX, 4N; LA, 4	4	945
1959	Jul	TX, 1N	1	984
1959	Jul	SC, 1	1	993
1959	Sep	SC, 3	3	950
1960	Sep	MS, 1	1	981
1960	Sep	FL, 4SW (Keys), 2NE; NC, NY, 3*; CT, RI, 2*; MA, NH, ME, 1*	4	930
1961	Sep	TX, 4C	4	931
1963	Sep	TX, 1N	1	996
1964	Aug	FL, 2SE	2	968
1964	Sep	FL, 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	FL, 2SW, 2SE	2	974
1965	Sep	FL, 3SE; LA, 3	3	948
1966	Jun	FL, 2NW	2	982
1966	Oct	FL, 1SW, (Keys)	1	983
1967	Sep	TX, 3S	3	950
1968	Oct	FL, 2NW, 1NE	2	977
1969	Aug	LA, MS, 5	5	909
1969	Sep	ME, 1	1	980
1970	Aug	TX, 3S	3	945
1971	Sep	LA, 2	2	978
1971	Sep	TX, 1C	1	979
1971	Sep	NC, 1	1	993
1972	Jun	FL, 1NW; NY, CT, 1	1	980
1974	Sep	LA, 3	3	952
1975	Sep	FL, 3NW	3	955
1976	Aug	NY, 1	1	980
1977	Sep	LA, 1	1	995
1979	Jul	LA, 1	1	986
1979	Sep	FL, 2SE, 2NE; GA, 2; SC, 2	2	970
1979	Sep	AL, MS, 3	3	946
1980	Aug	TX, 3S	3	945

* No hurricanes struck the U.S. coastline in 1981 or 1982.

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 page is a geographical area likely to be affected solely by a given hurricane. However, pages 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.

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 31 million coastal residents, is 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 1980, unofficial estimates indicate that most Gulf and Atlantic coastal populations have continued to increase. 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. Ms. Joan David updated all of the drafting material previously done by Ms. Mary Watson, and Ms. Gayle Shickel did the revised typing.

REFERENCES

Cry, G.W., 1965: "Tropical Cyclones of the North Atlantic", Technical Paper, No. 55, U. S. Weather Bureau, Washington D.C., 148 pp.

Dunn, G.E., and B.I. Miller, 1964: "Atlantic Hurricanes", Revised Edition, Louisiana State University Press, Baton Rouge, Louisiana, 377 pp.

Kraft, R.H.: "Great Hurricanes, 1955-1965", Mariners Weather Log, Vol. 19, No. 6, Nov. 1966, pp. 200-202.

Ludlum, D.M., 1963: "Early American Hurricanes 1492-1870", American Meteorological Society, Boston, Massachusetts, 198 pp.

Simpson, R.H., and M.B. Lawrence, 1971: "Atlantic Hurricane Frequencies Along the U. S. Coastline", NOAA Technical Memorandum NWS SR-58, U. S. Department of Commerce, National Weather Service, Southern Region Headquarters, Fort Worth, Texas, 14 pp.

Sugg, A.L., L.G. Pardue, and R.L. Carrodus, 1971: "Memorable Hurricanes of the United States Since 1873", NOAA Technical Memorandum NWS SR-56, U. S. Department of Commerce, National Weather Service, Southern Region Headquarter, Fort Worth, Texas, 52 pp.

Tannehill, I.R., 1956: "Hurricanes", 9th Edition, Princeton University Press, Princeton, N.J., 308 pp.

U. S. Department of Commerce, 1970: "Census '80", Bureau of the Census Pamphlets (18 States - Population Statistics for Earlier Years), Washington, D.C.

U. S. Department of Commerce, 1971: "1970 Census of Population, Number of Inhabitants - Texas, etc...", Final Report PC(1)-A45 Texas, etc... (18 States), U. S. Bureau of the Census, Washington, D.C.

U. S. Department of Commerce, 1980: "Census of Population and Housing", Advance Reports (18 States), U. S. Bureau of the Census, Washington, D.C.

APPENDIX A

THE SAFFIR/SIMPSON[3] 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 more than 155 miles per hour, 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.

---

[3]Developed 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 roof 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 1900-1980. Indications are that this increasing trend in coastal populations has continued into 1983 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 1900-1982. 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.)

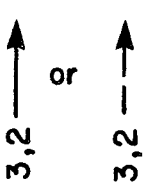
Examples (Symbols used in Hurricane Climatology/Population Graphs)

- Direct Hit by a Category 2 Hurricane

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

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

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



- 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.)

- 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 (Morehead 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), 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)

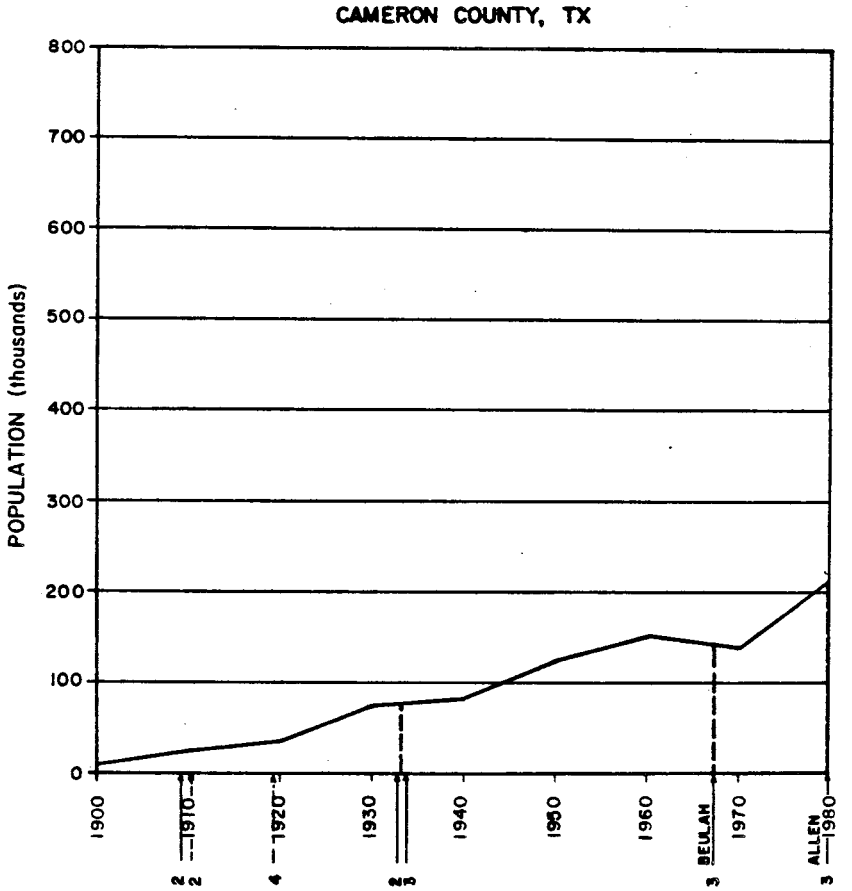
Bristol (New Bedford), Dukes (Martha's Vineyard), Nantucket (Nantucket), Barnstable (Cape Cod), Plymouth (Plymouth), Norfolk, Suffolk (Boston), Essex (Gloucester).

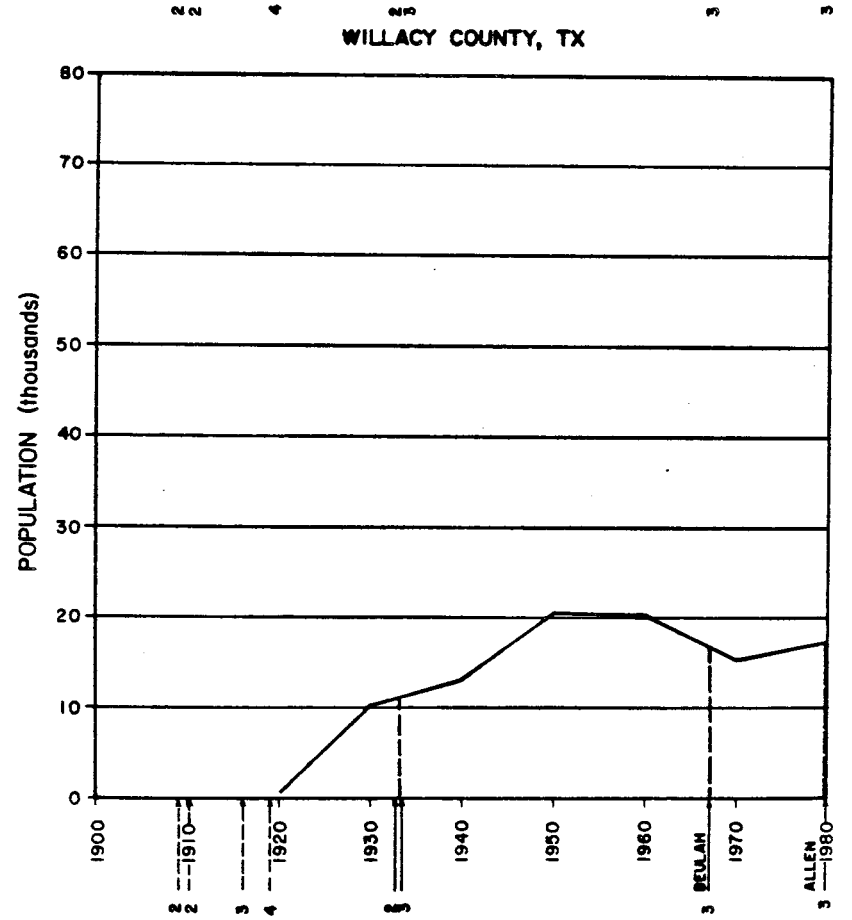
17. NEW HAMPSHIRE (1)

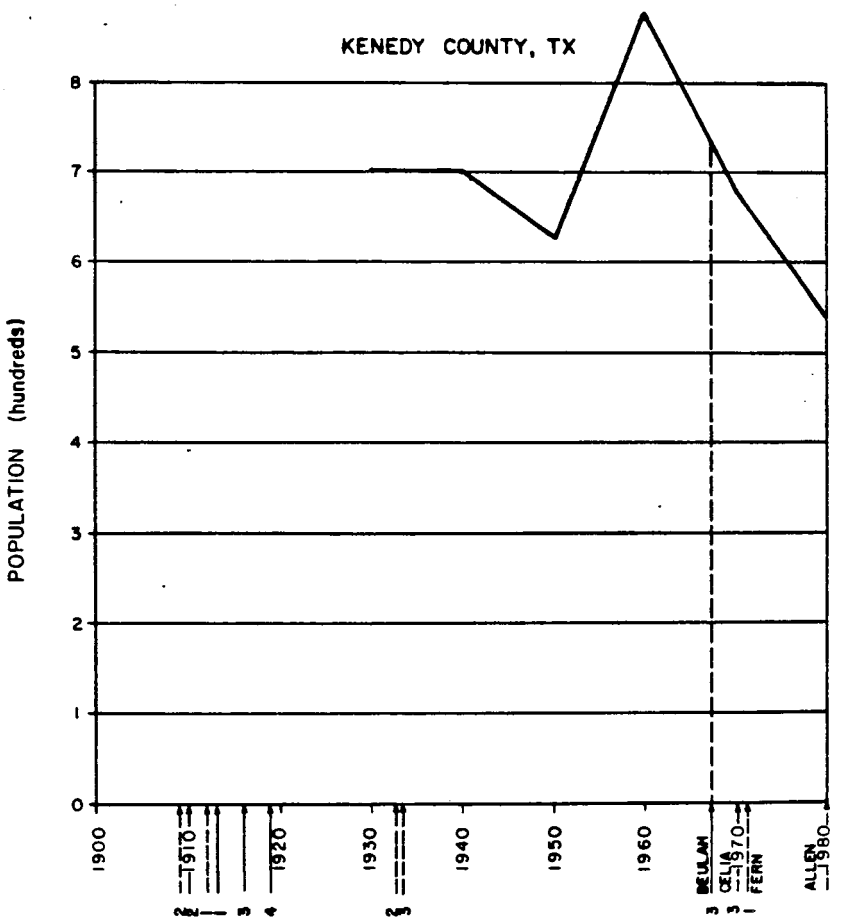
Rockingham (Portsmouth).

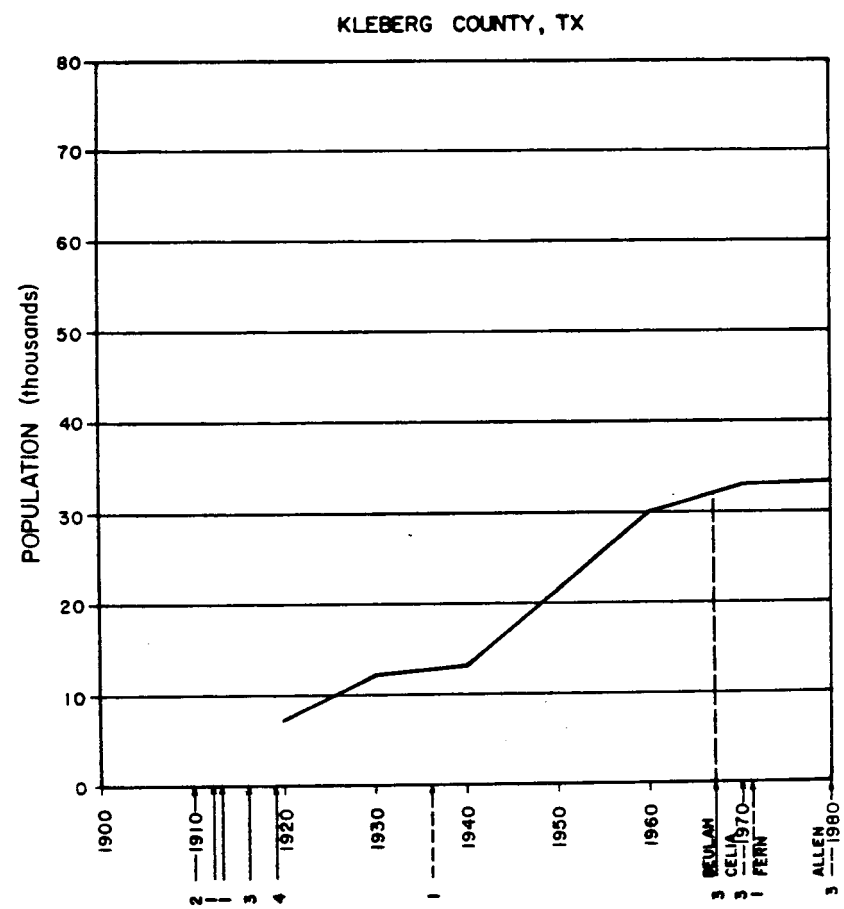
18. MAINE (8)

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

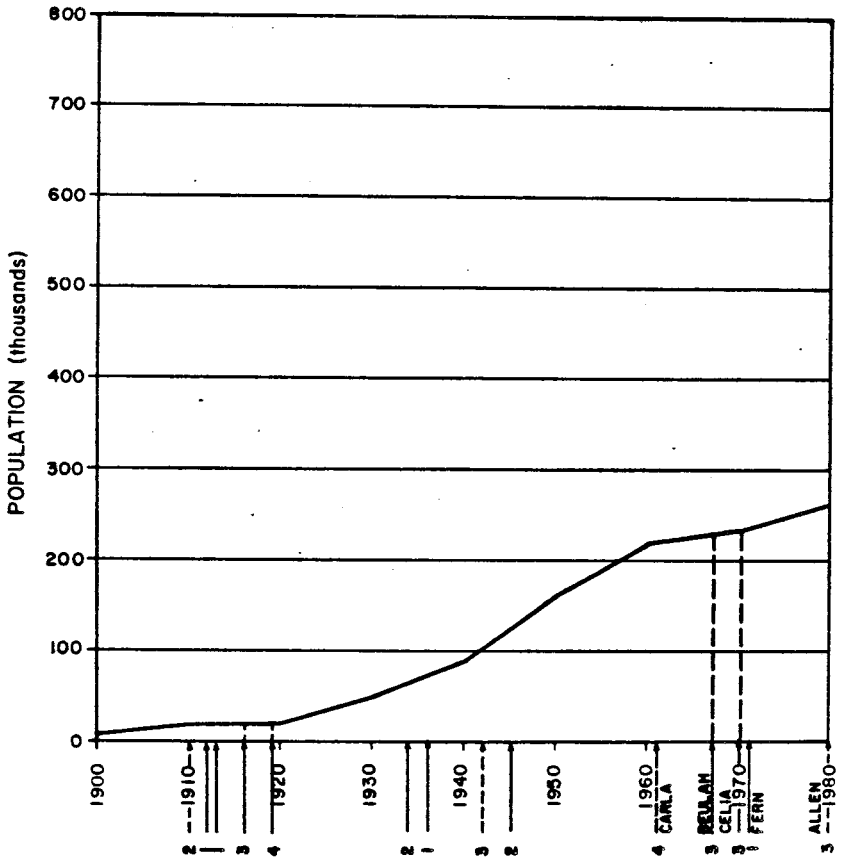

CAMERON COUNTY, TX
POPULATION (thousands)
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
BEULAH
ALLEN


WILLACY COUNTY, TX
POPULATION (thousands)
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
BEULAH
ALLEN

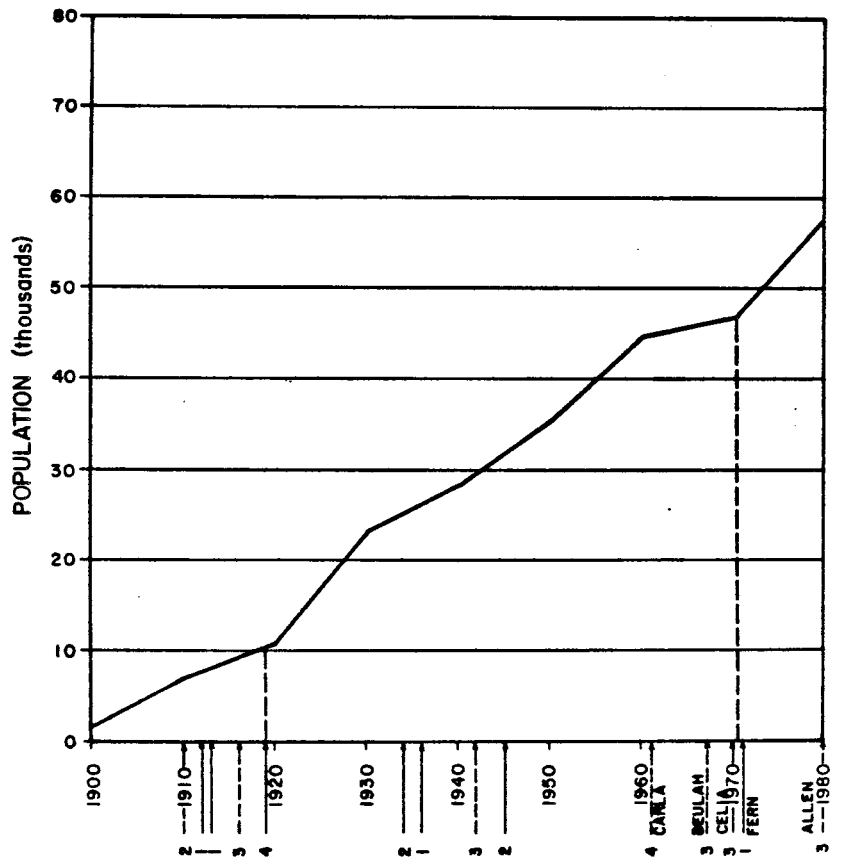

KENEDY COUNTY, TX
POPULATION (hundreds)
0
1
2
3
4
5
6
7
8
1900
1910
1920
1930
1940
1950
1960
1970
1980
BEULAH
CELIA
FERN
ALLEN


KLEBERG COUNTY, TX
POPULATION (thousands)
0
10
20
30
40
50
60
70
80
1900
1910
1920
1930
1940
1950
1960
1970
1980
BEULAH
CELIA
FERN
ALLEN

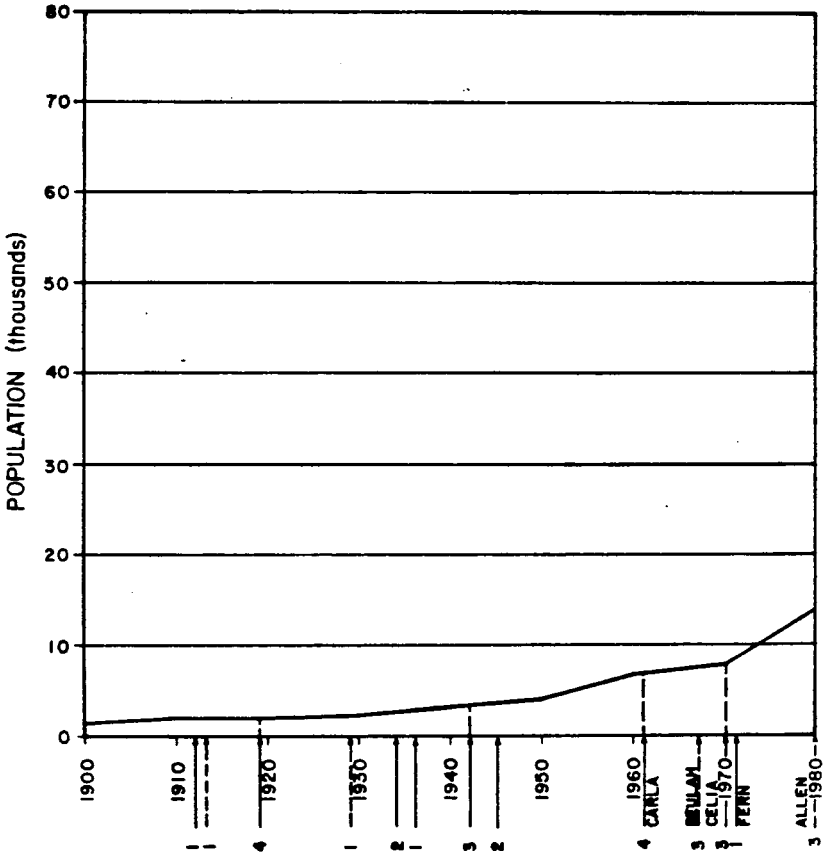
NUECES COUNTY, TX



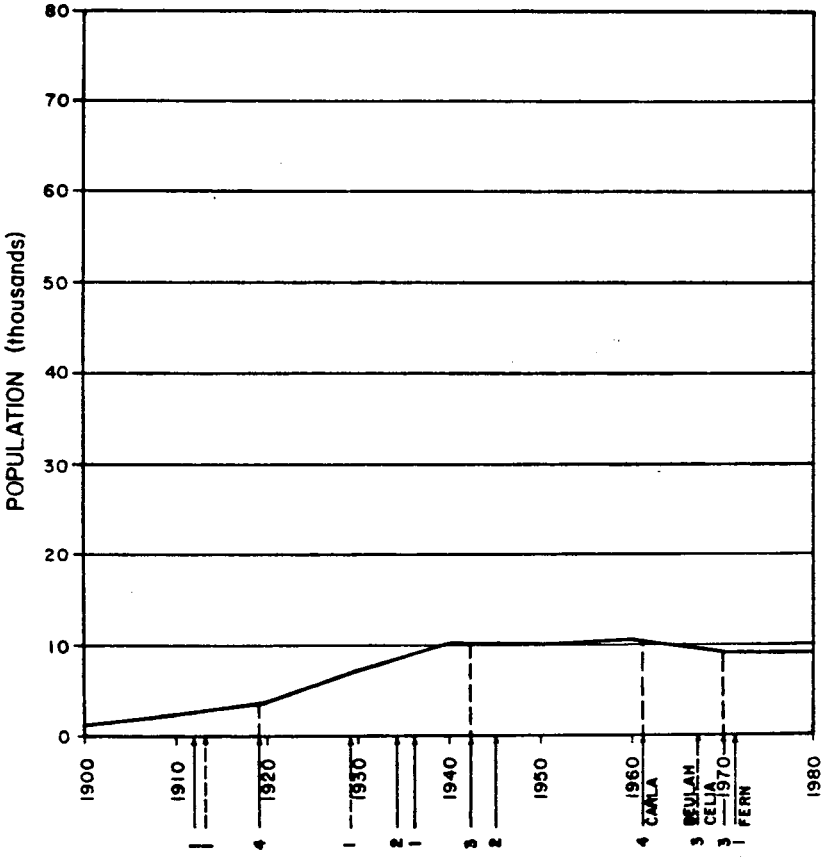
SAN PATRICIO COUNTY, TX

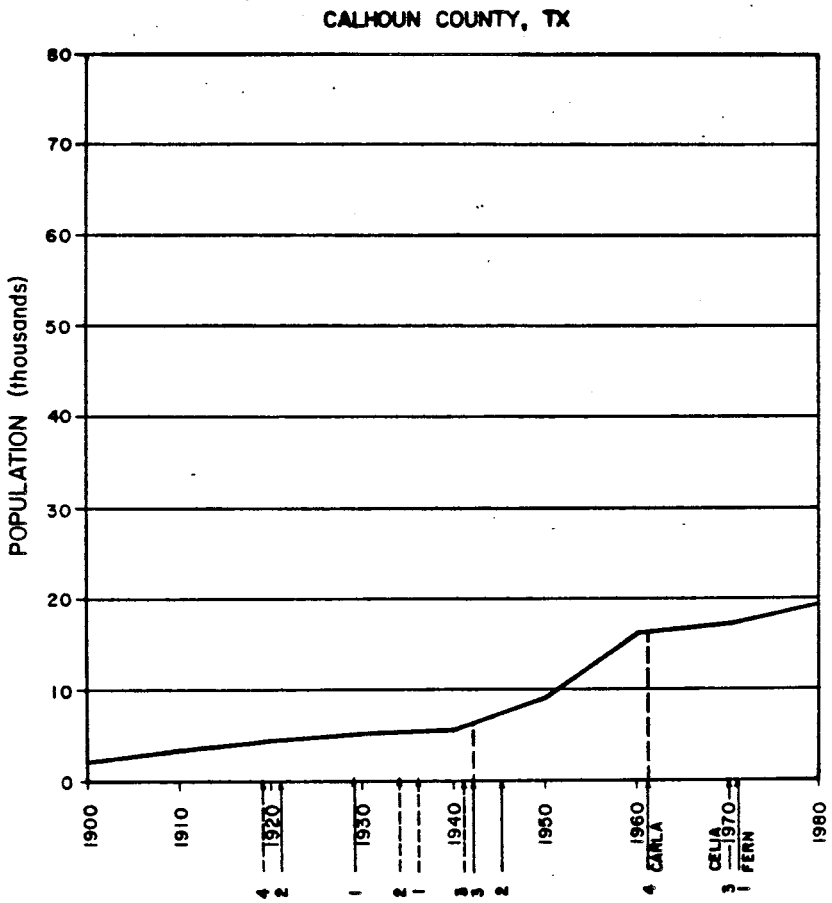


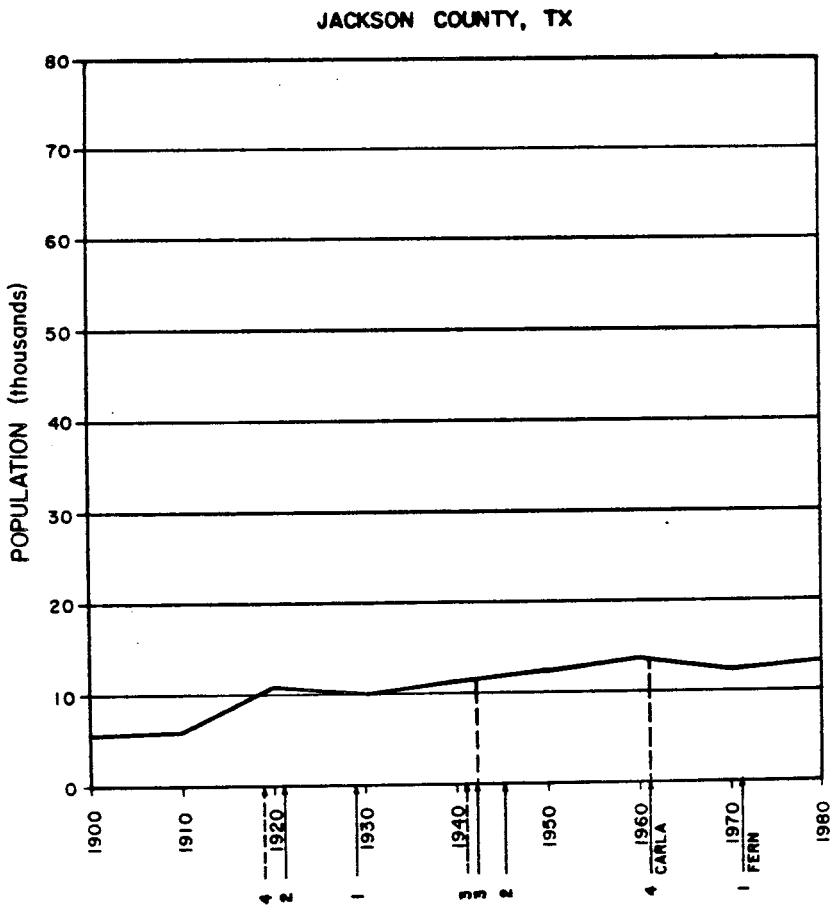
ARANSAS COUNTY, TX



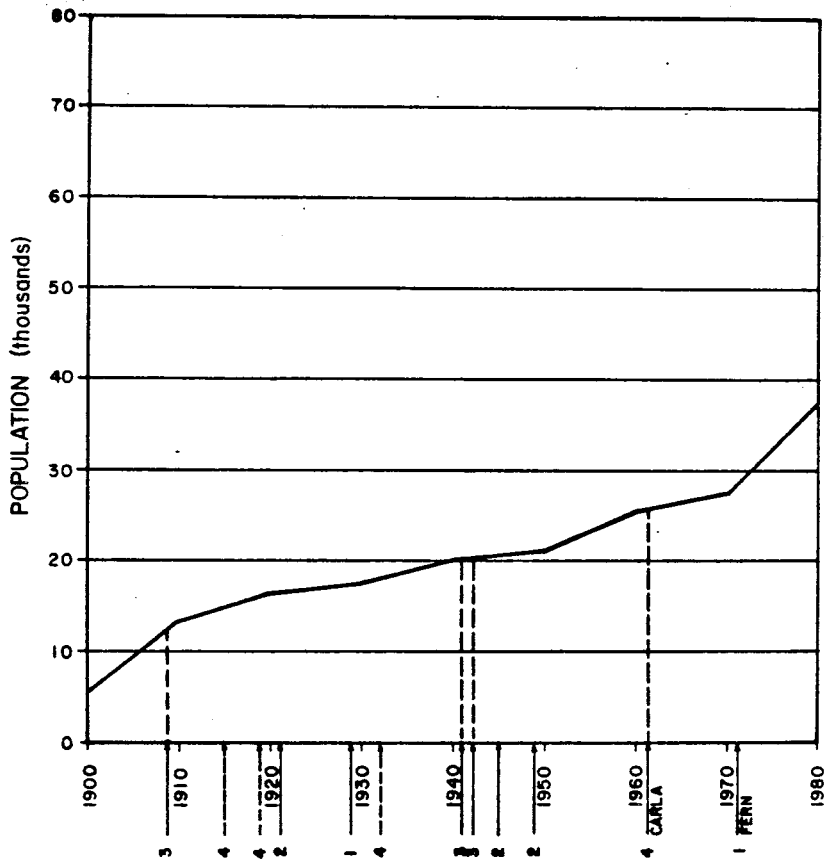
REFUGIO COUNTY, TX



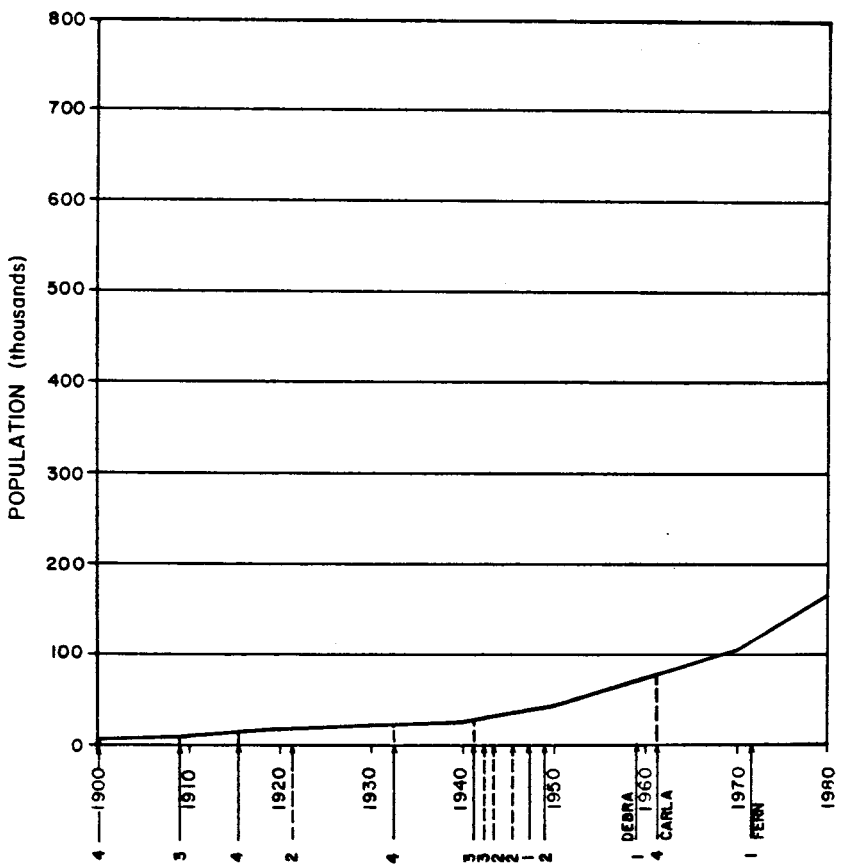

CALHOUN COUNTY, TX
POPULATION (thousands)
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
CARLA
CELIA
FERN


JACKSON COUNTY, TX
POPULATION (thousands)
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
CARLA
FERN

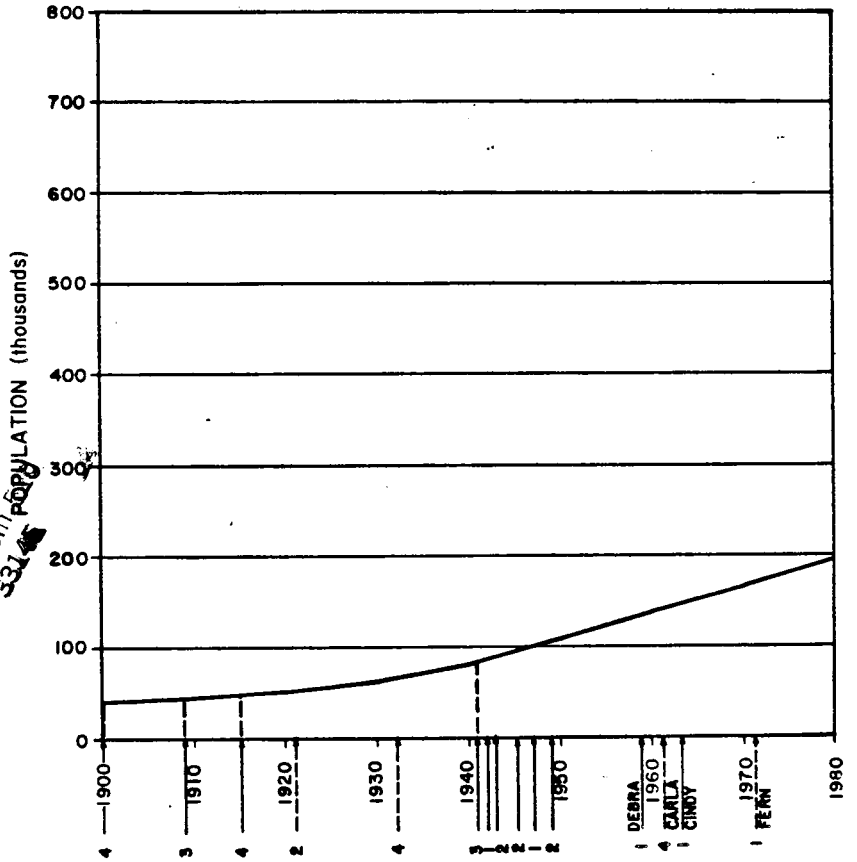
MATAGORDA COUNTY, TX



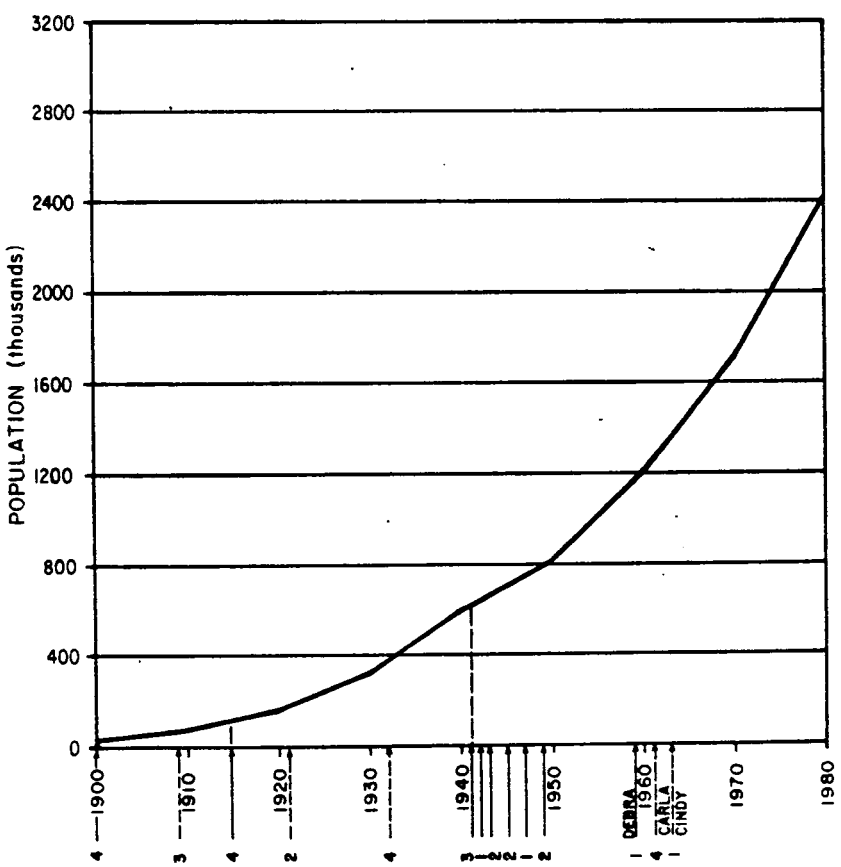
BRAZORIA COUNTY, TX

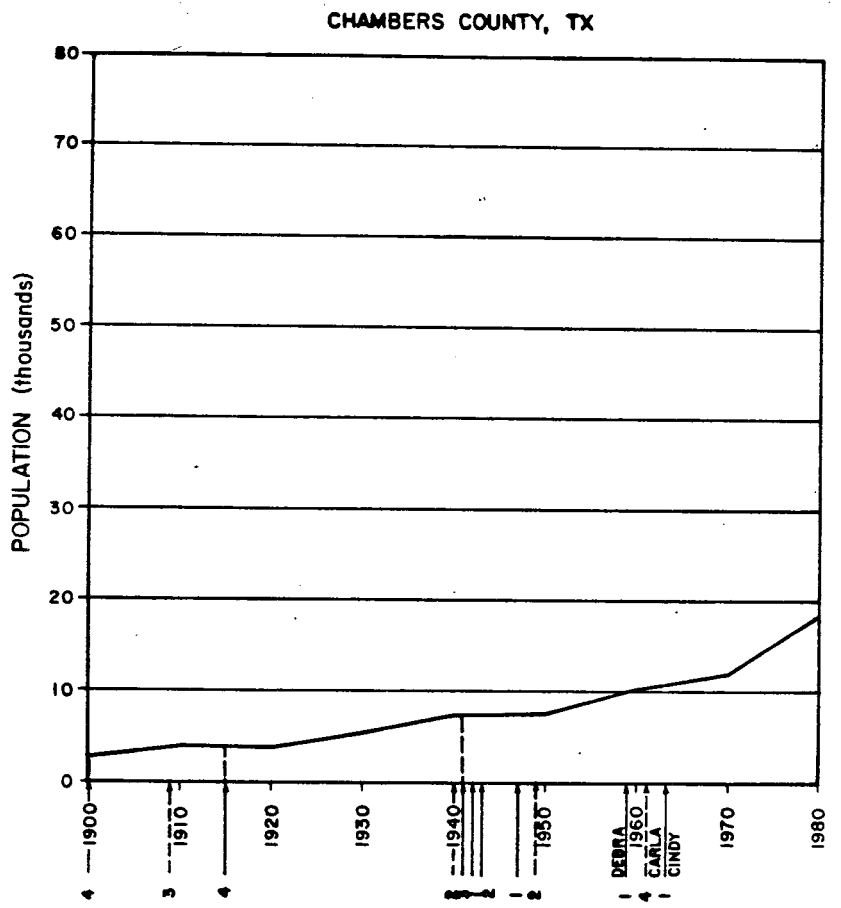


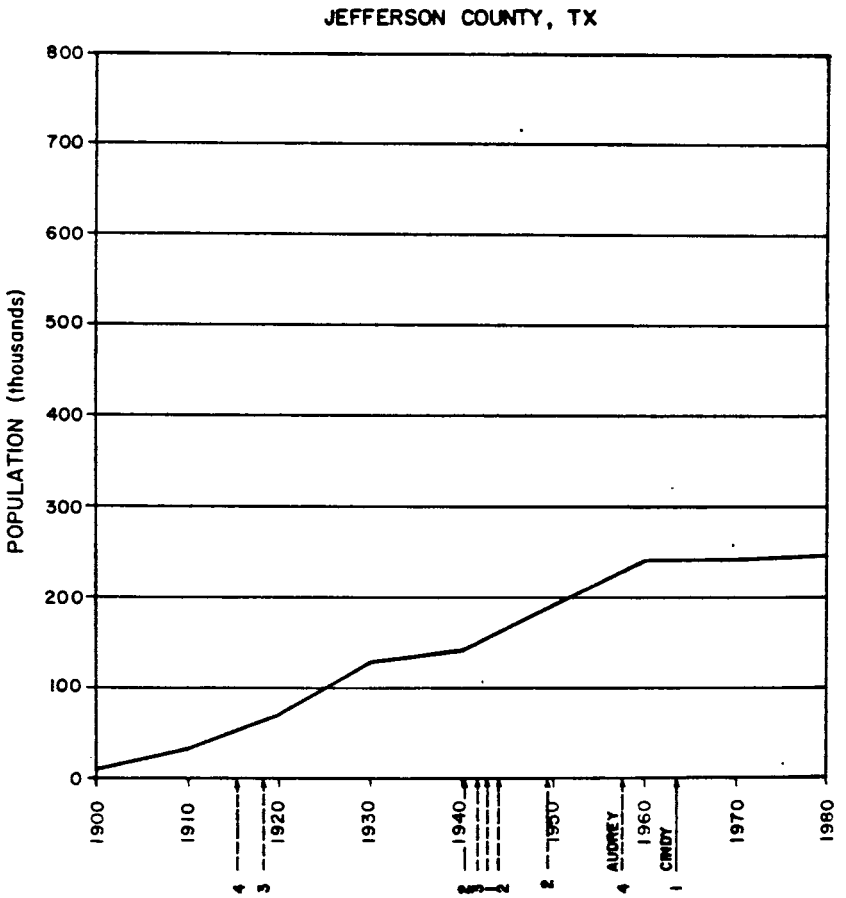
GALVESTON COUNTY, TX

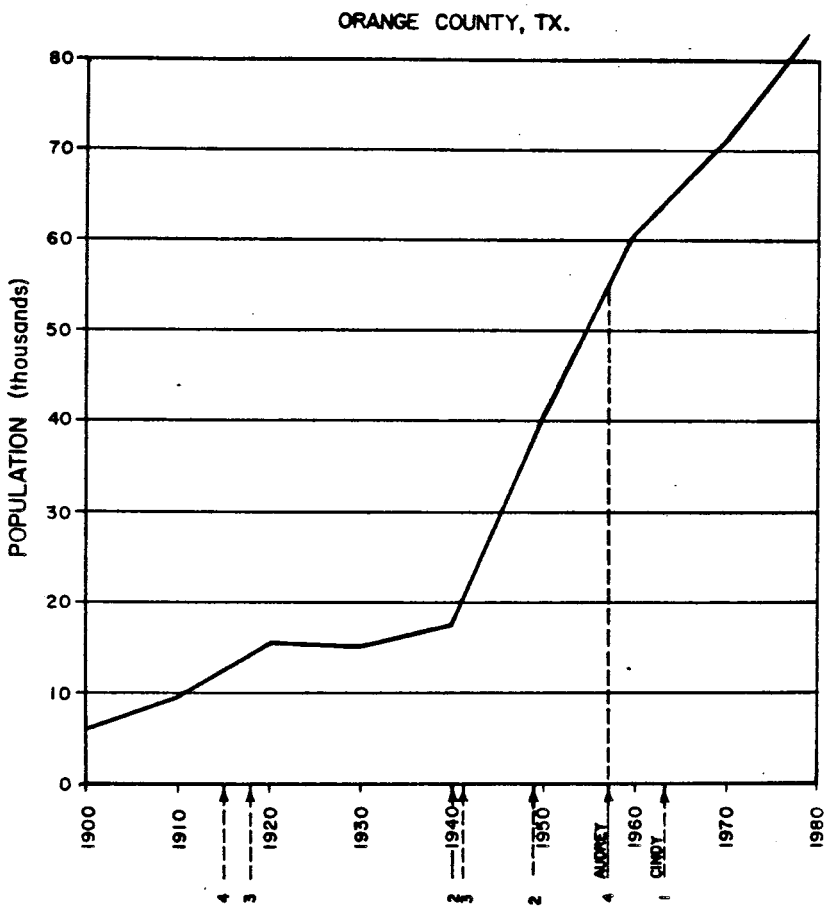


HARRIS COUNTY, TX



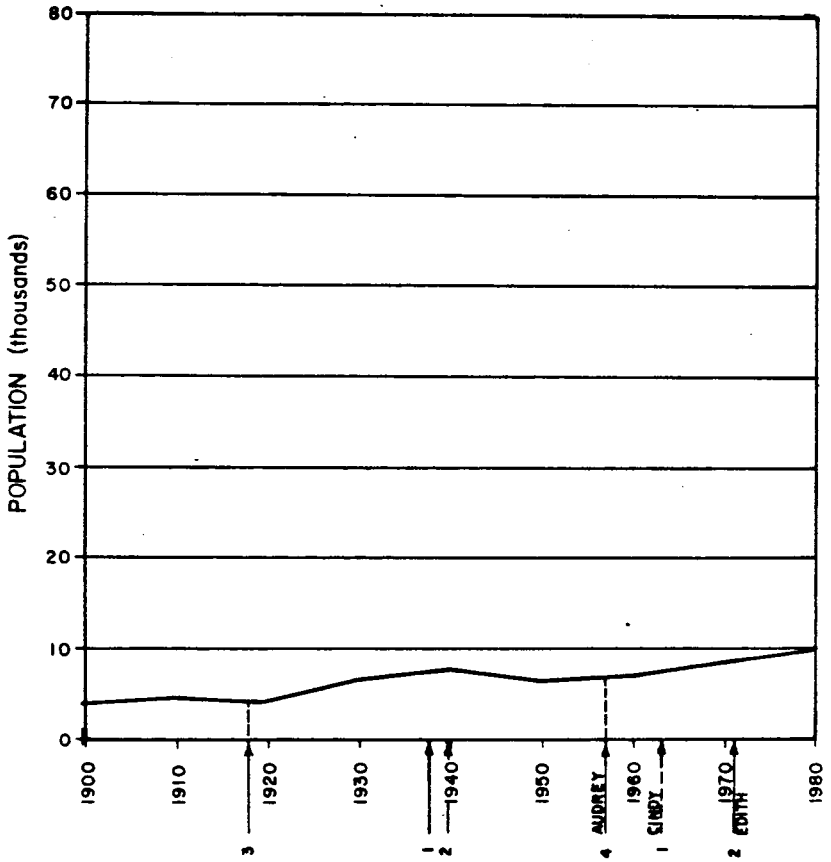

CHAMBERS COUNTY, TX
POPULATION (thousands)
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
DEBRA
CARLA
CINDY


JEFFERSON COUNTY, TX
POPULATION (thousands)
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
AUDREY
CINDY

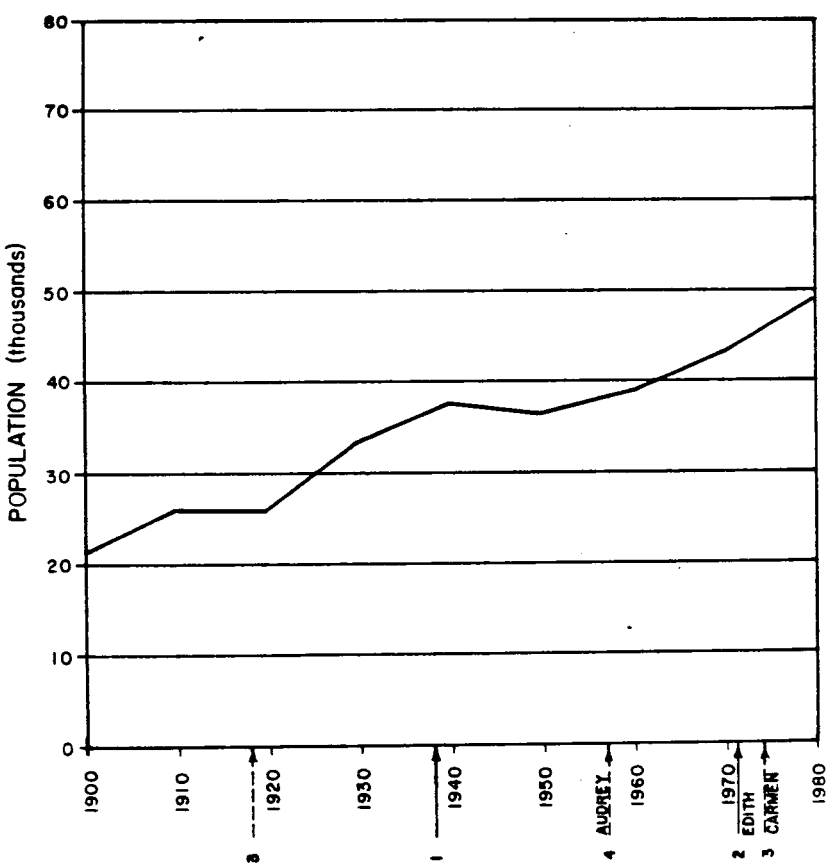


END OF TEXAS COUNTIES

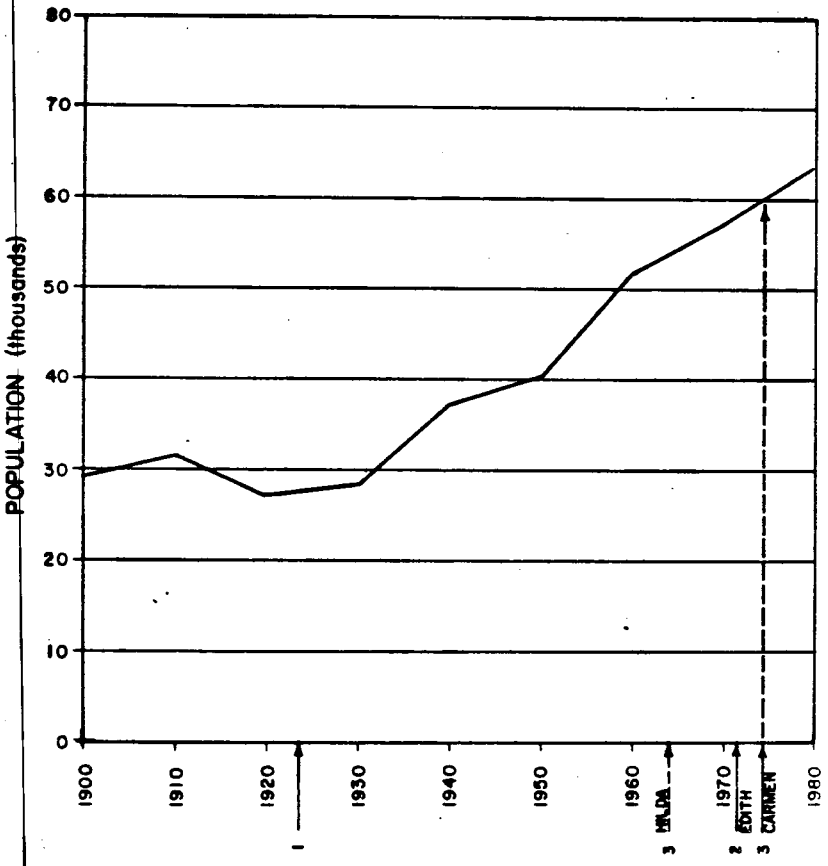
CAMERON PARISH, LA.



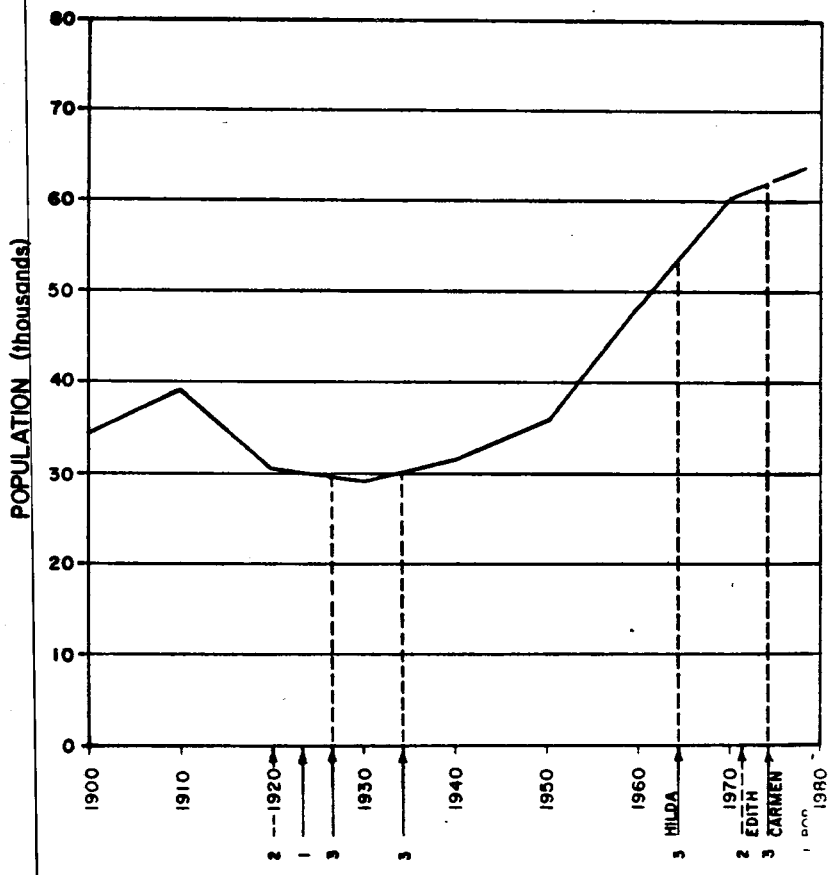
VERMILION PARISH, LA.



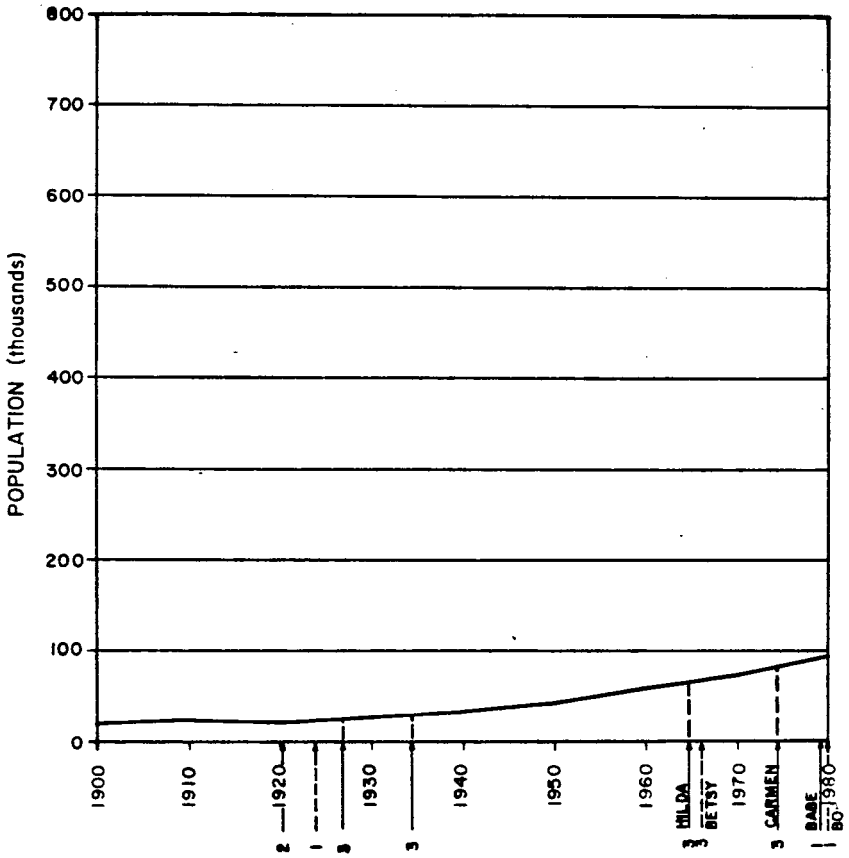
IBERIA PARISH, LA.



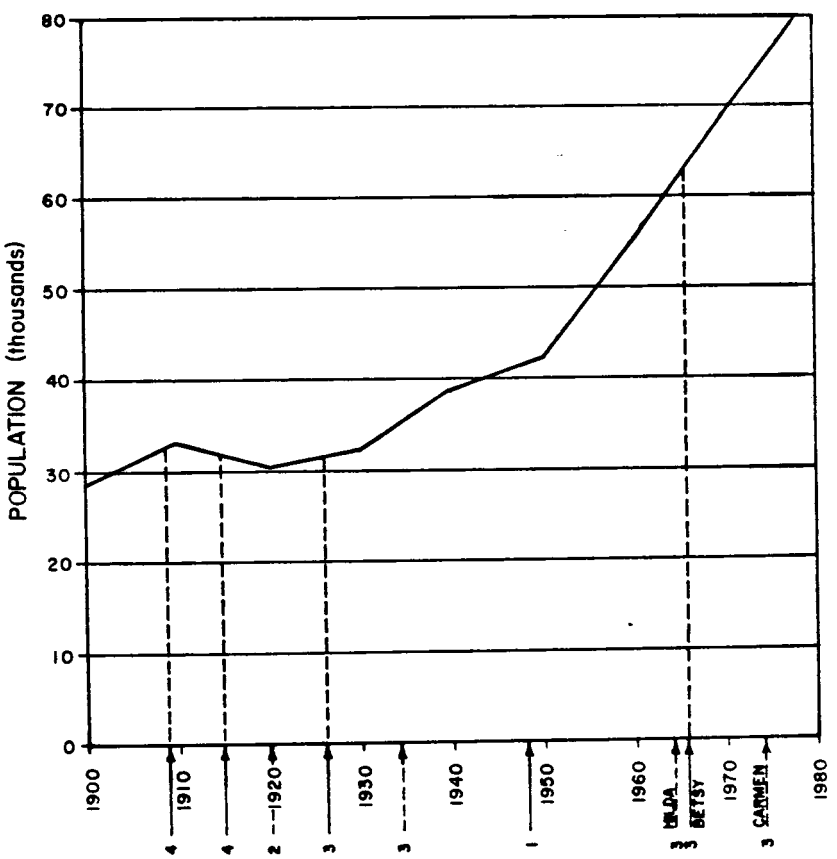
ST. MARY PARISH, LA.

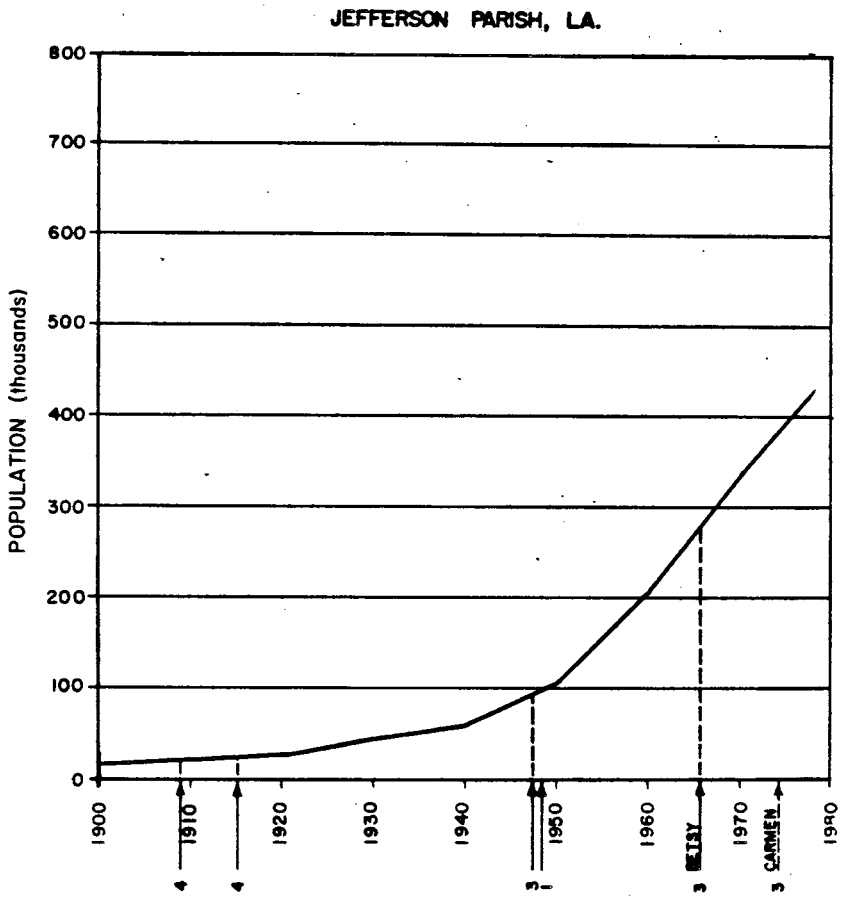


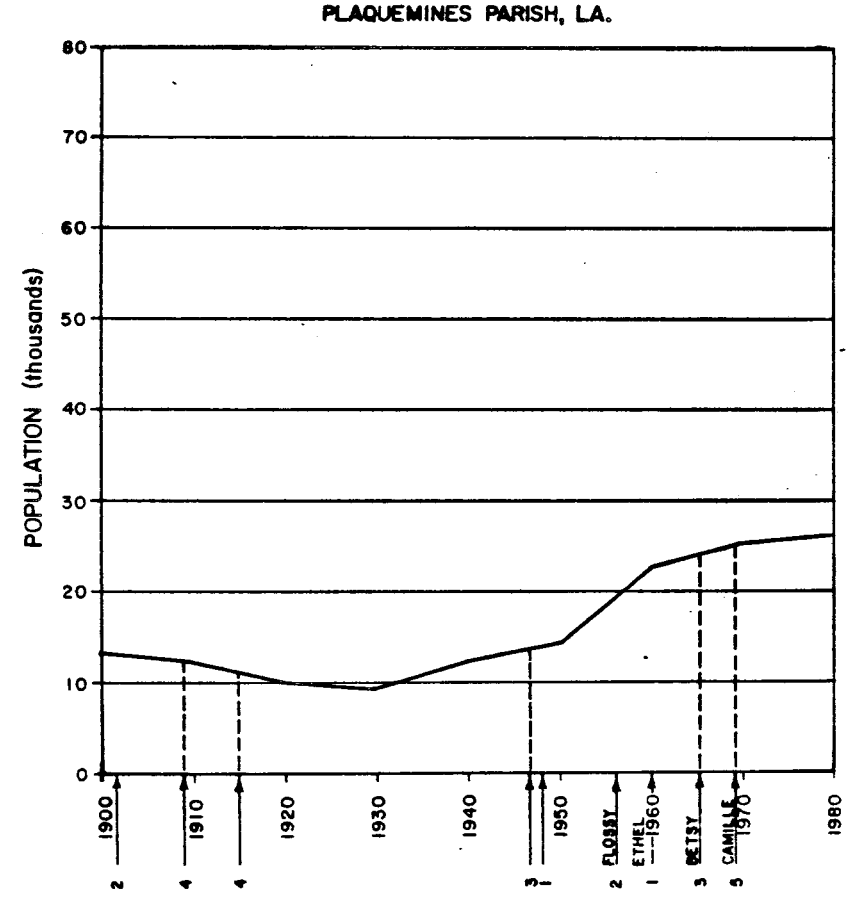
TERREBONNE PARISH, LA



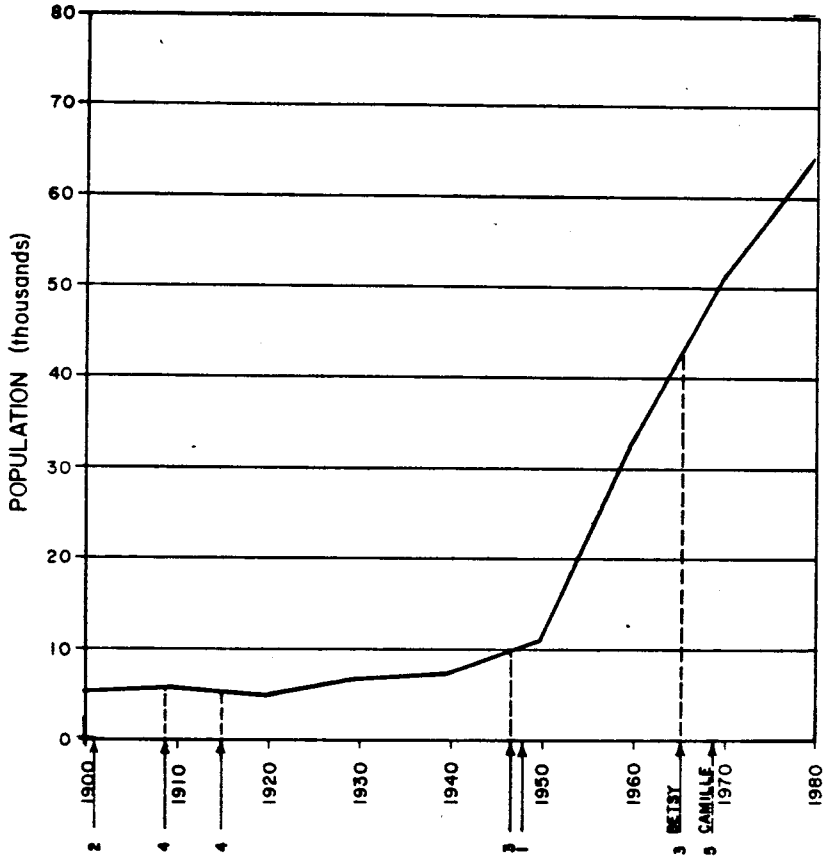
LAFOURCHE PARISH, LA.



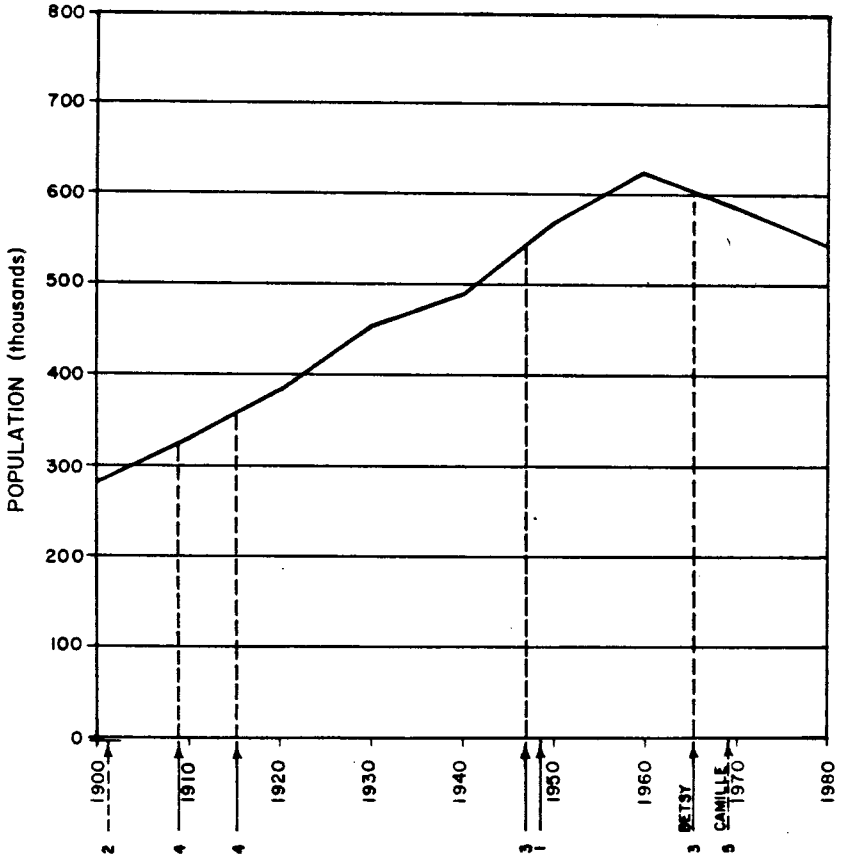

JEFFERSON PARISH, LA.
POPULATION (thousands)
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
4
4
3
3
BETSY
3
CARMEN

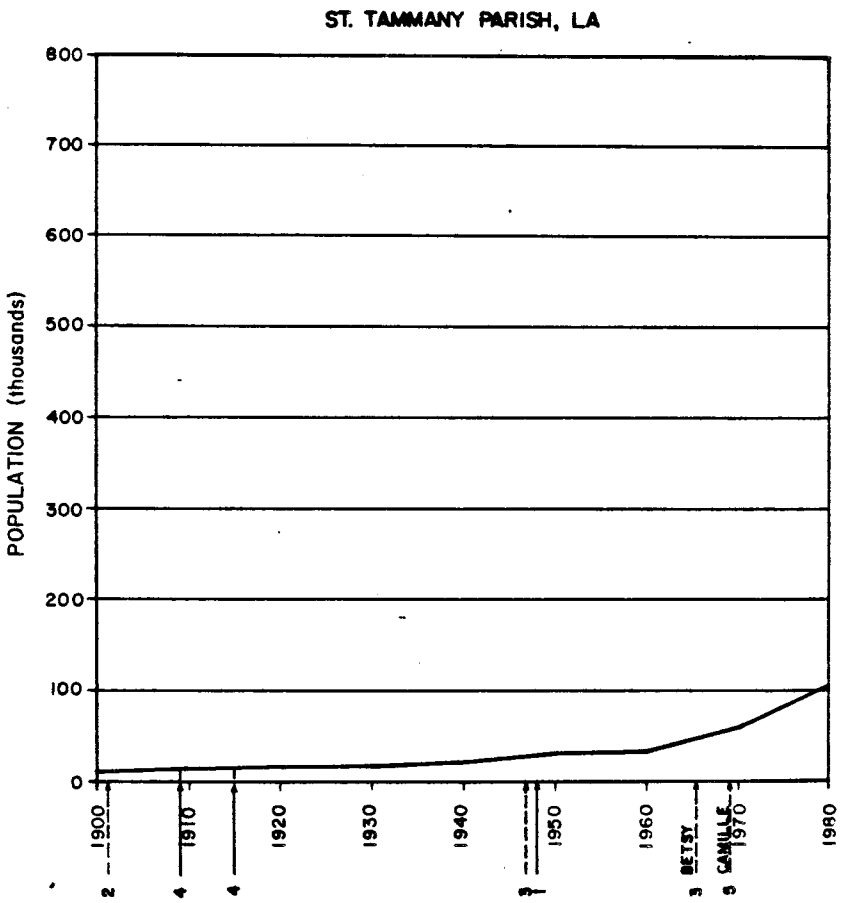

PLAQUEMINES PARISH, LA.
POPULATION (thousands)
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
2
4
4
3
2
FLOSSY
1
ETHEL
3
BETSY
5
CAMILLE

ST. BERNARD PARISH, LA.



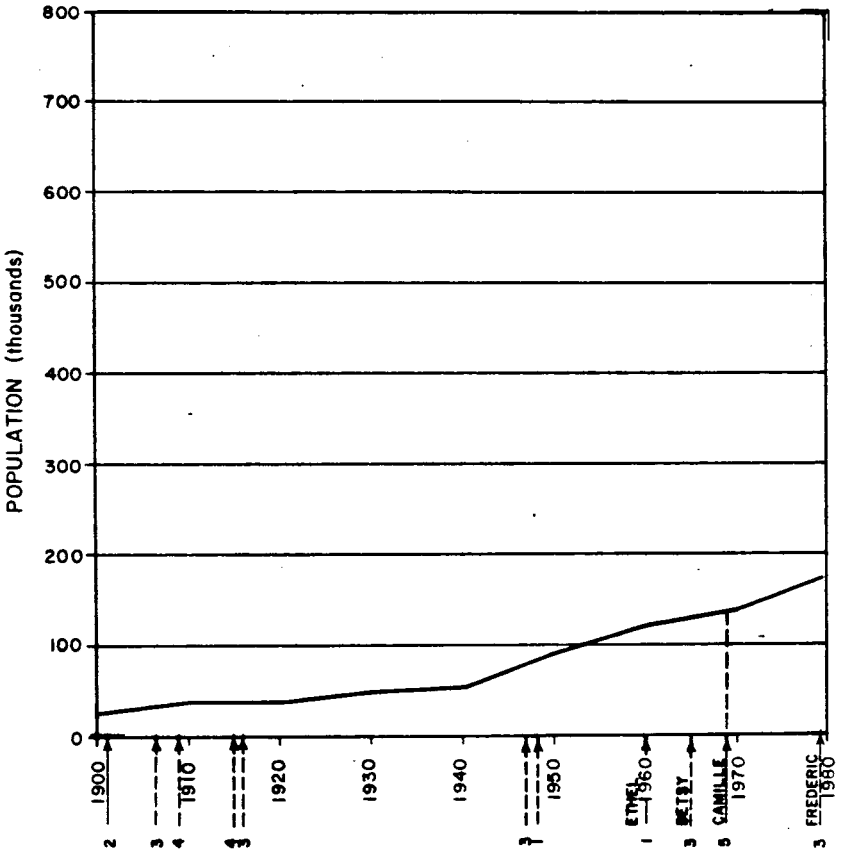
ORLEANS PARISH, LA.



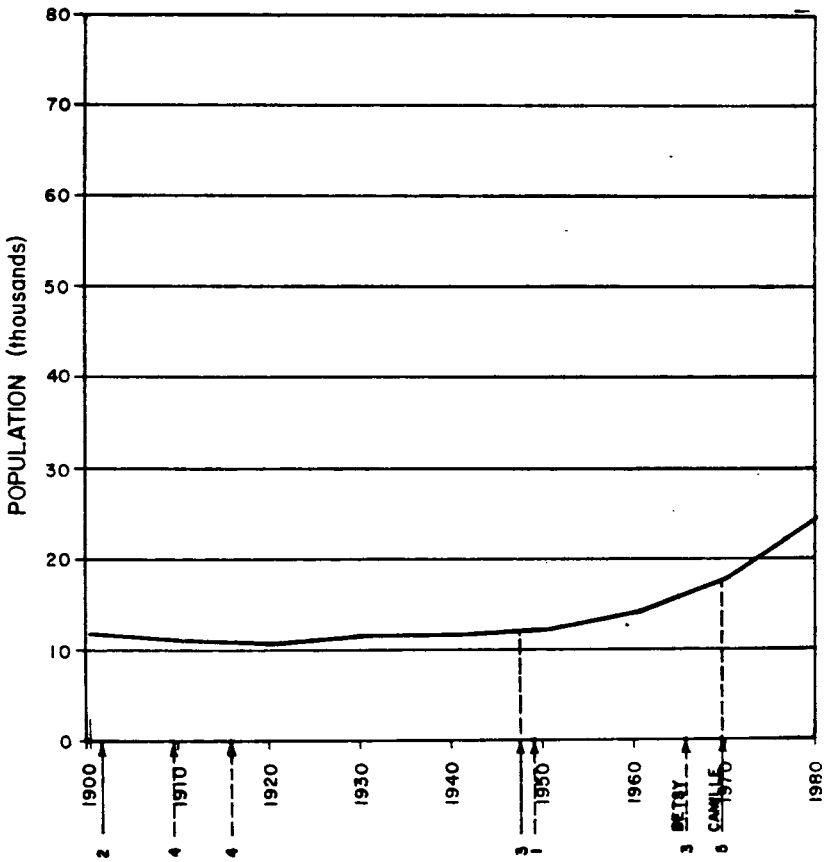


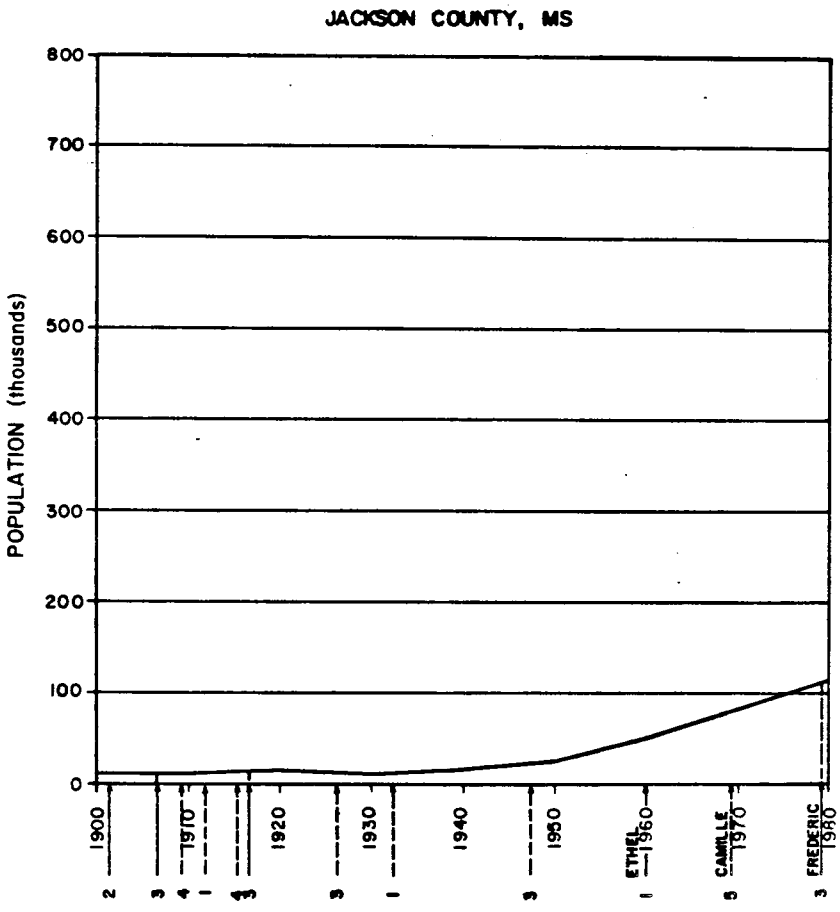
END OF LOUISIANA PARISHES.

HARRISON COUNTY, MS



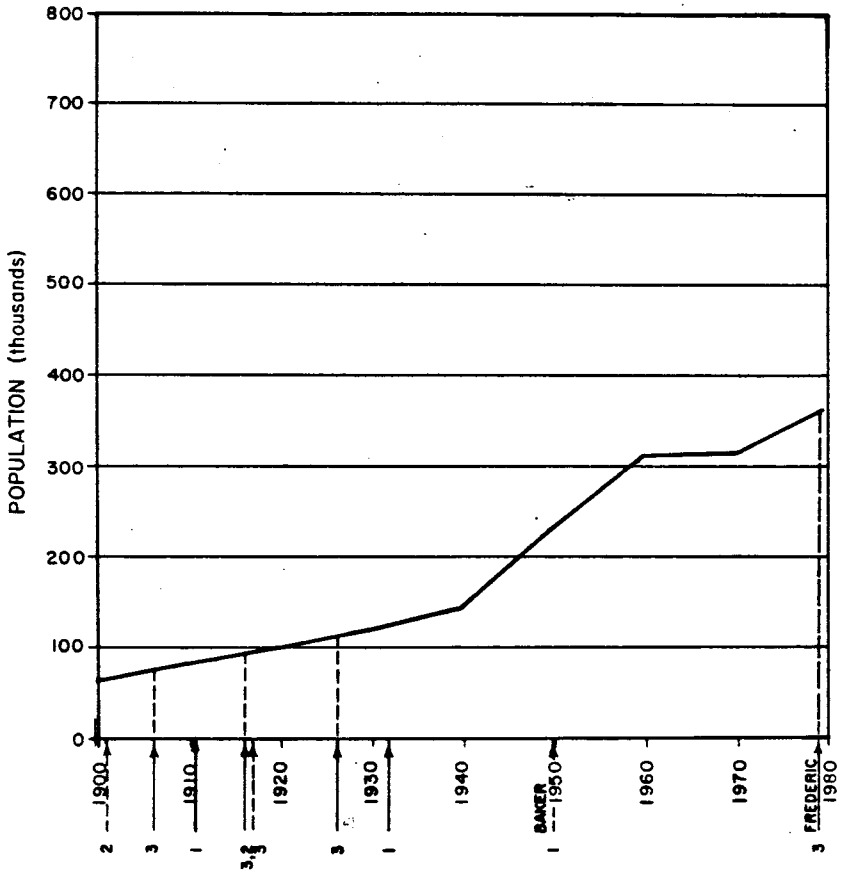
HANCOCK COUNTY, MS



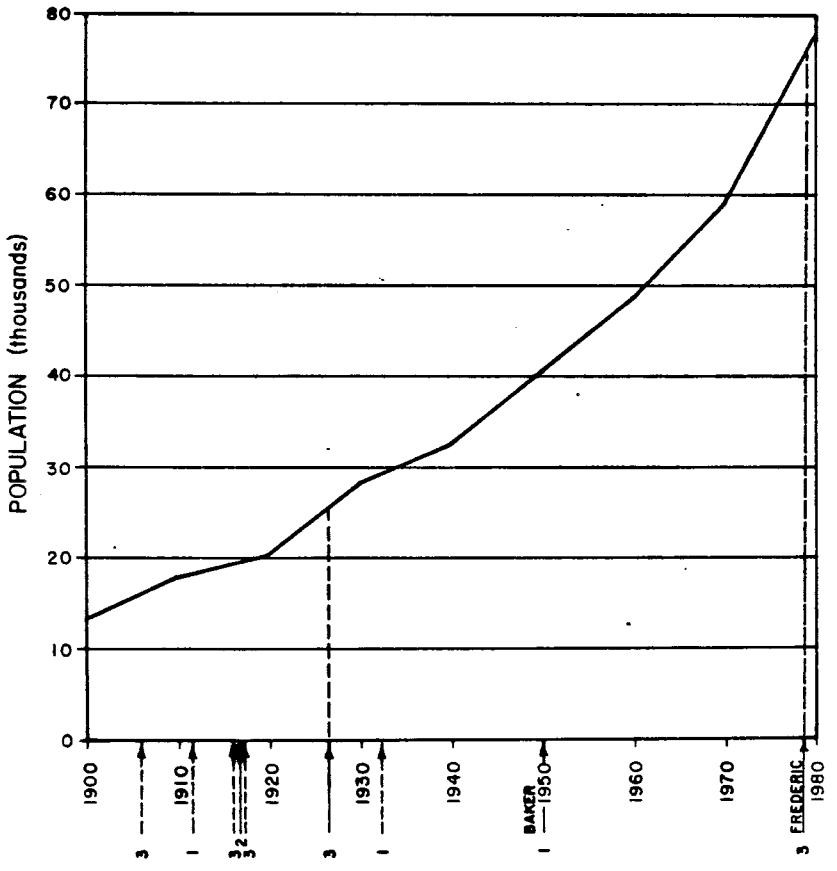


END OF MISSISSIPPI COUNTIES

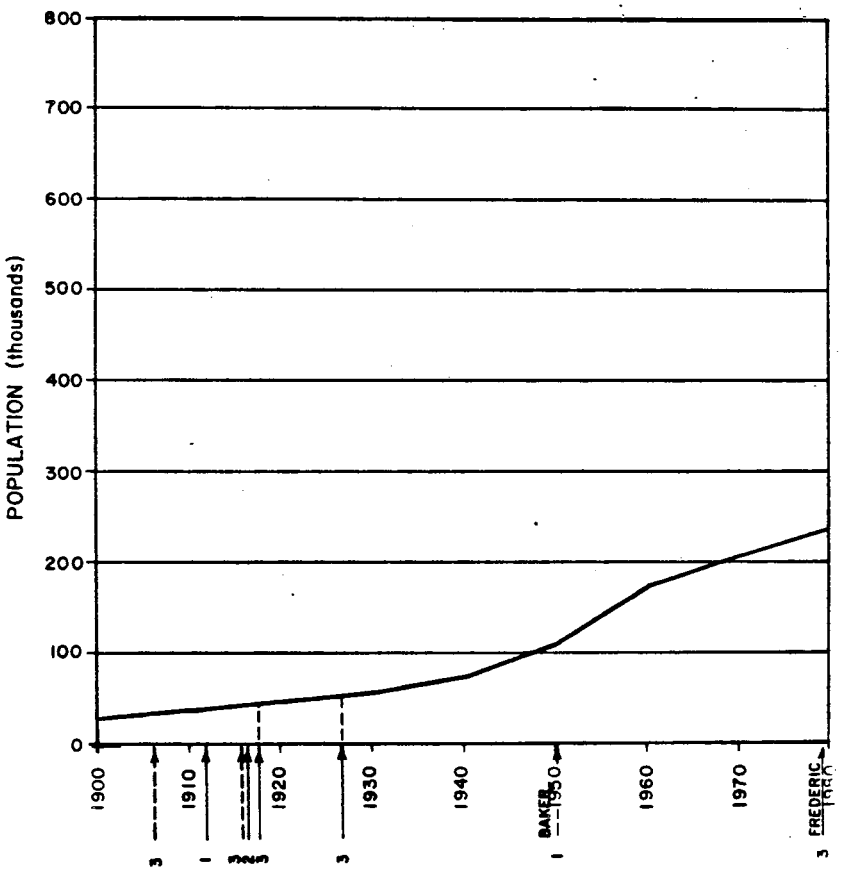
MOBILE COUNTY, AL



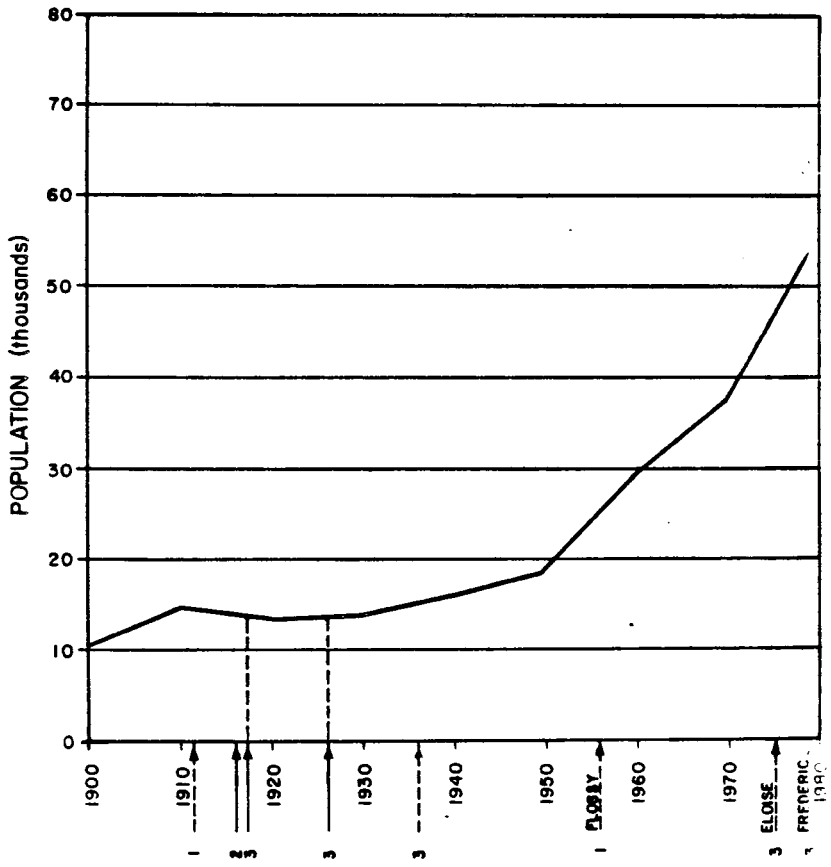
BALDWIN COUNTY, AL

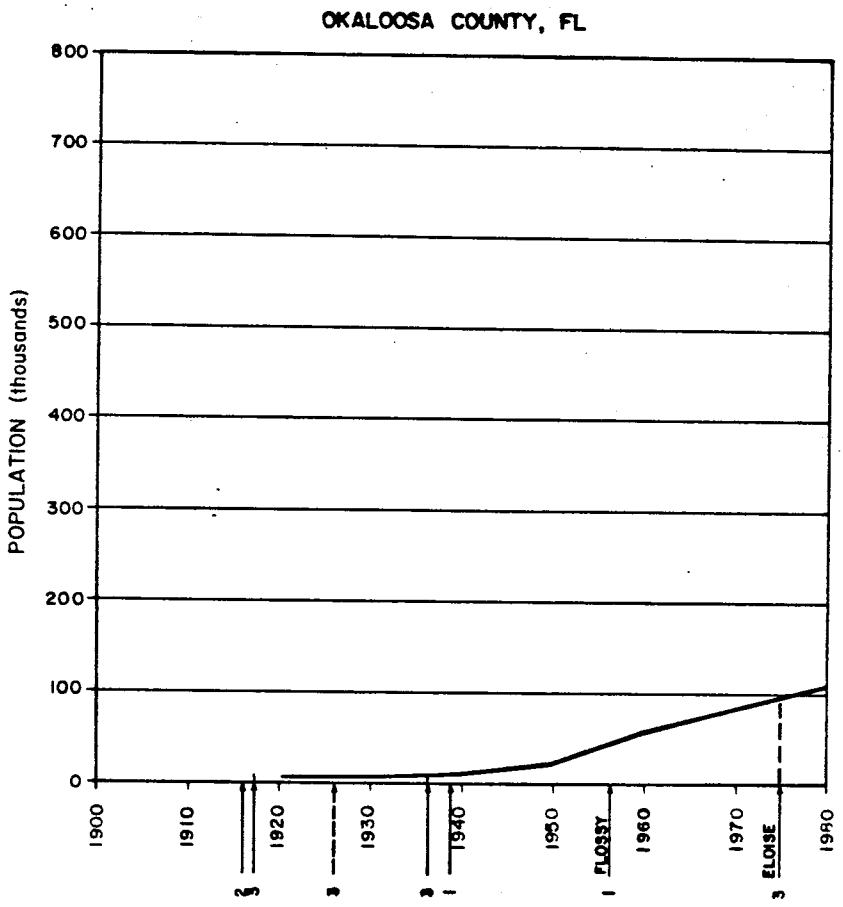


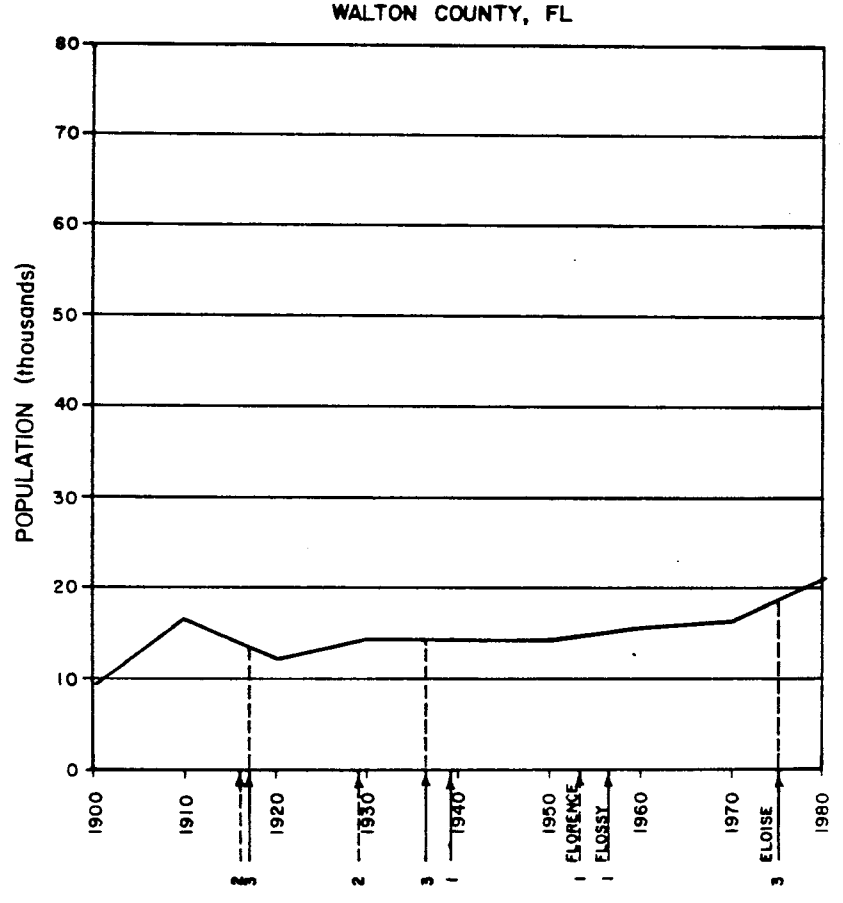
ESCAMBIA COUNTY, FL



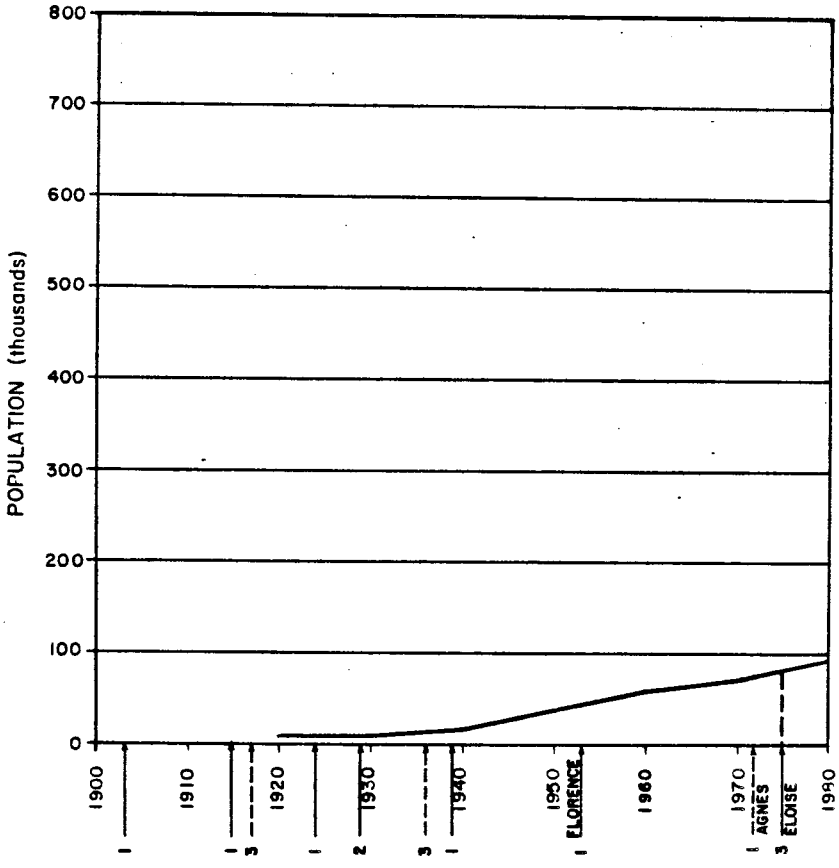
SANTA ROSA COUNTY, FL



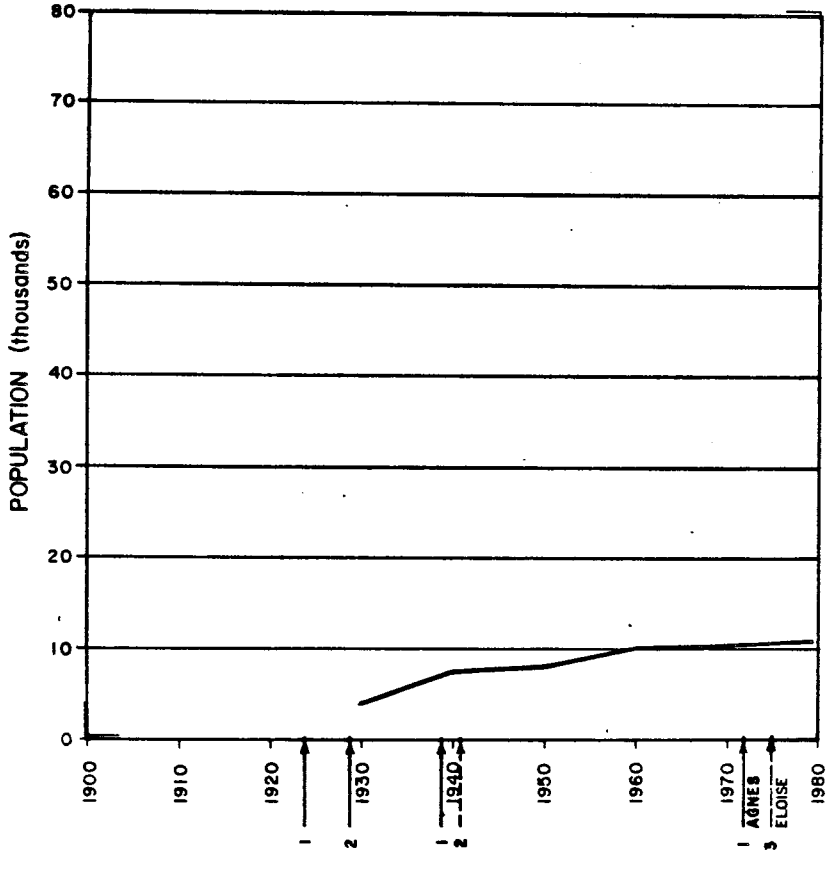

OKALOOSA COUNTY, FL
POPULATION (thousands)
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
FLOSSY
ELOISE


WALTON COUNTY, FL
POPULATION (thousands)
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
FLORENCE
FLOSSY
ELOISE

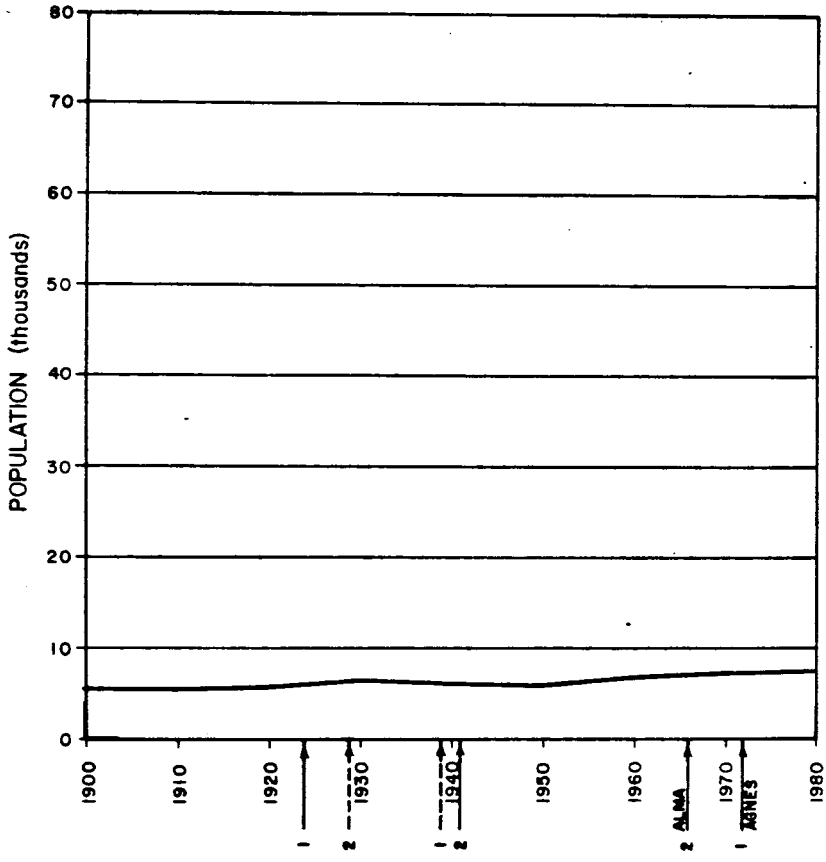
BAY COUNTY, FL



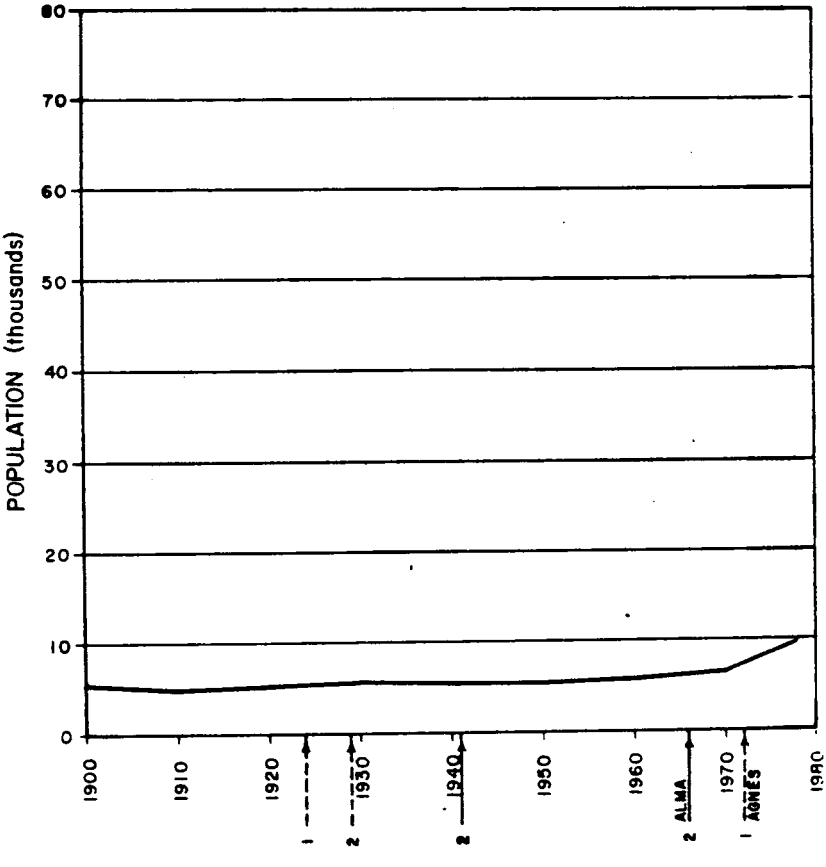
GULF COUNTY, FL

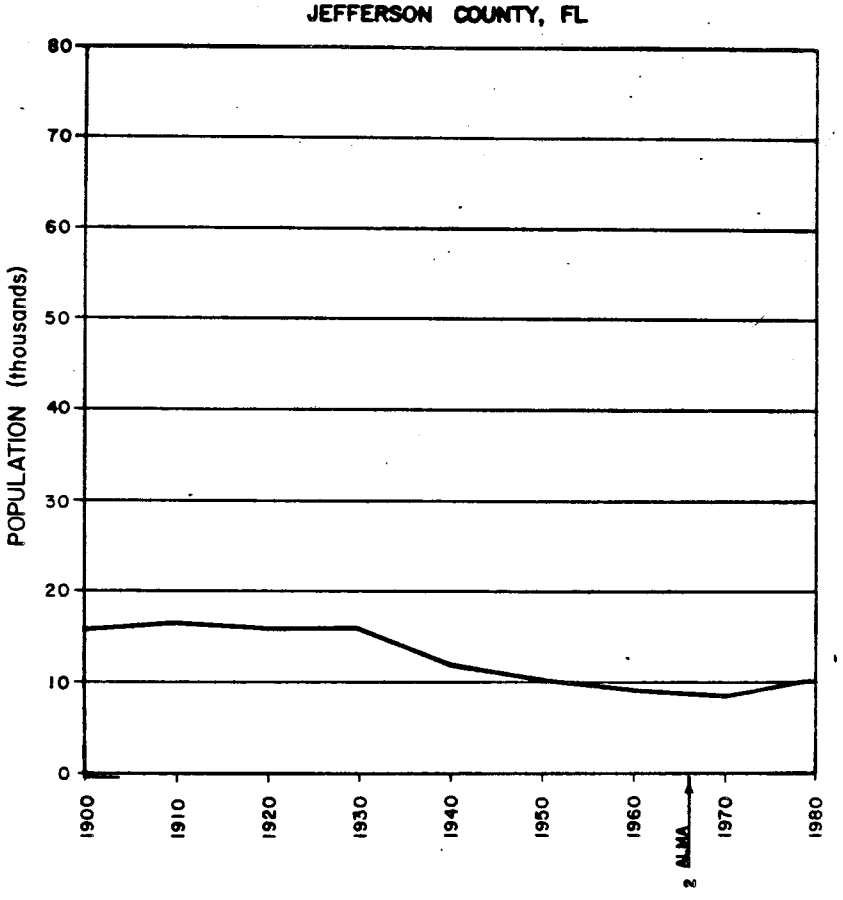


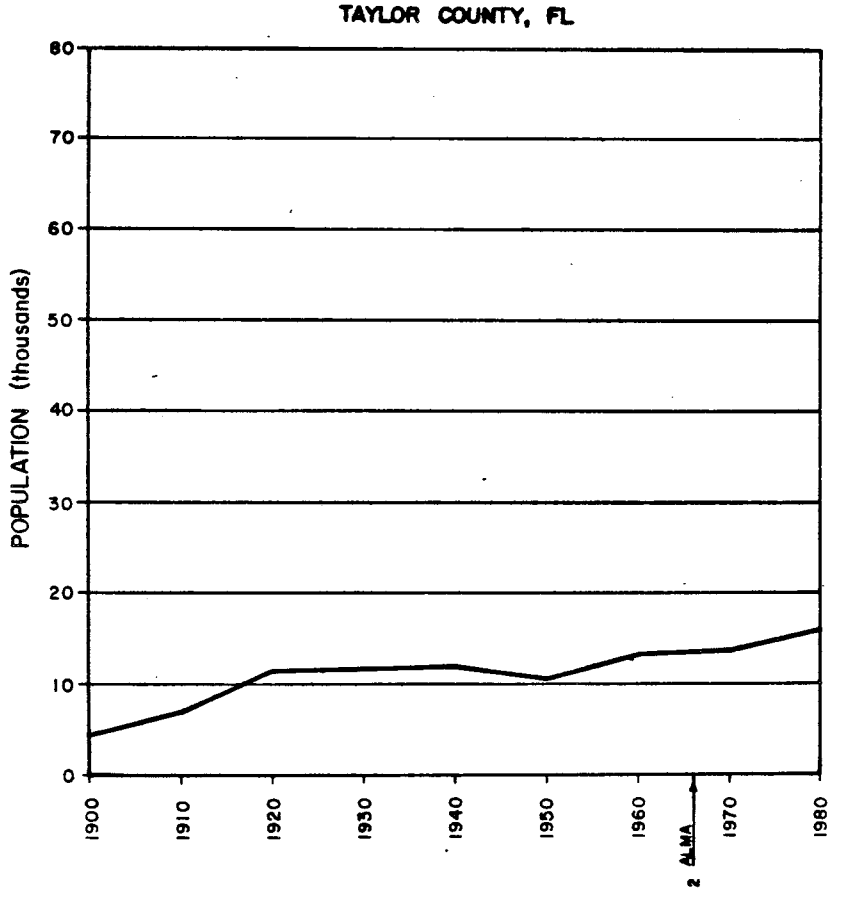
FRANKLIN COUNTY, FL



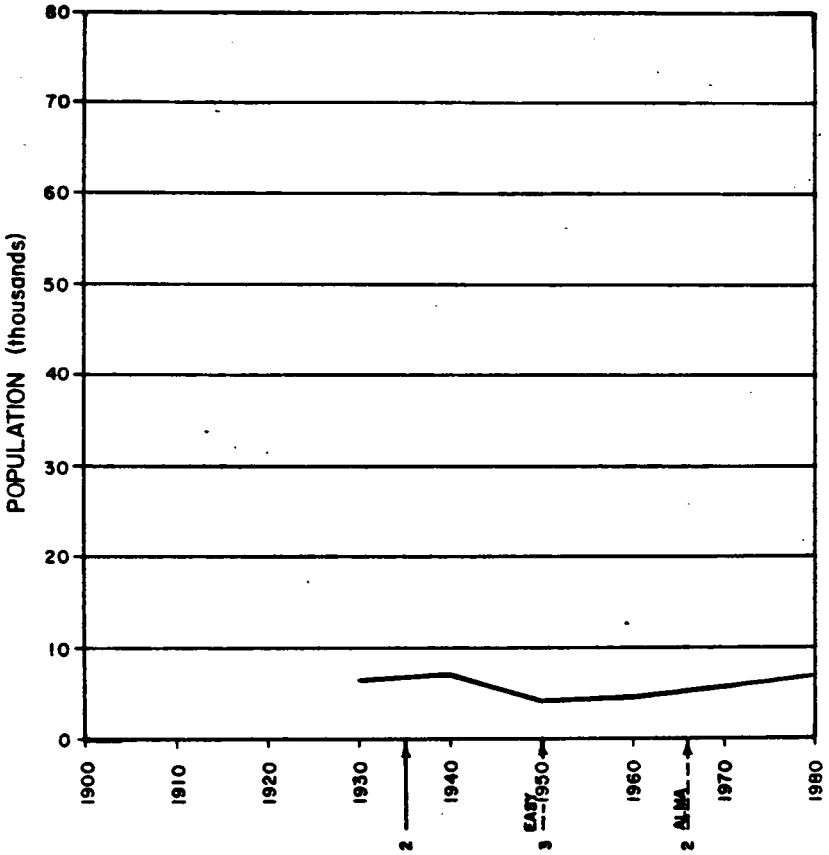
WAKULLA COUNTY, FL



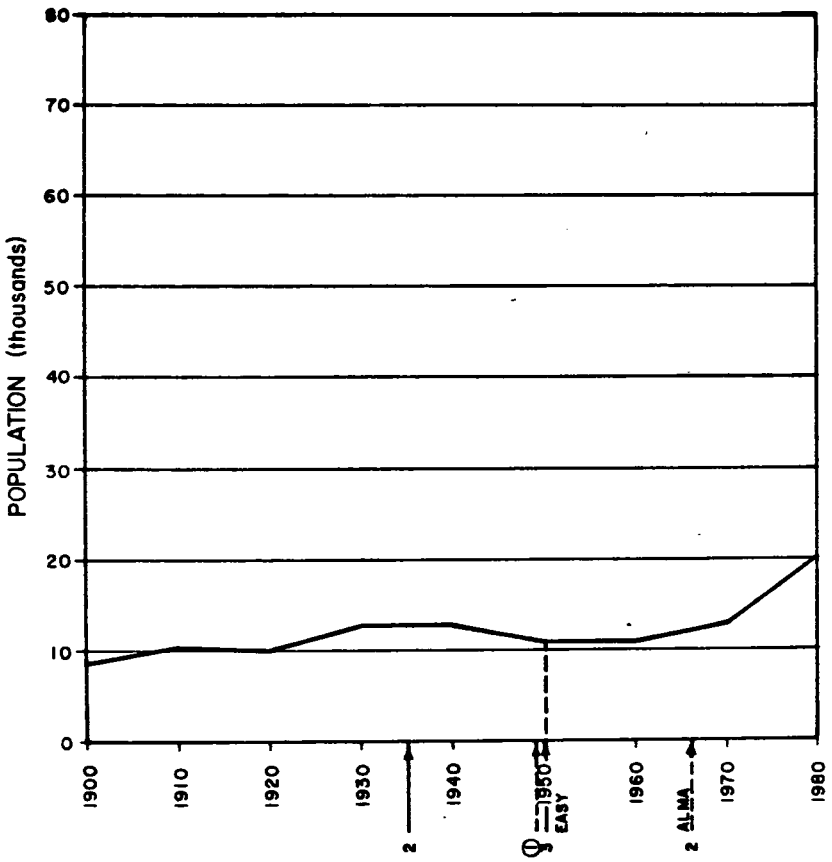

JEFFERSON COUNTY, FL
POPULATION (thousands)
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
2 ALMA


TAYLOR COUNTY, FL
POPULATION (thousands)
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
2 ALMA

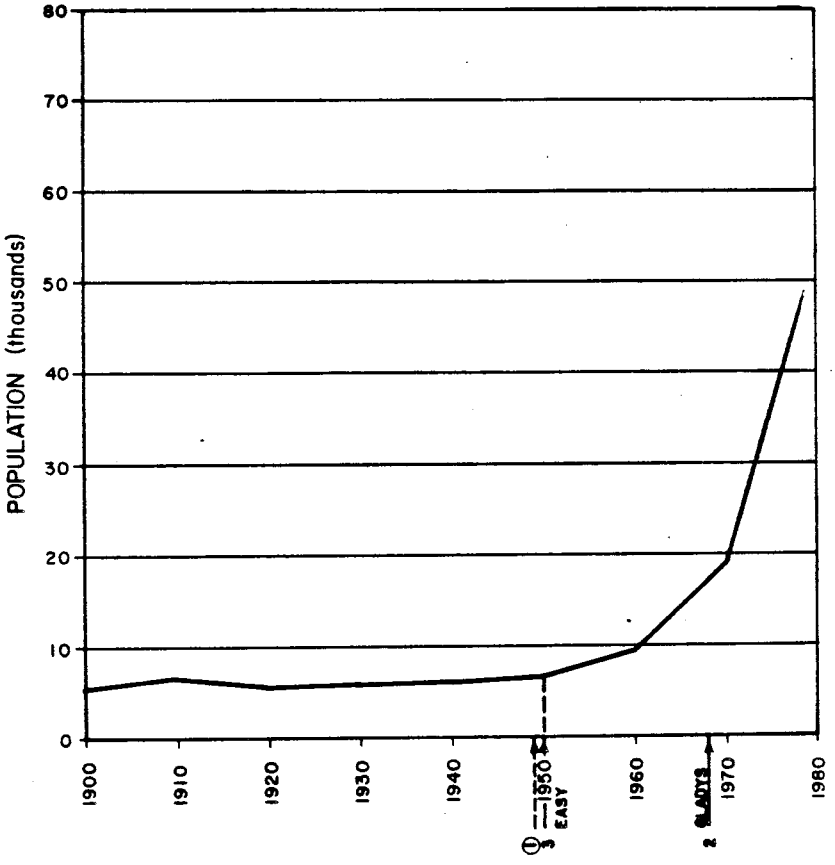
DIXIE COUNTY, FL



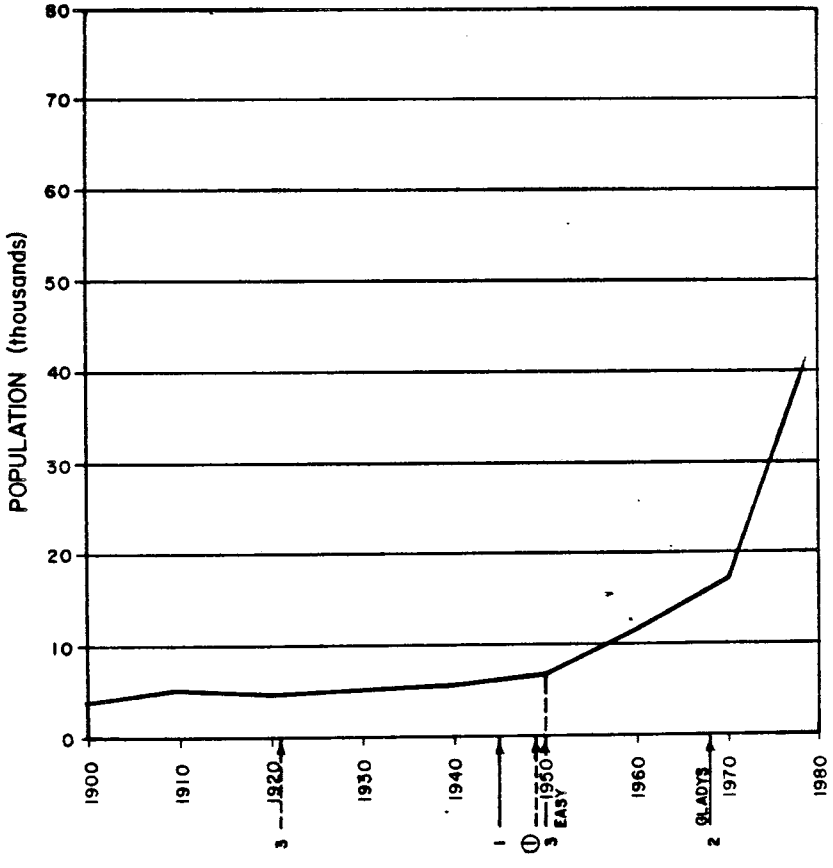
LEVY COUNTY, FL



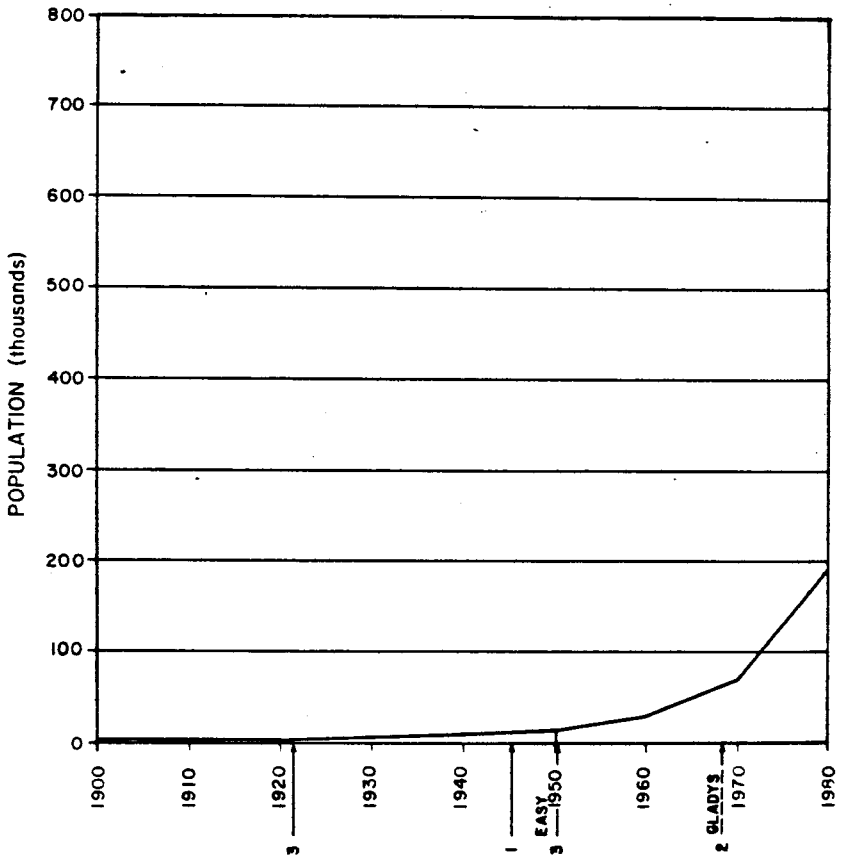
CITRUS COUNTY, FL



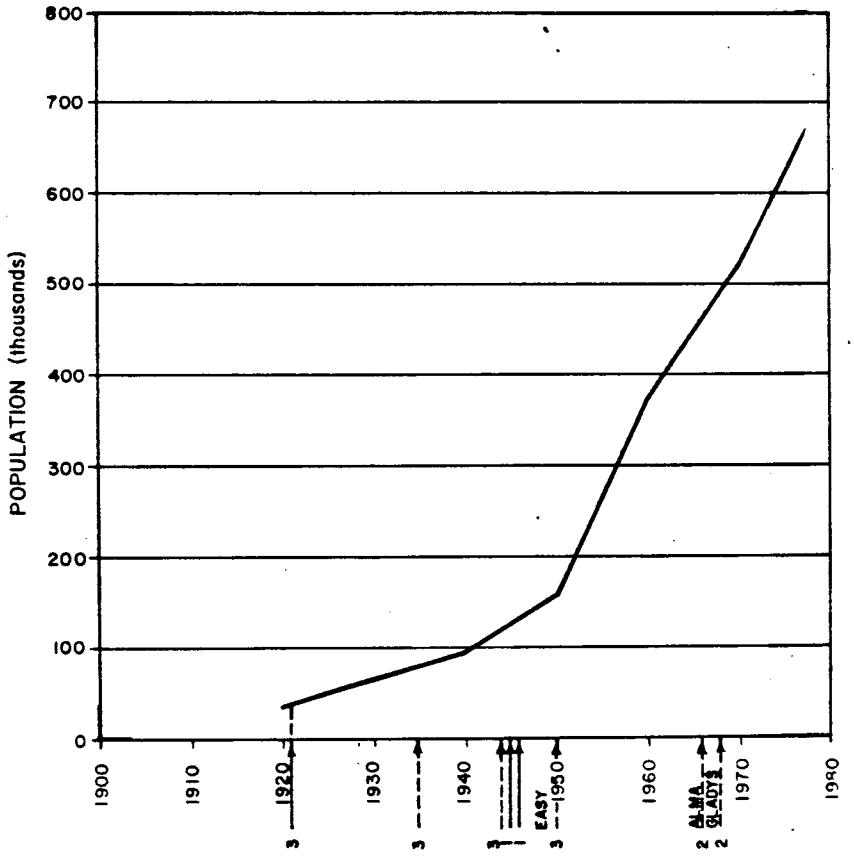
HERNANDO COUNTY, FL

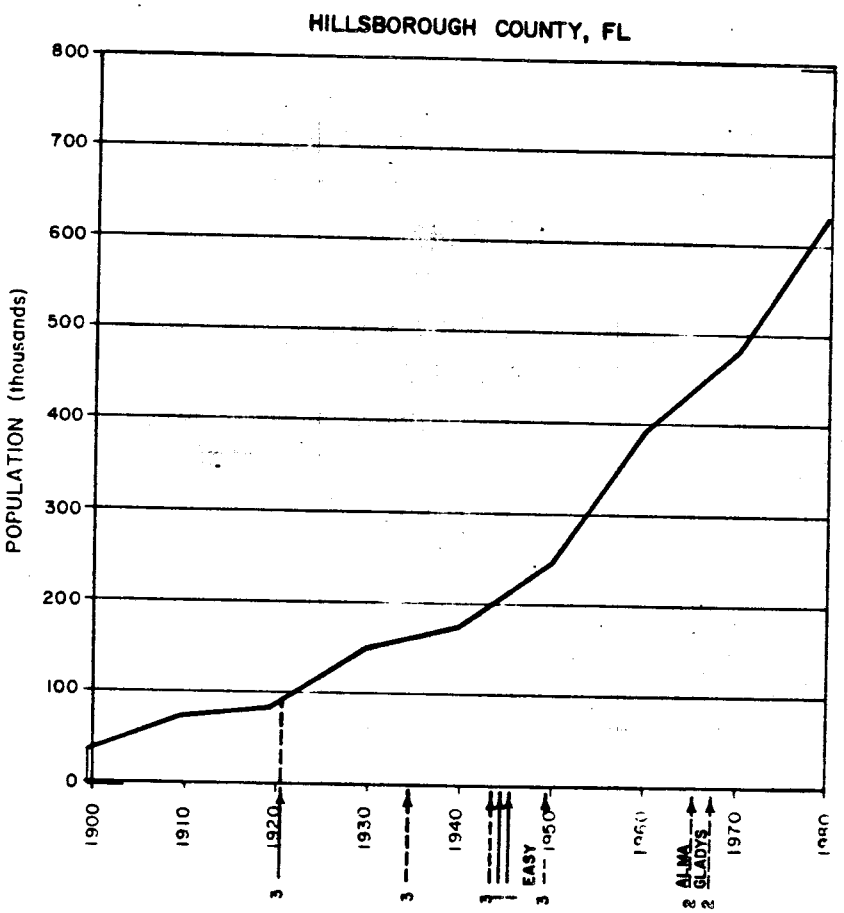


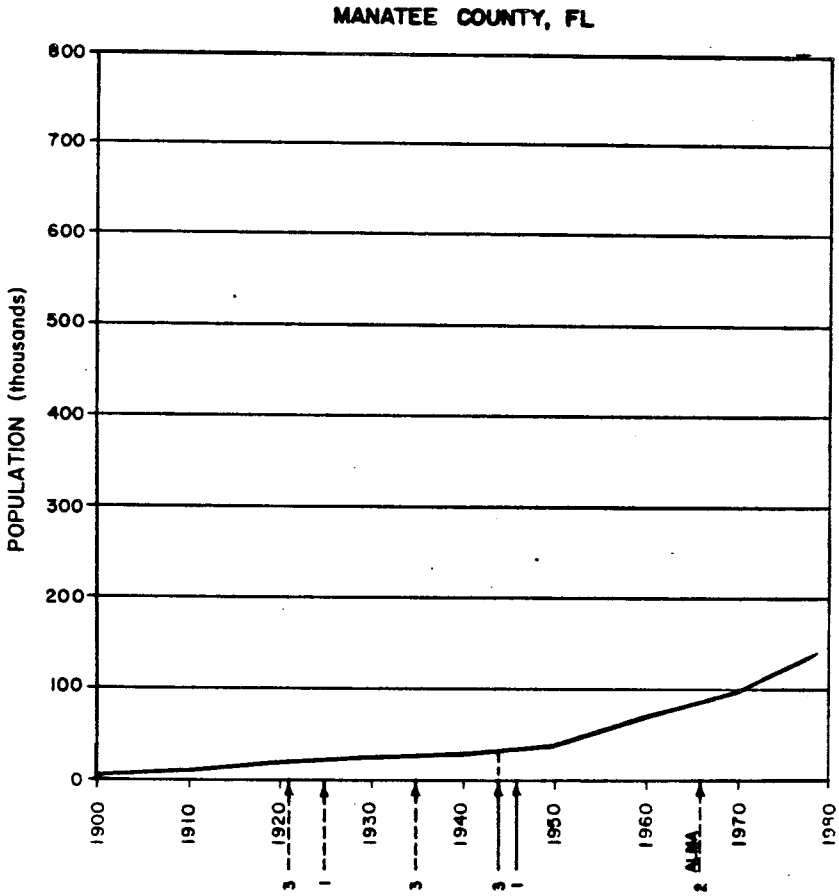
PASCO COUNTY, FL



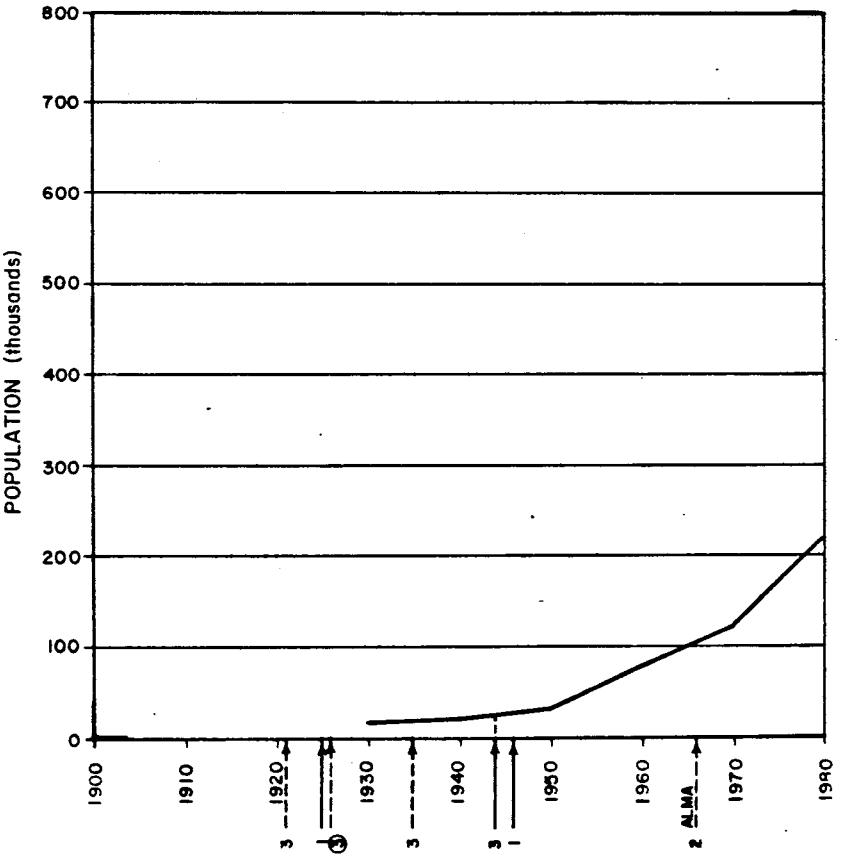
PINELLAS COUNTY, FL



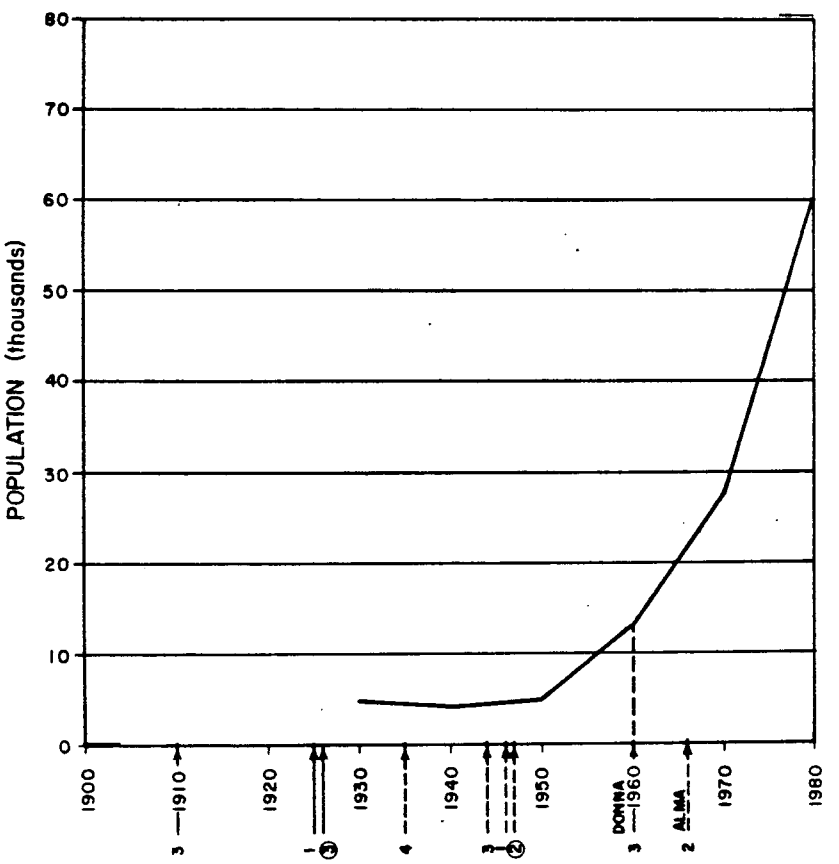

HILLSBOROUGH COUNTY, FL
POPULATION (thousands)
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
3
3
3
3
EASY
2 ALMA
2 GLADYS

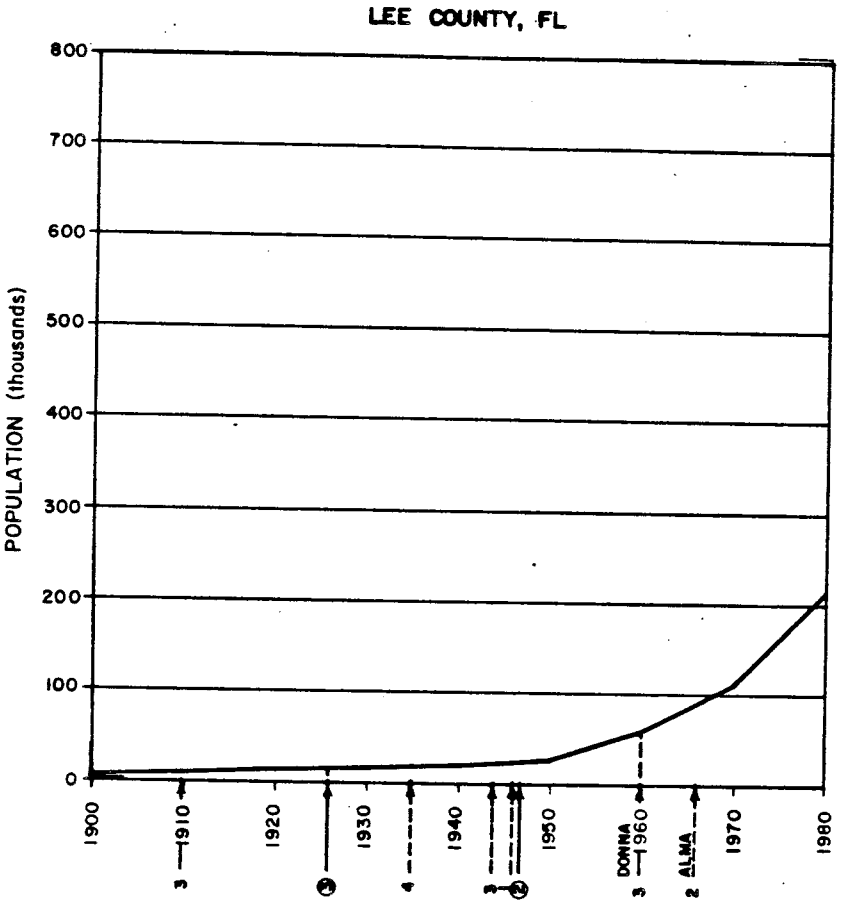

MANATEE COUNTY, FL
POPULATION (thousands)
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1990
3
1
3
3
1
2 ALMA

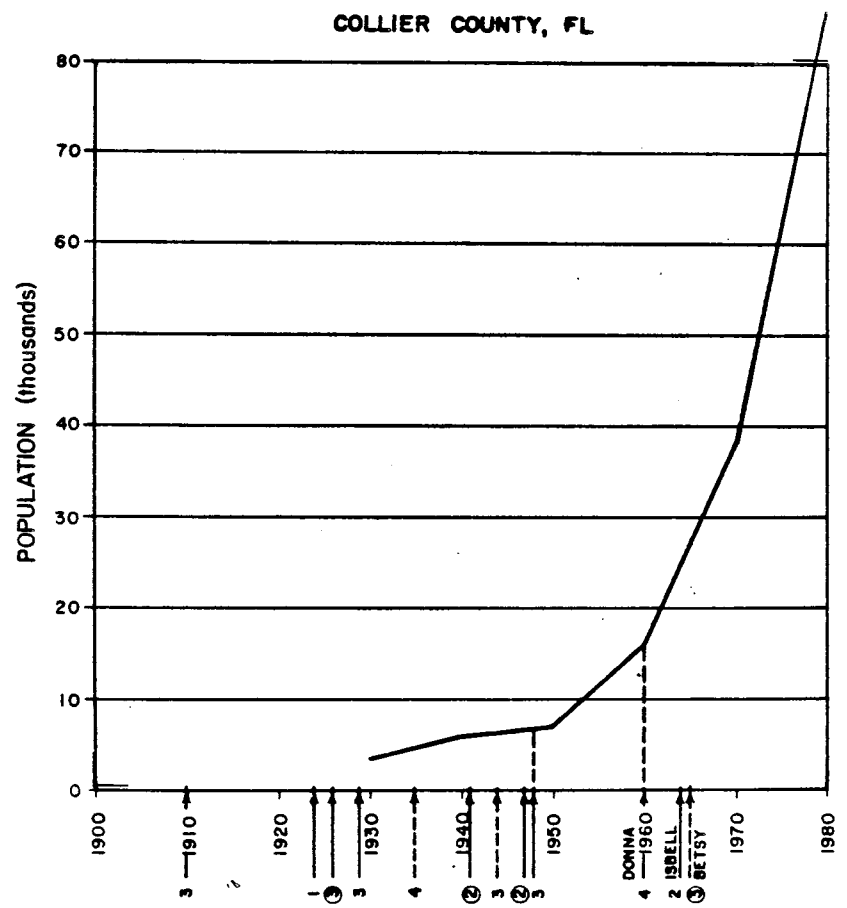
SARASOTA COUNTY, FL



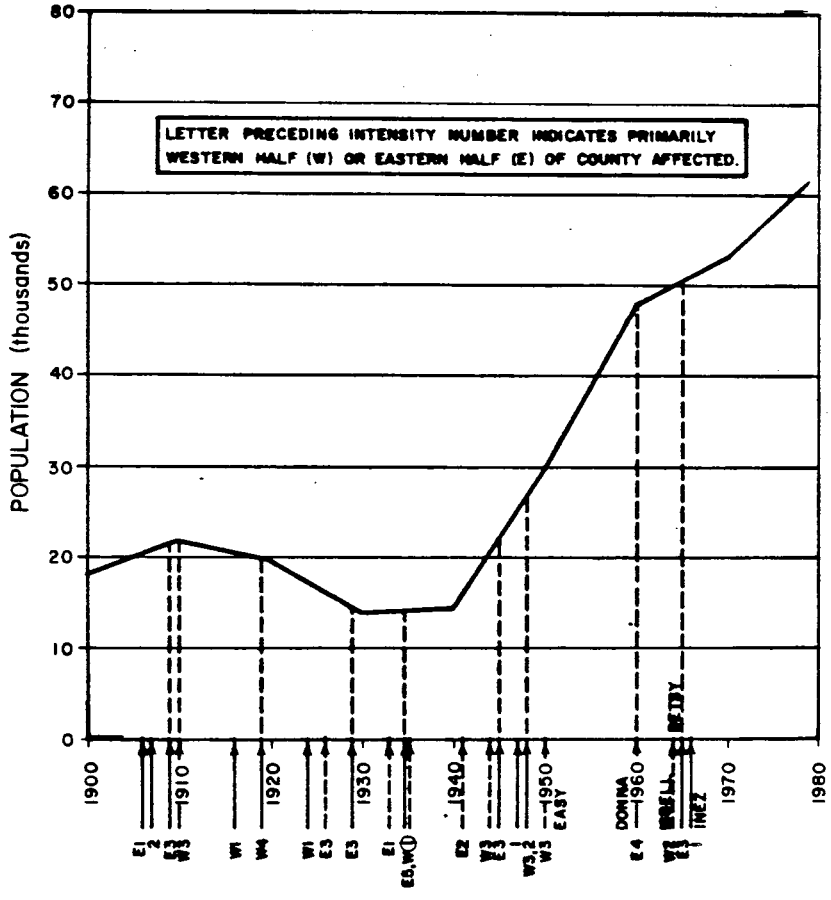
CHARLOTTE COUNTY, FL



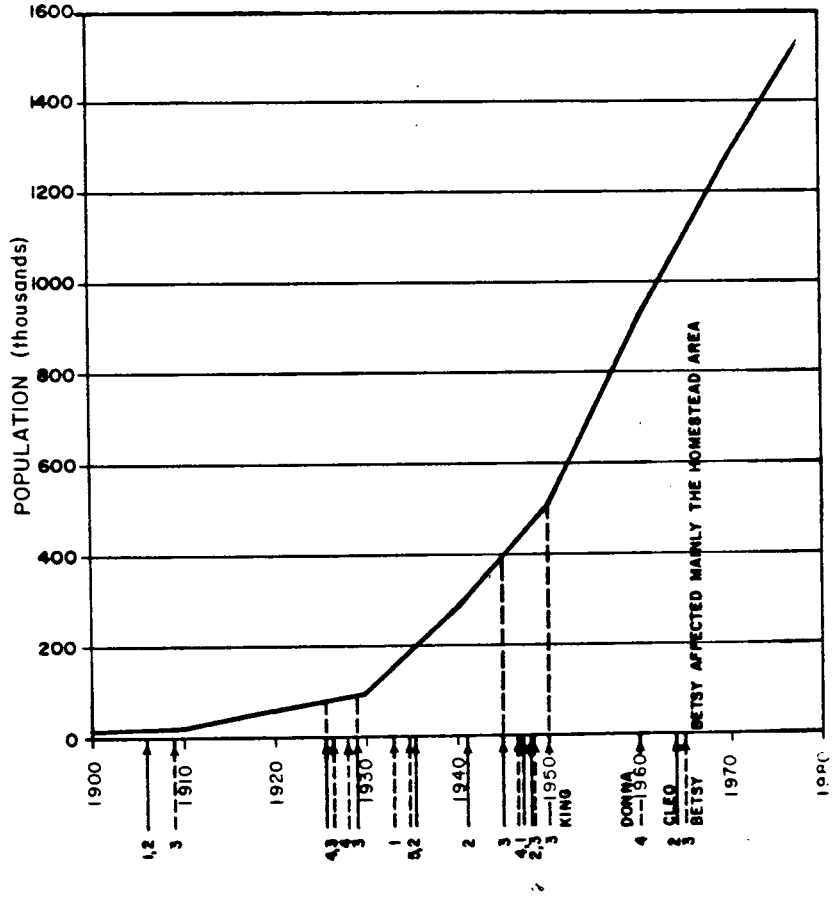

LEE COUNTY, FL
POPULATION (thousands)
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
DONNA
ALMA


COLLIER COUNTY, FL
POPULATION (thousands)
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
DONNA
ISBELL
BETSY

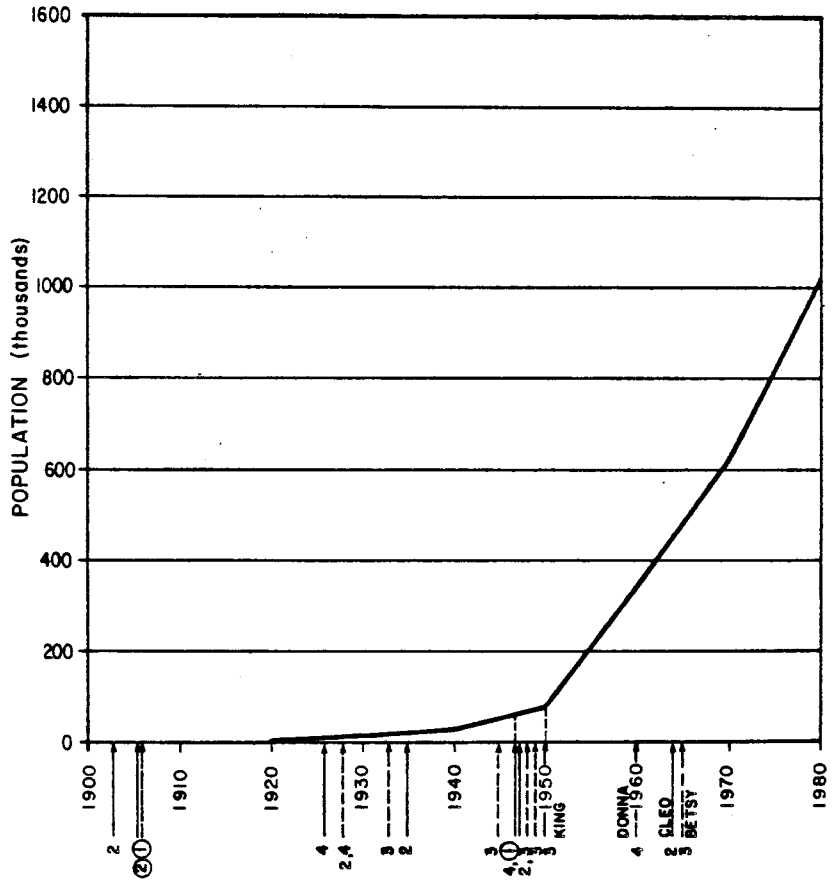
MONROE COUNTY, FL



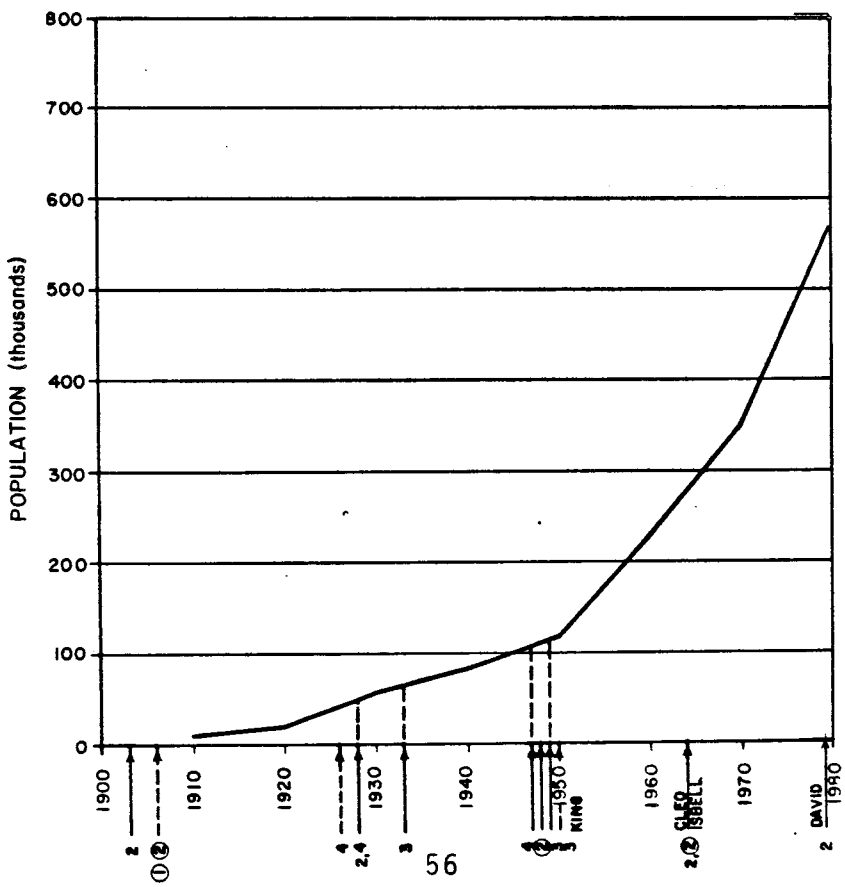
DADE COUNTY, FL



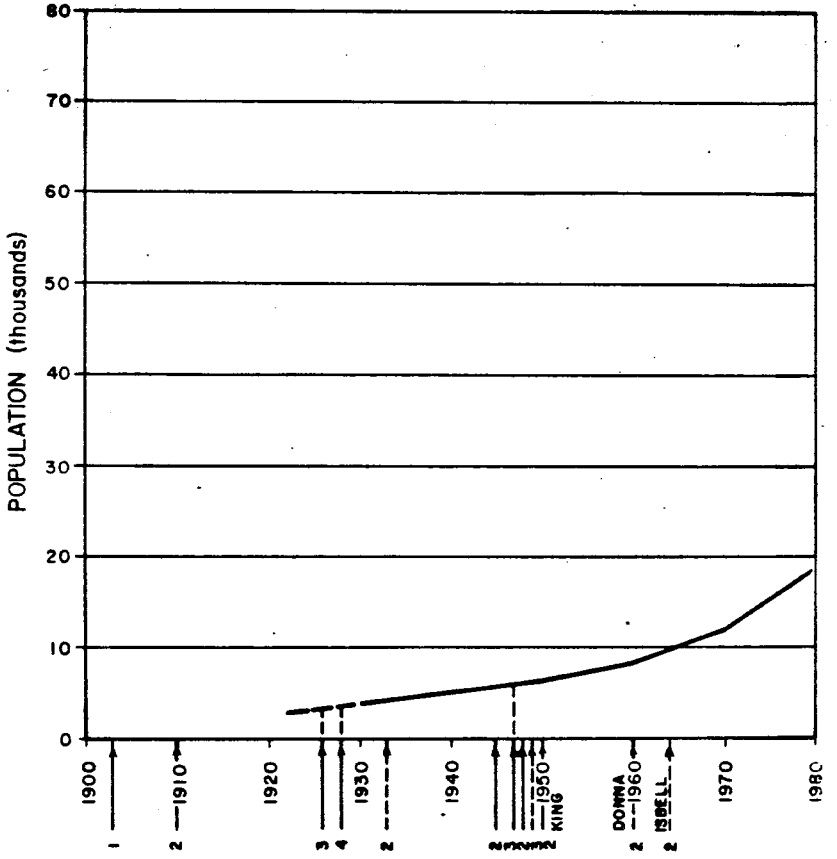
BROWARD COUNTY, FL



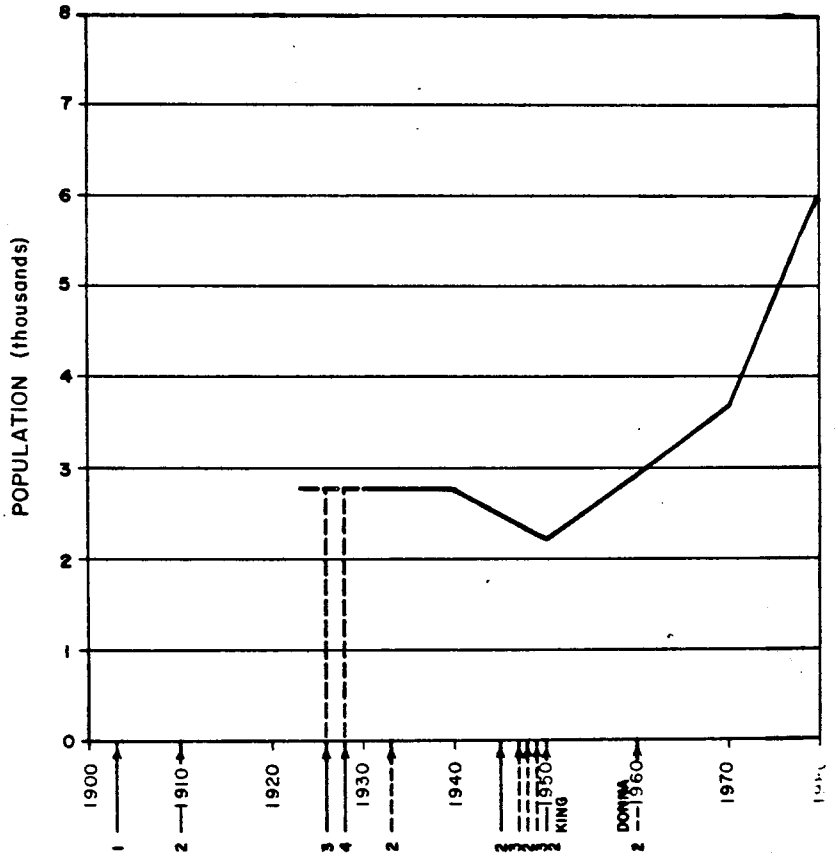
PALM BEACH COUNTY, FL



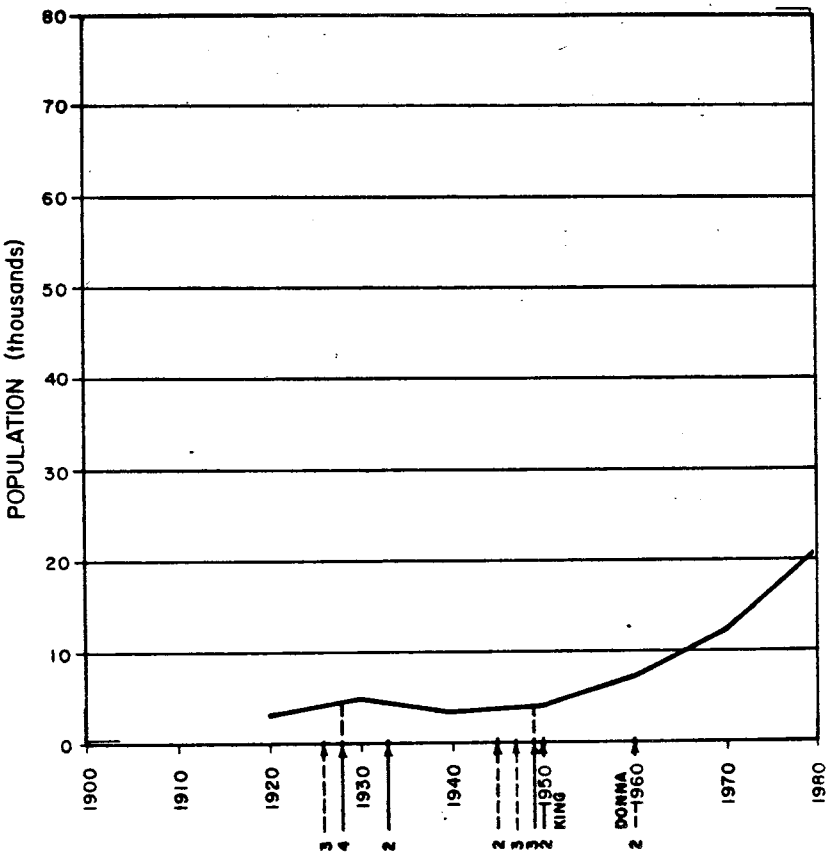
HENDRY COUNTY, FL



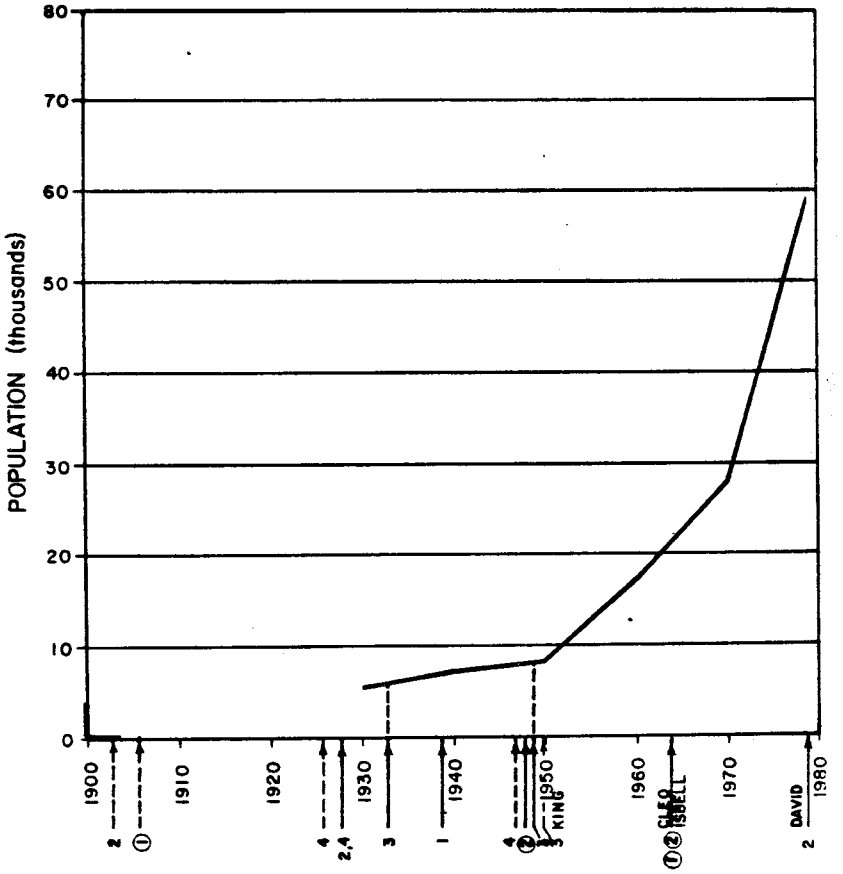
GLADES COUNTY, FL



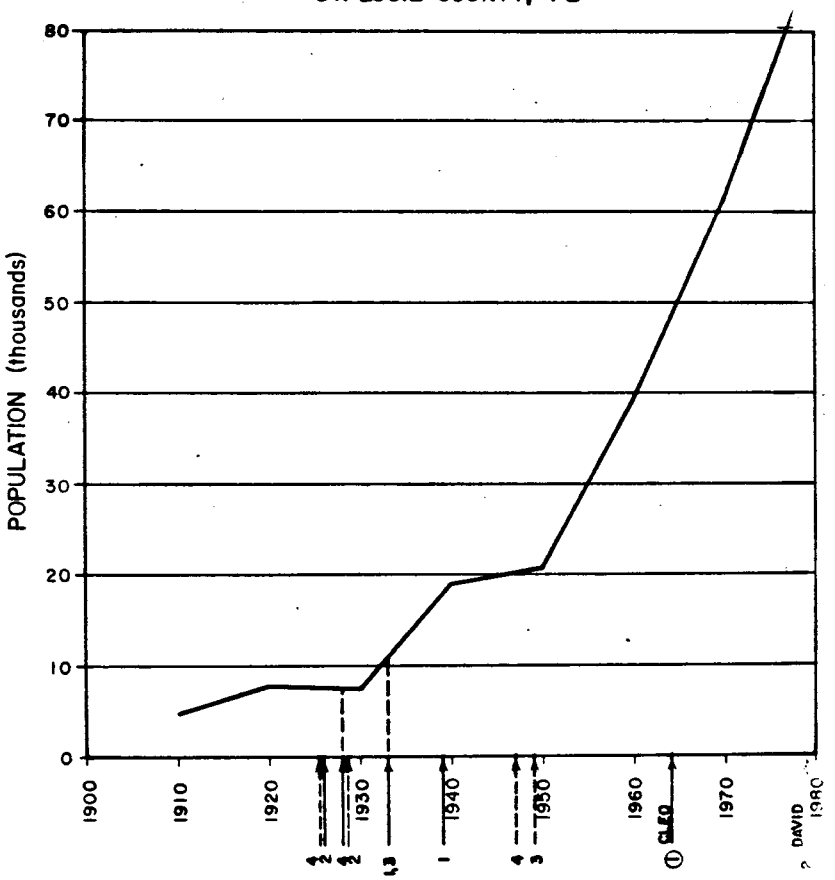
OKEECHOBEE COUNTY, FL



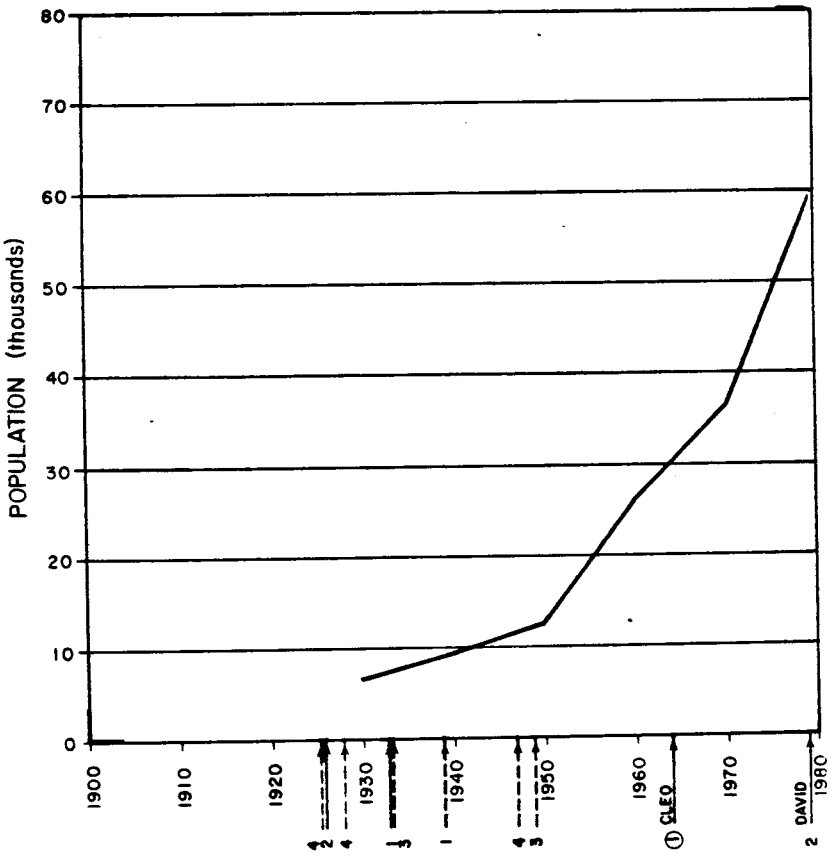
MARTIN COUNTY, FL



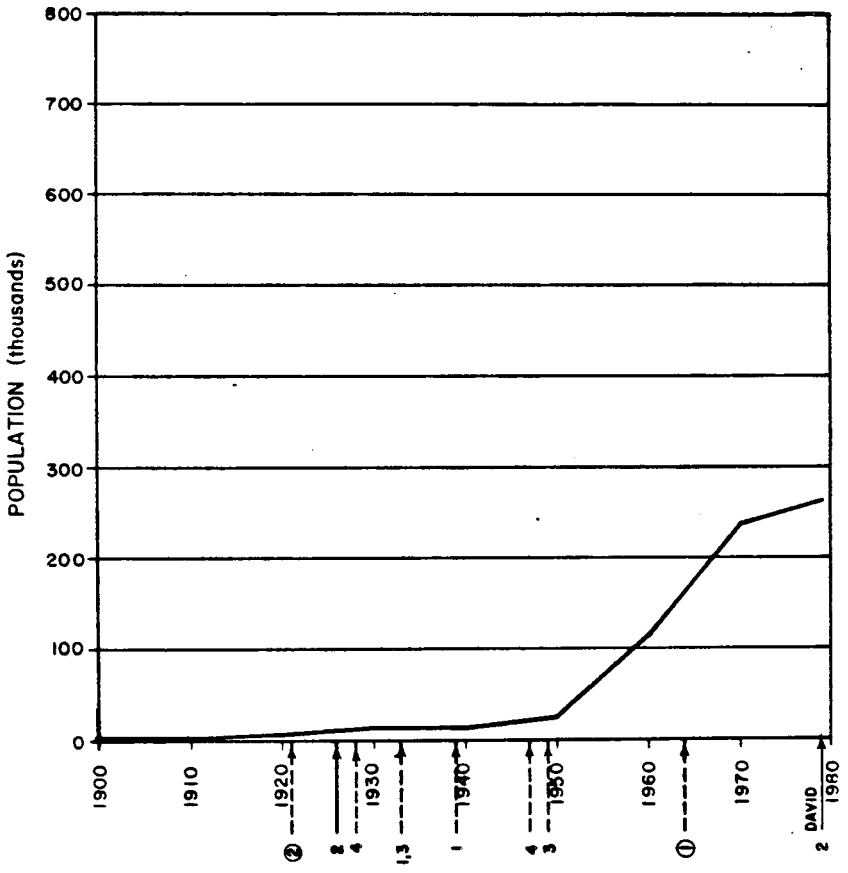
ST. LUCIE COUNTY, FL



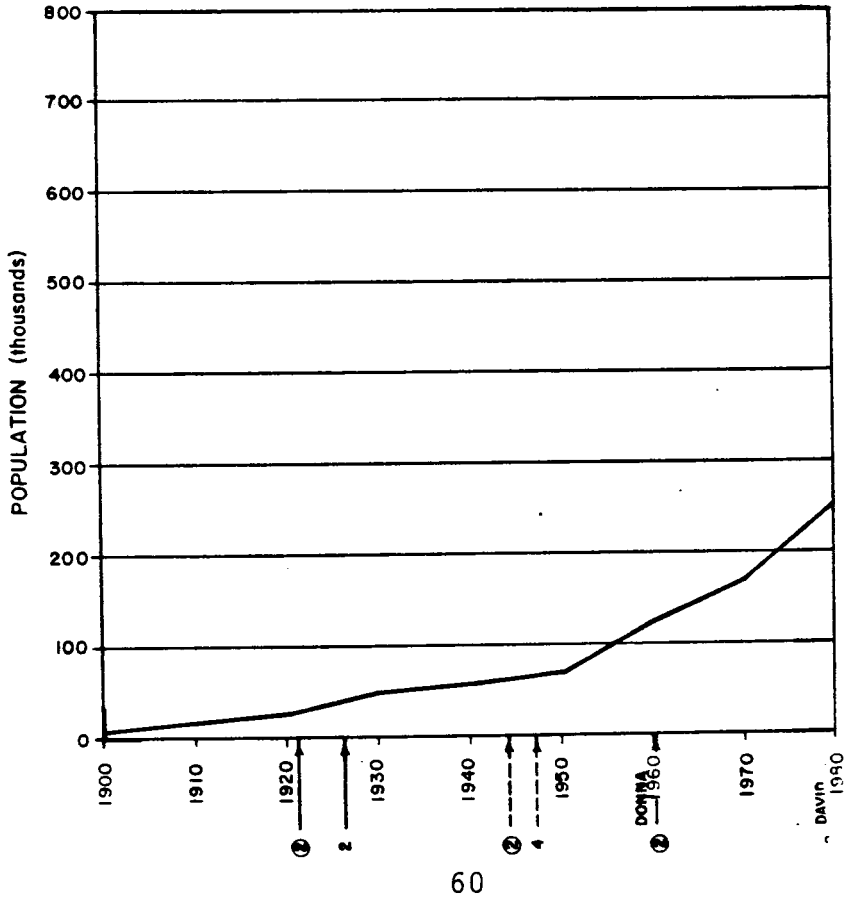
INDIAN RIVER COUNTY, FL



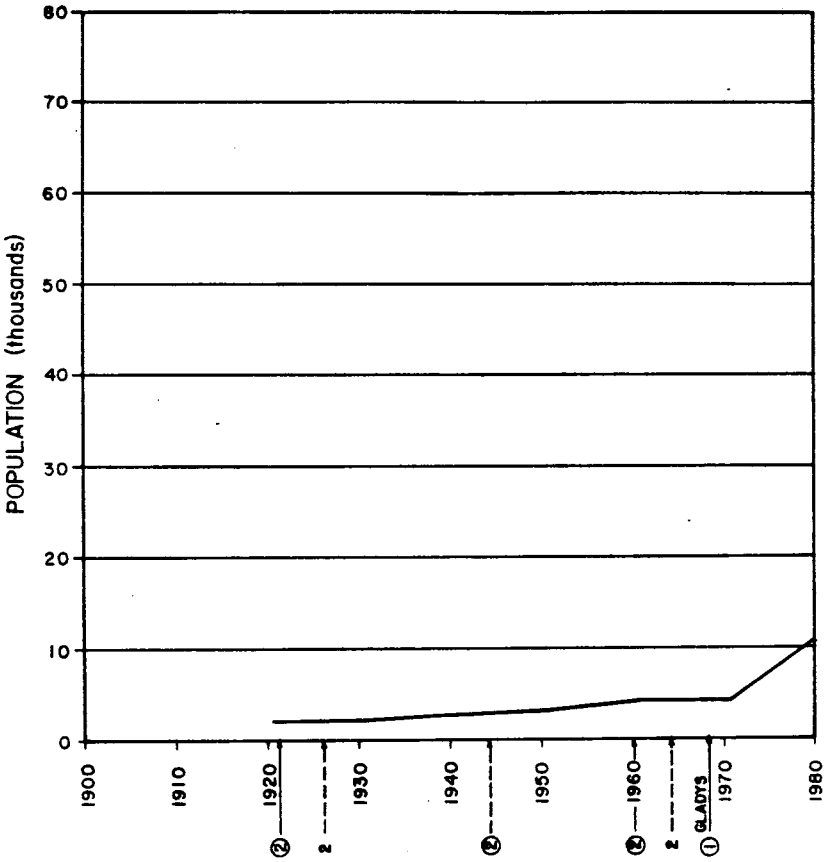
BREVARD COUNTY, FL



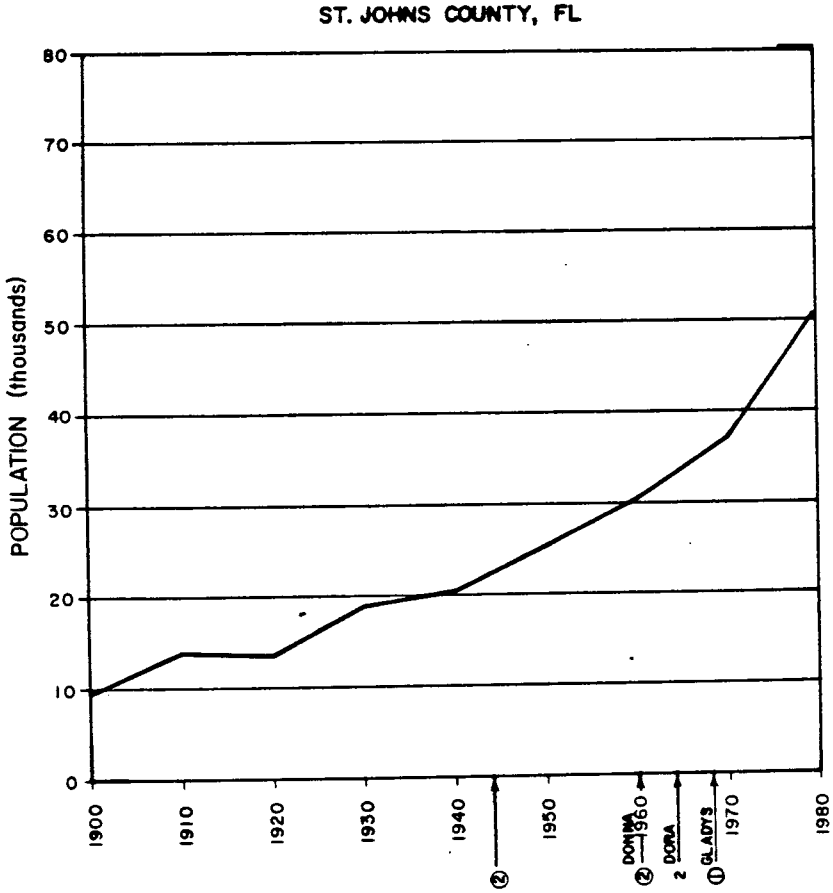
VOLUSIA COUNTY, FL

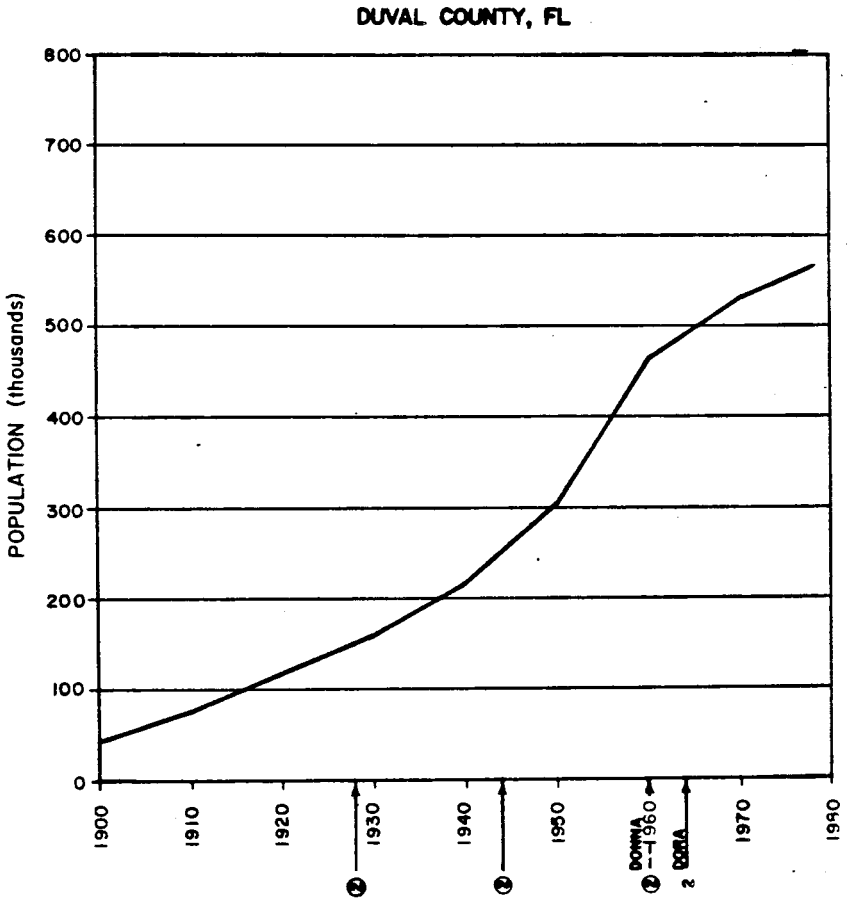


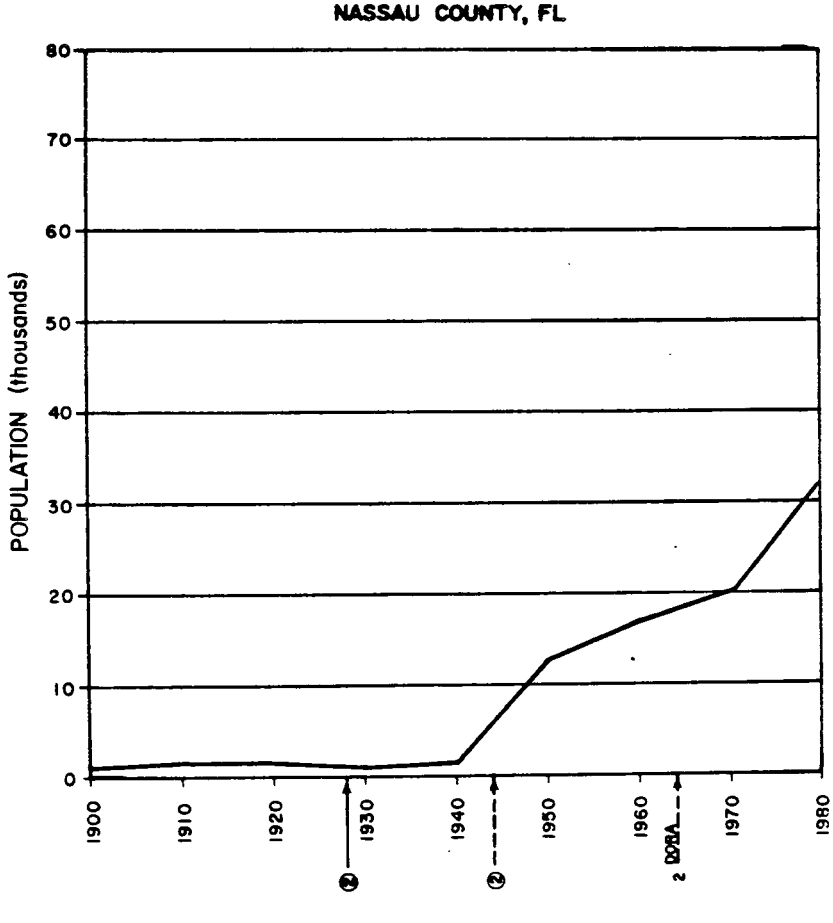
FLAGLER COUNTY, FL



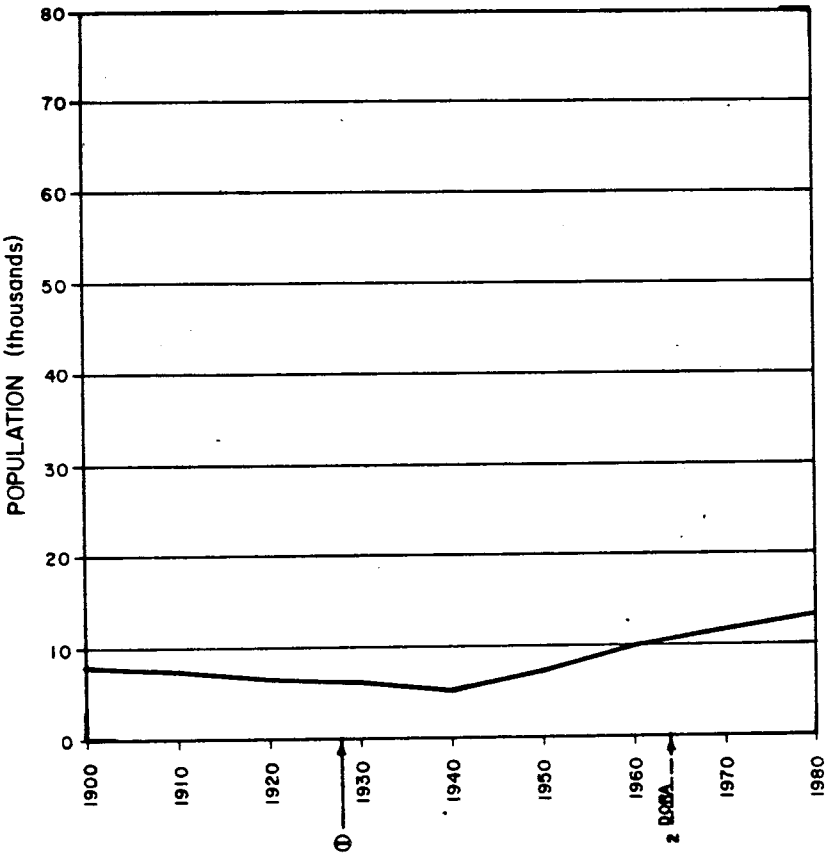
ST. JOHNS COUNTY, FL



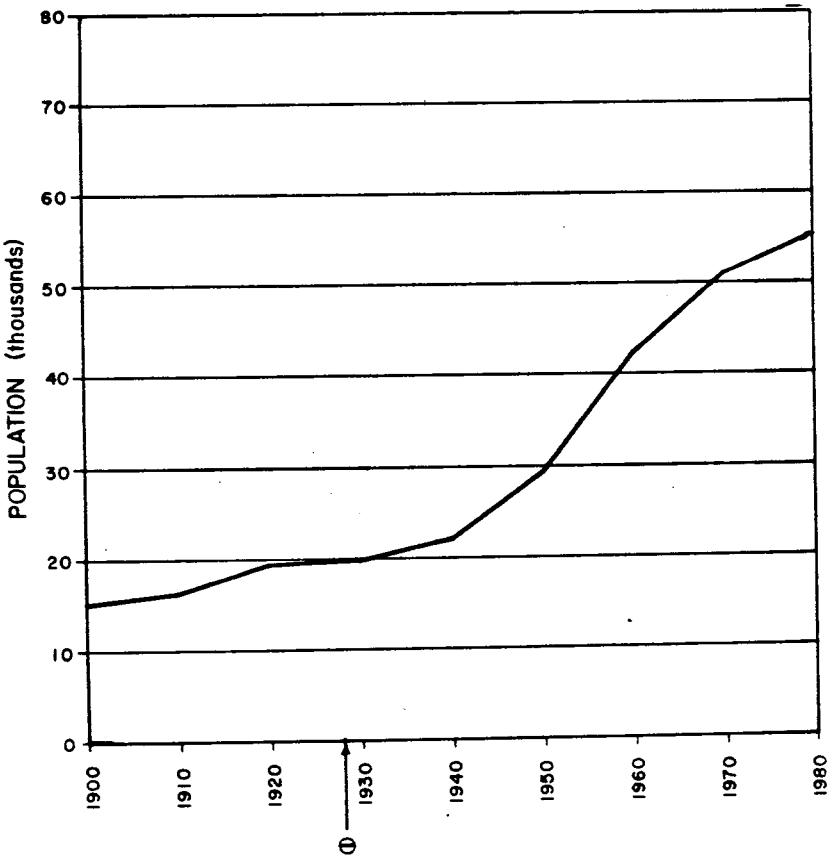

DUVAL COUNTY, FL
POPULATION (thousands)
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1990
DONNA
DORA
2
2
2
2

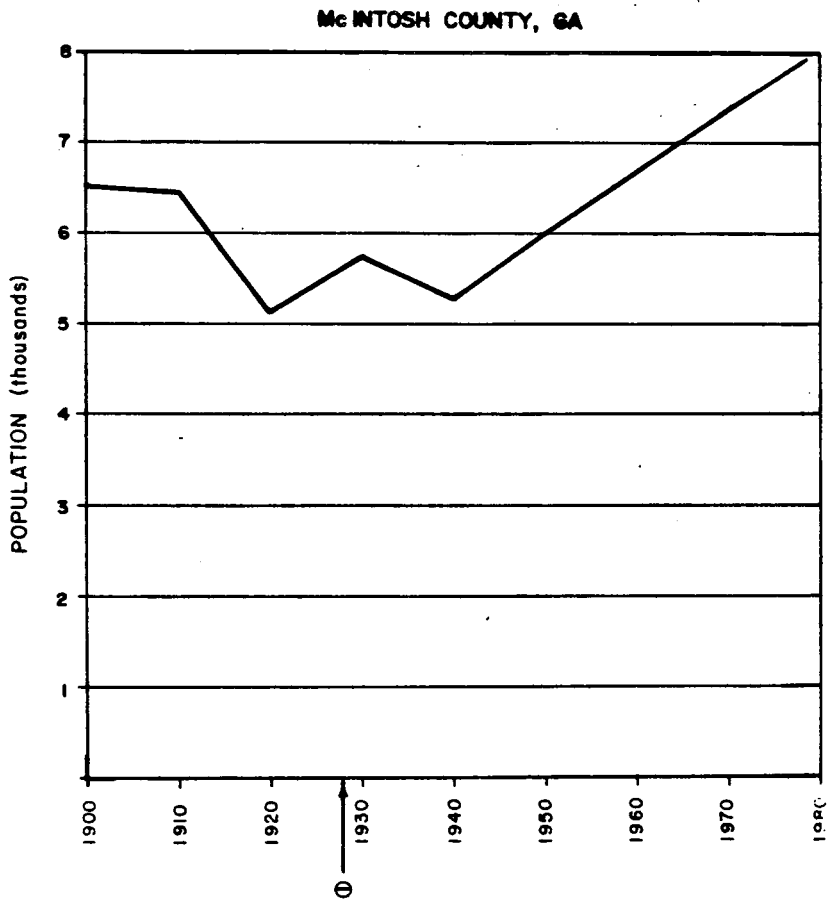

NASSAU COUNTY, FL
POPULATION (thousands)
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
2
2
2
DORA

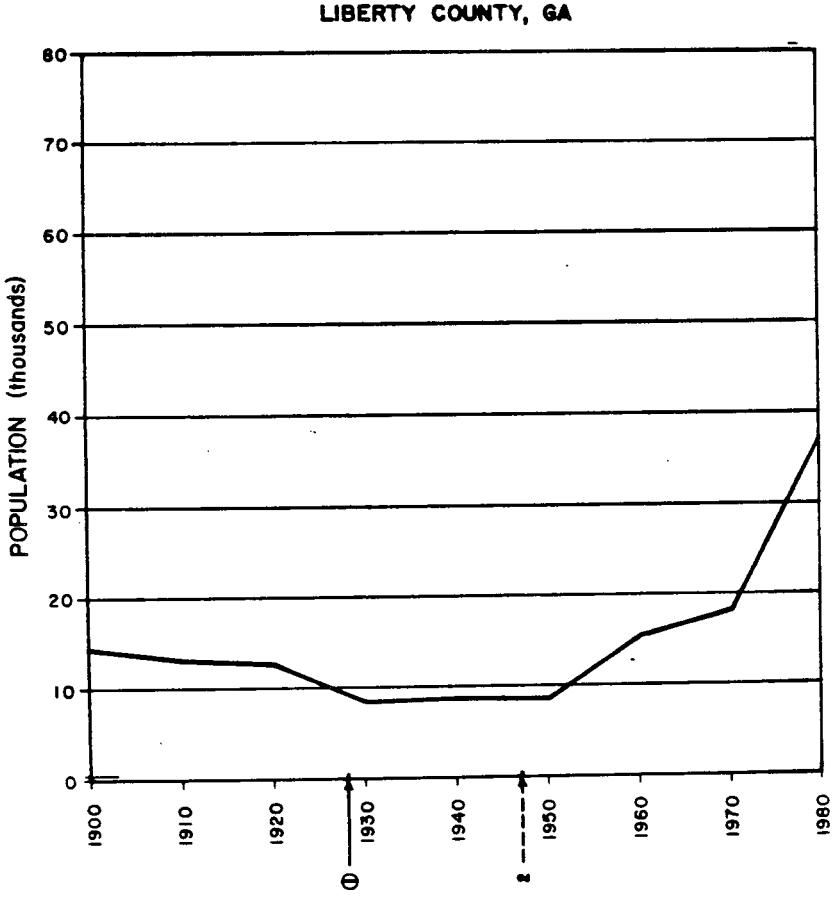
CAMDEN COUNTY, GA

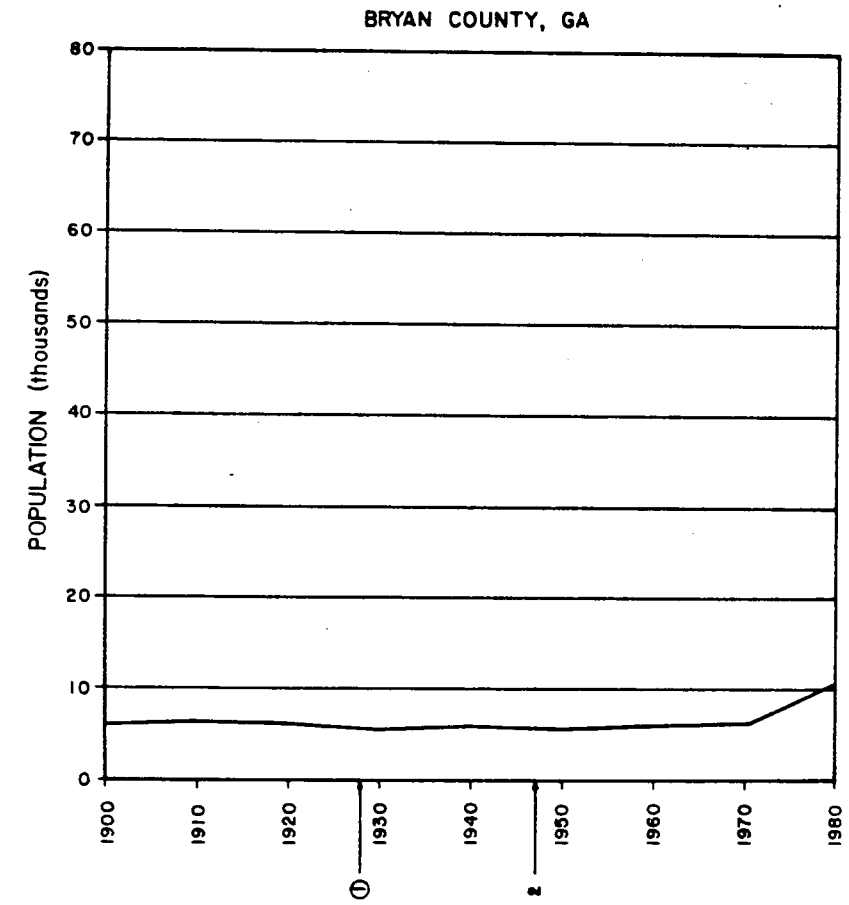


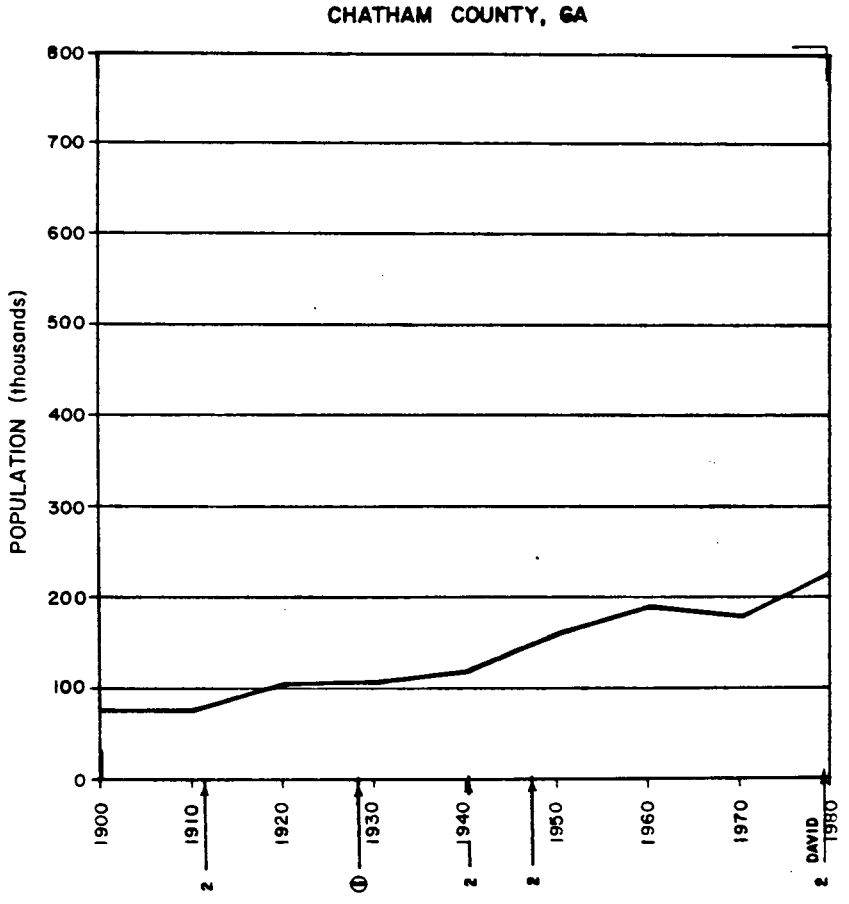
GLYNN COUNTY, GA



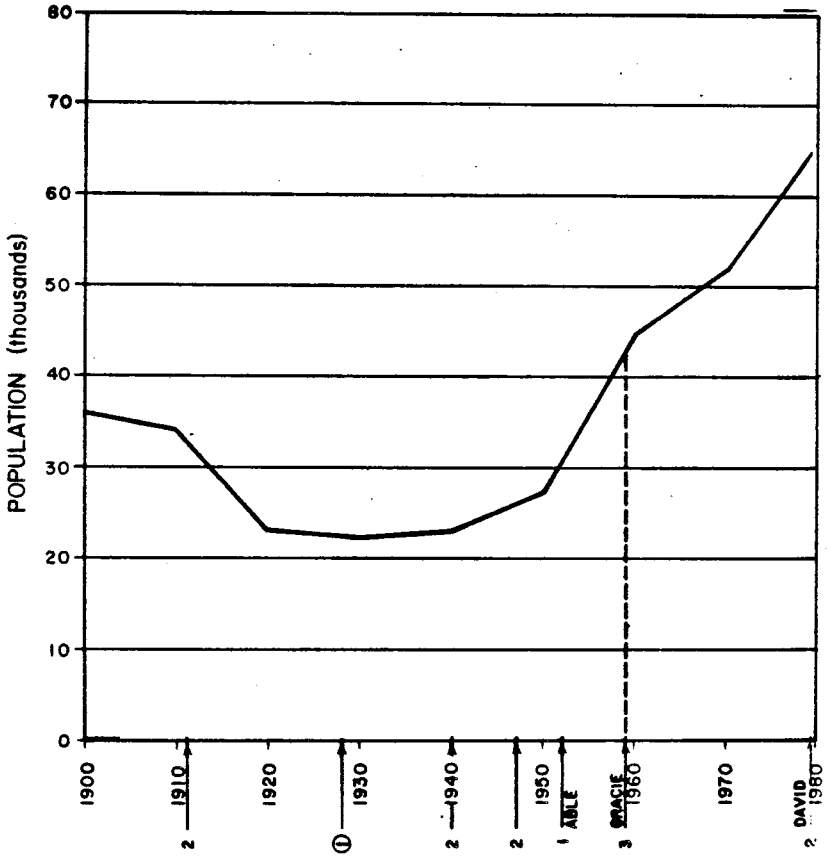

McINTOSH COUNTY, GA
POPULATION (thousands)
8
7
6
5
4
3
2
1
1900
1910
1920
1930
1940
1950
1960
1970


LIBERTY COUNTY, GA
POPULATION (thousands)
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
1940
1950
1960
1970
1980

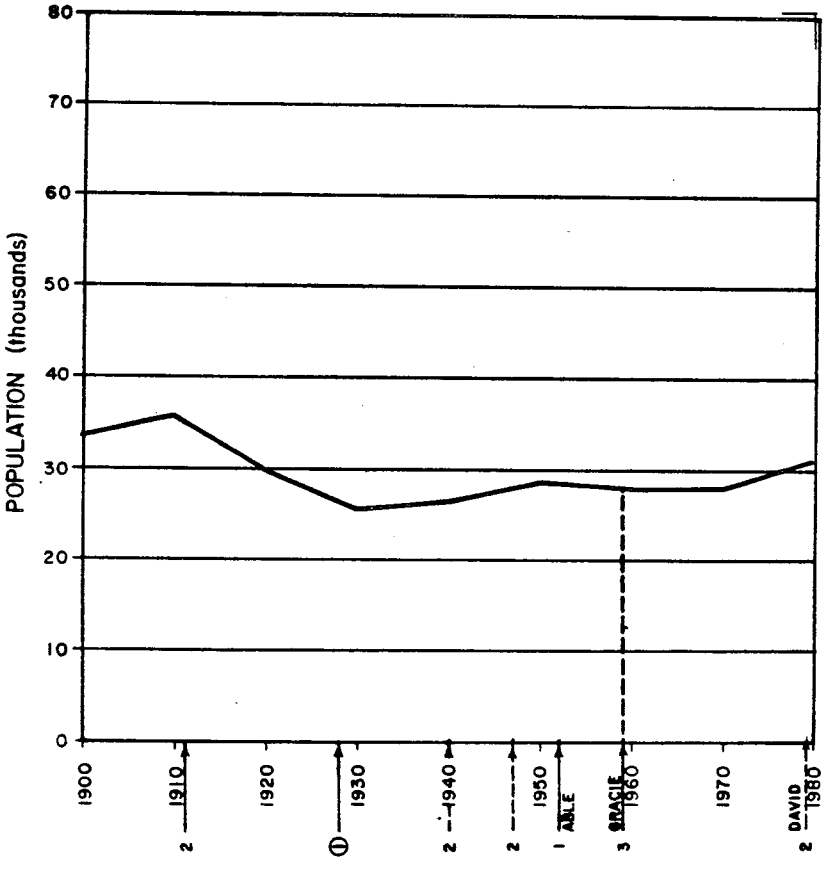

BRYAN COUNTY, GA
POPULATION (thousands)
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1
2


CHATHAM COUNTY, GA
POPULATION (thousands)
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
DAVID
1980
2
1
2
2
2

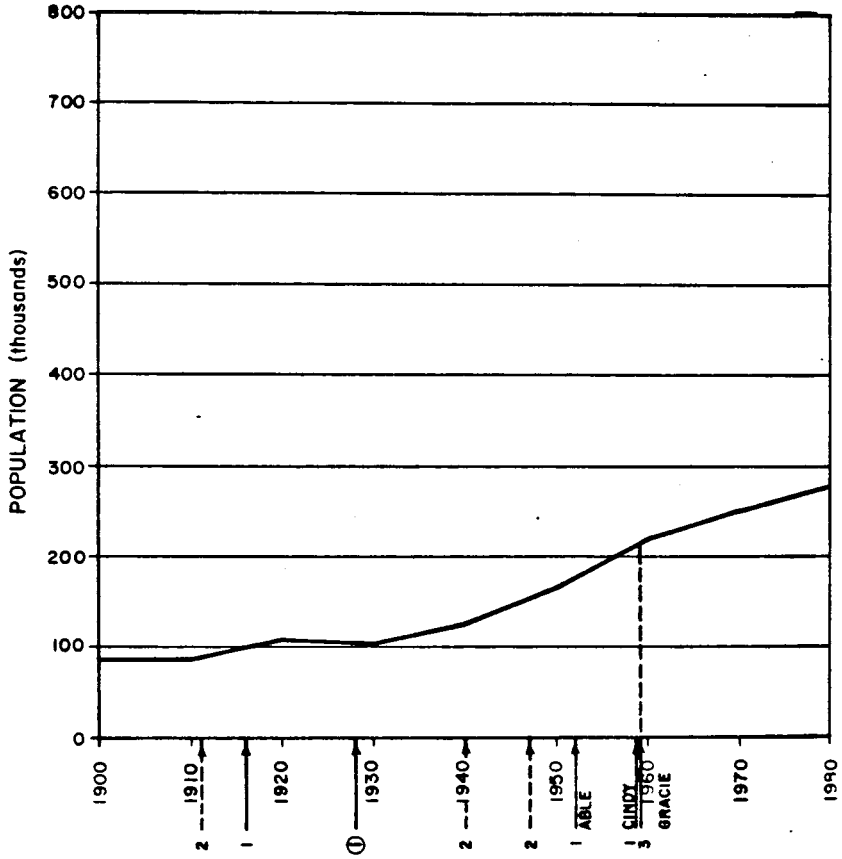
BEAUFORT COUNTY, SC



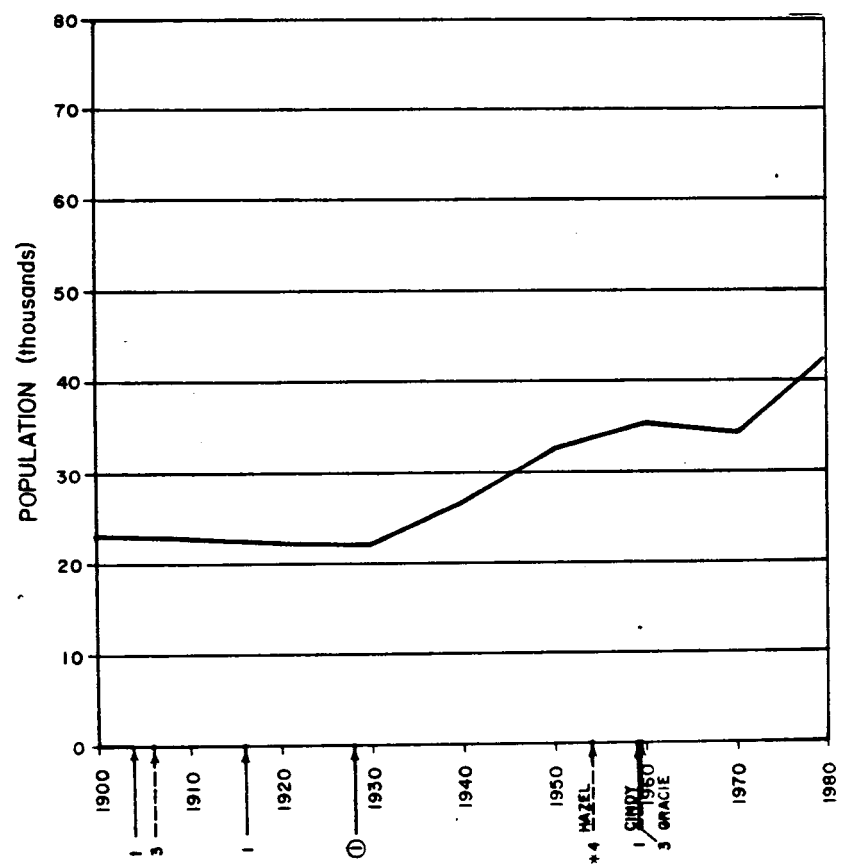
COLLETON COUNTY, SC

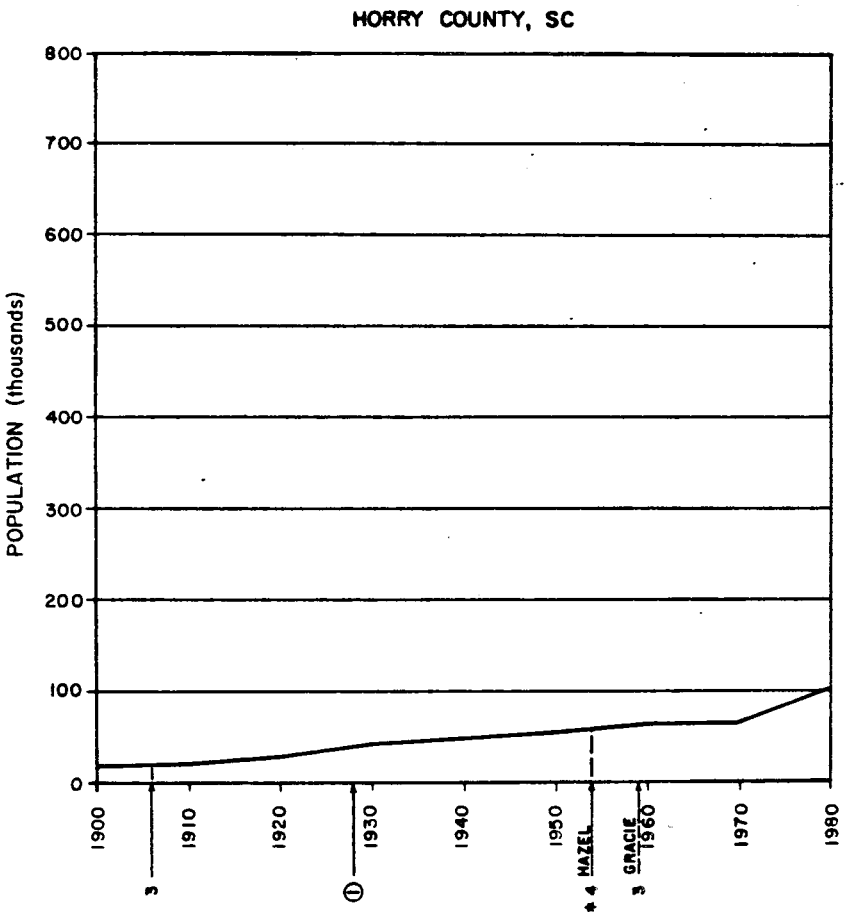


CHARLESTON COUNTY, SC



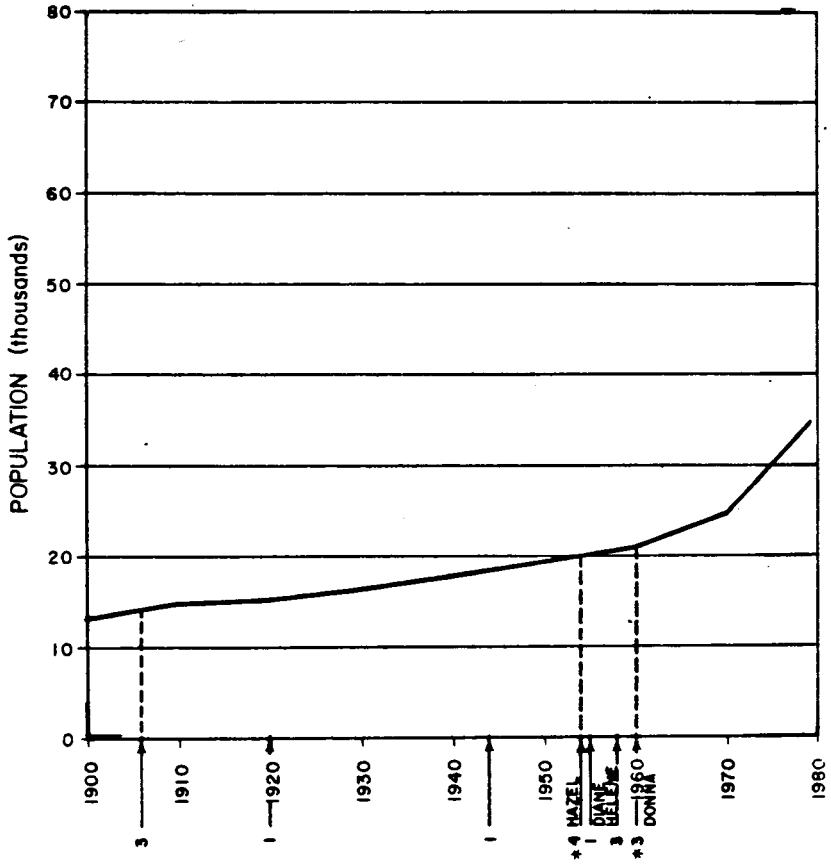
GEORGETOWN COUNTY, SC



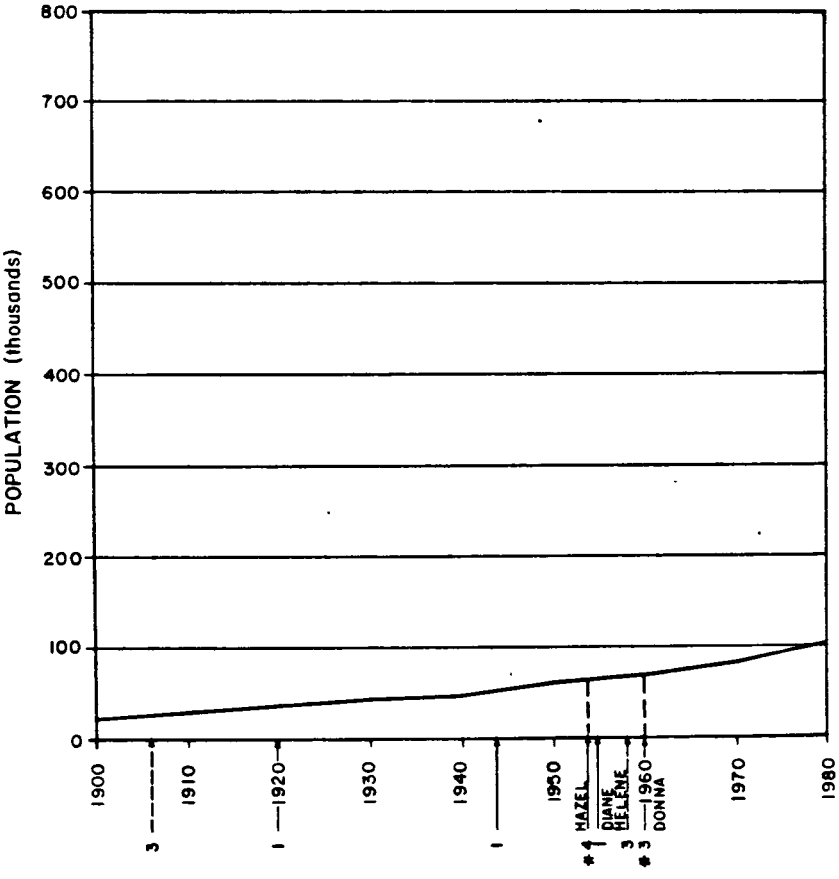


END OF SOUTH CAROLINA COUNTIES

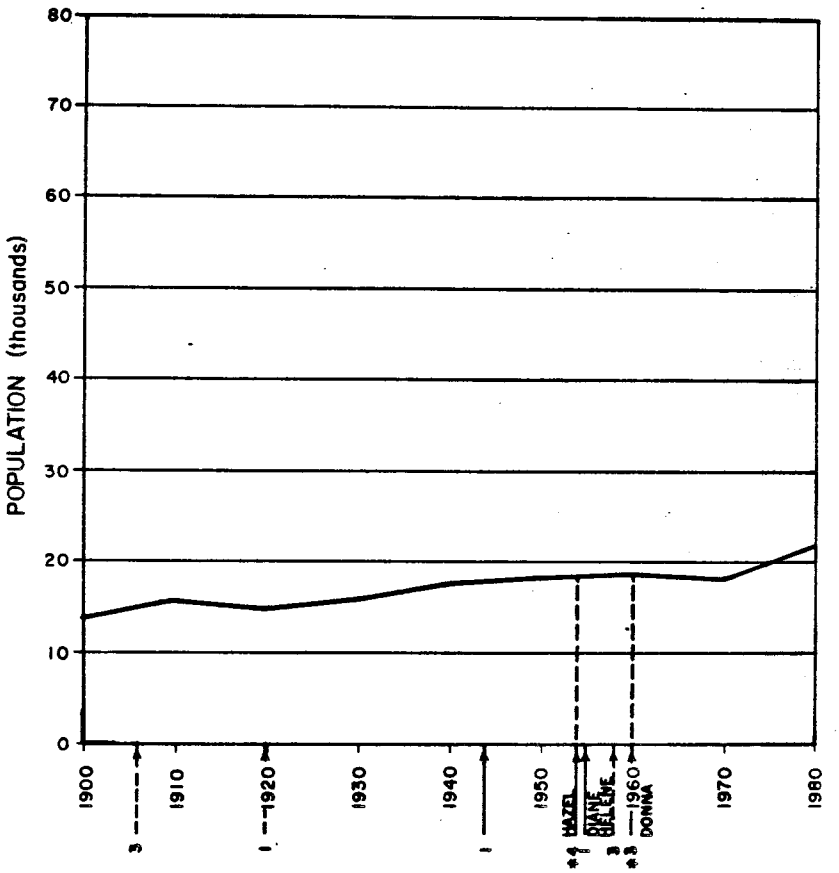
BRUNSWICK COUNTY, NC



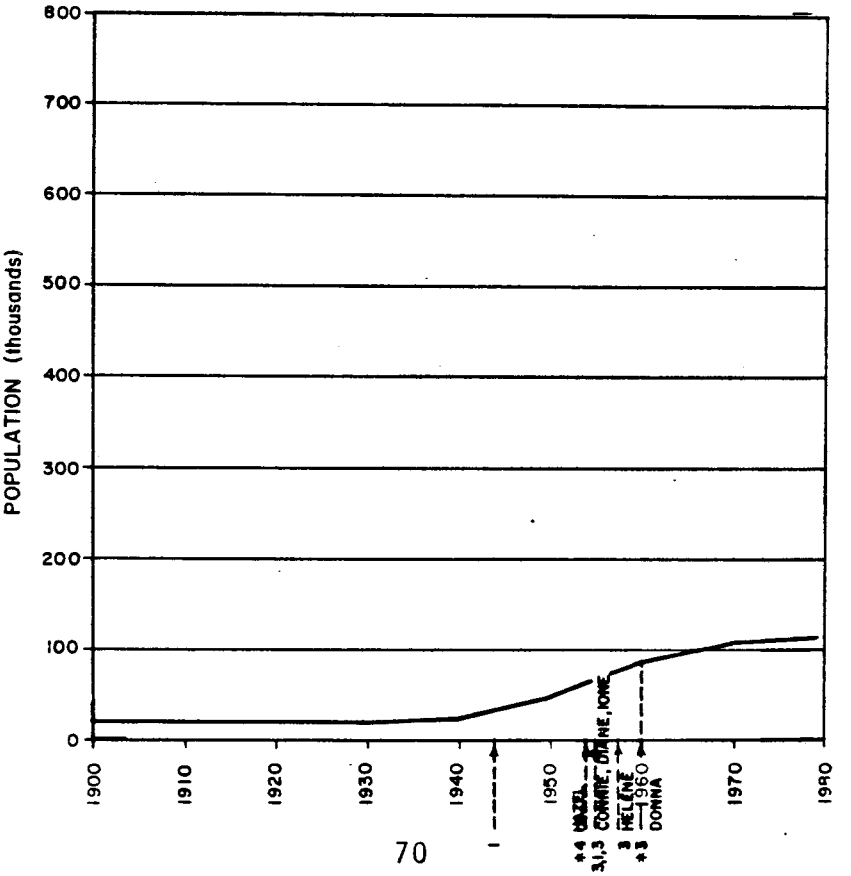
NEW HANOVER COUNTY, NC



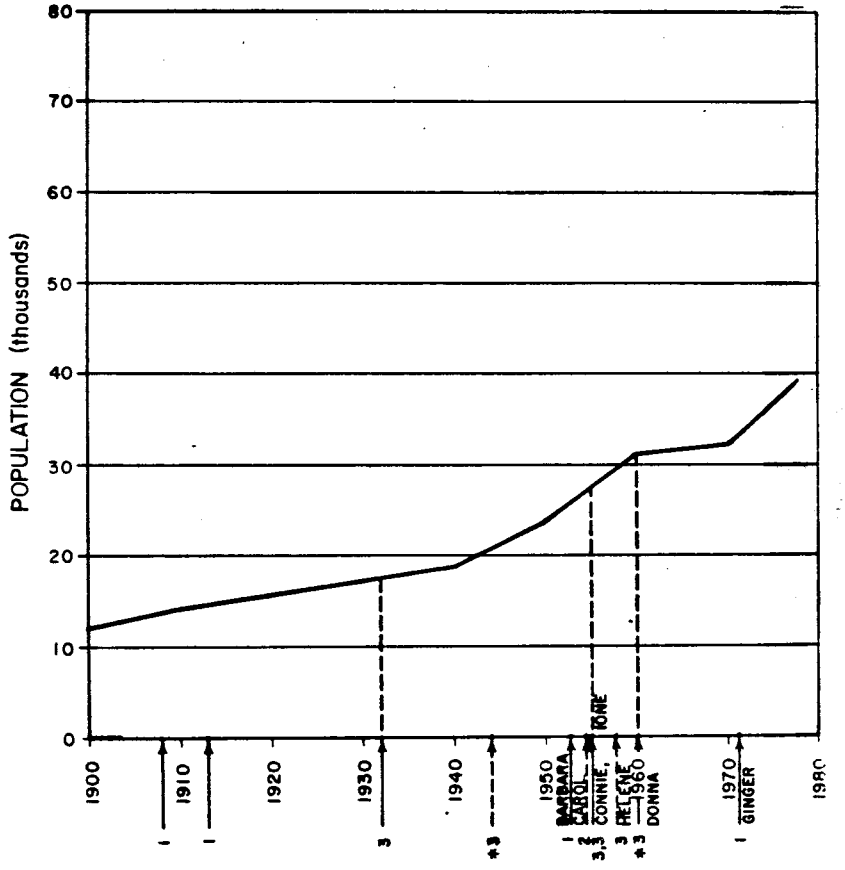
PENDER COUNTY, NC



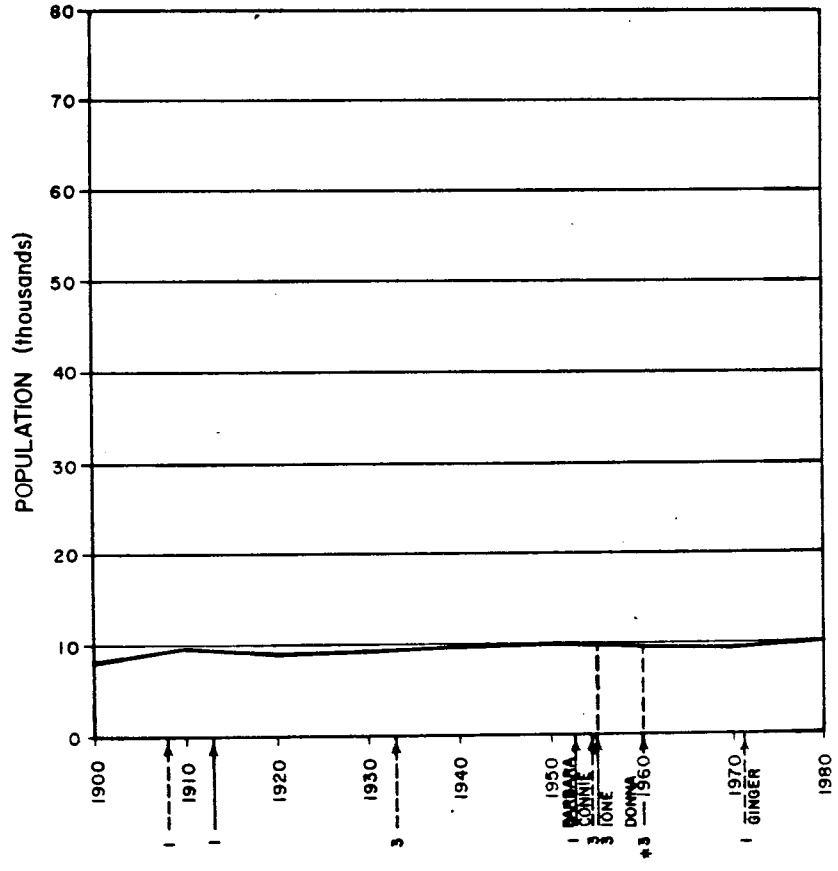
ONSLOW COUNTY, NC



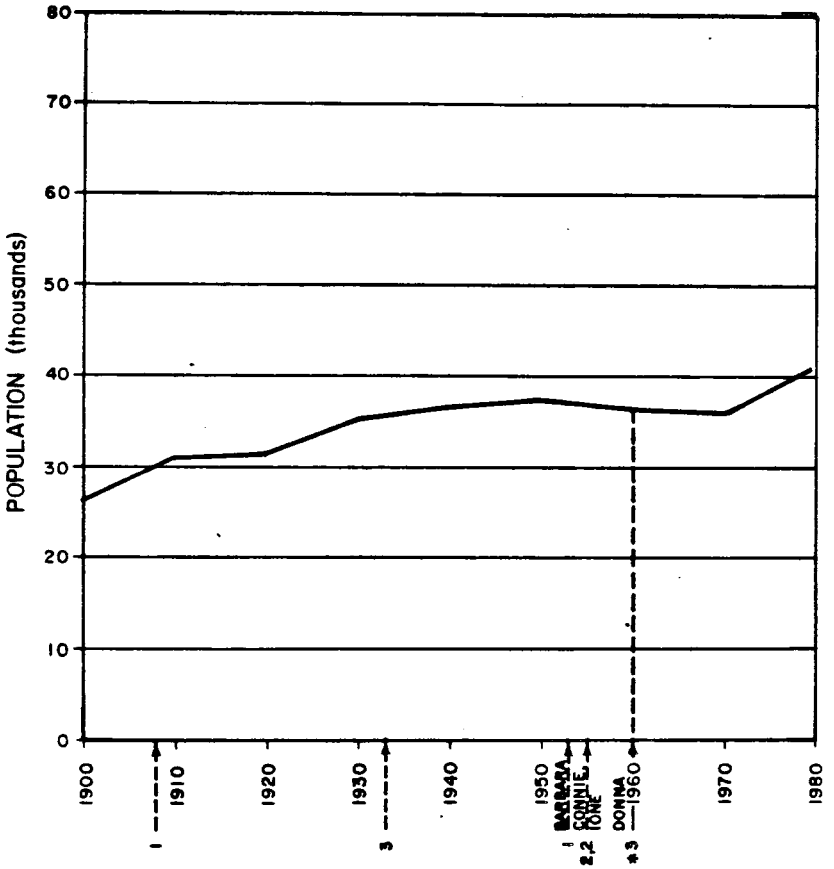
CARTERET COUNTY, NC



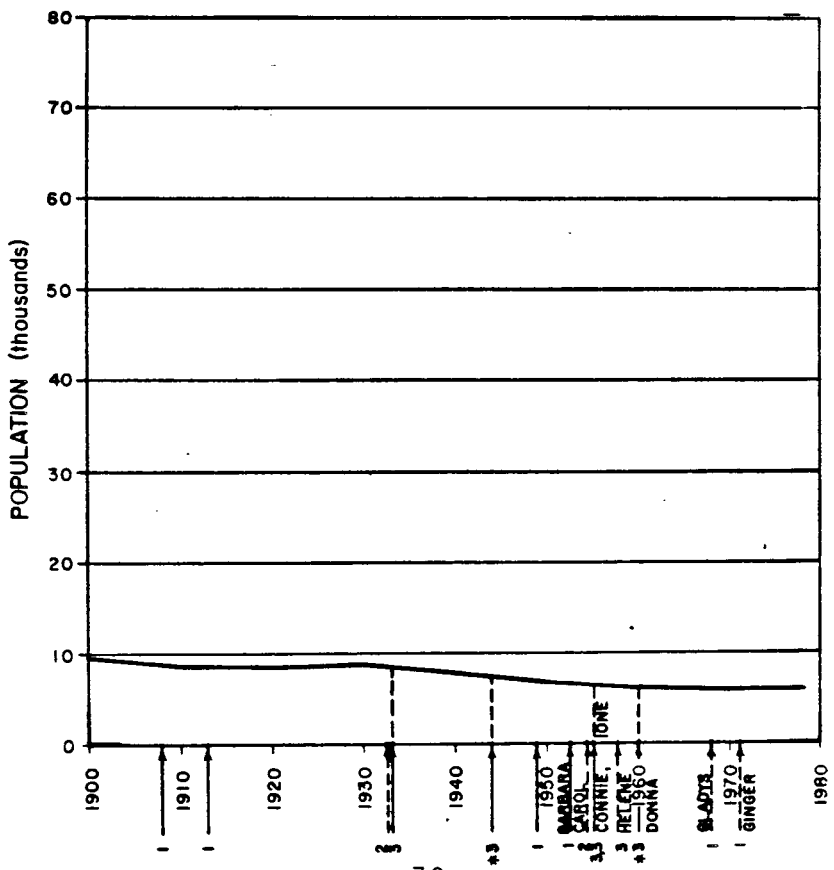
PAMLICO COUNTY, NC



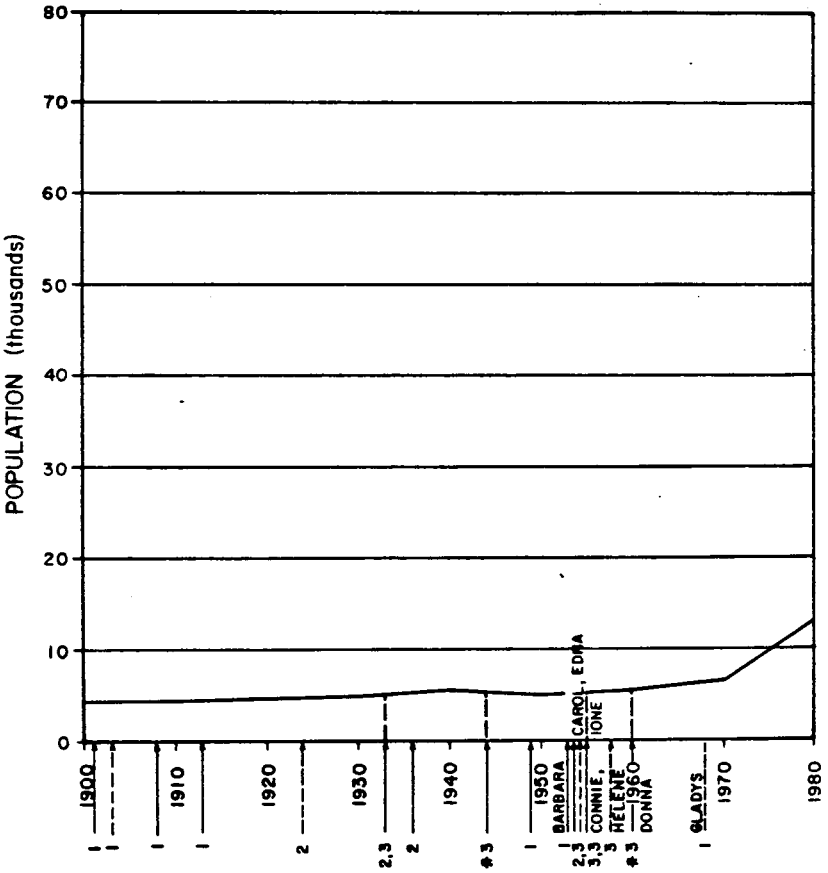
BEAUFORT COUNTY, NC



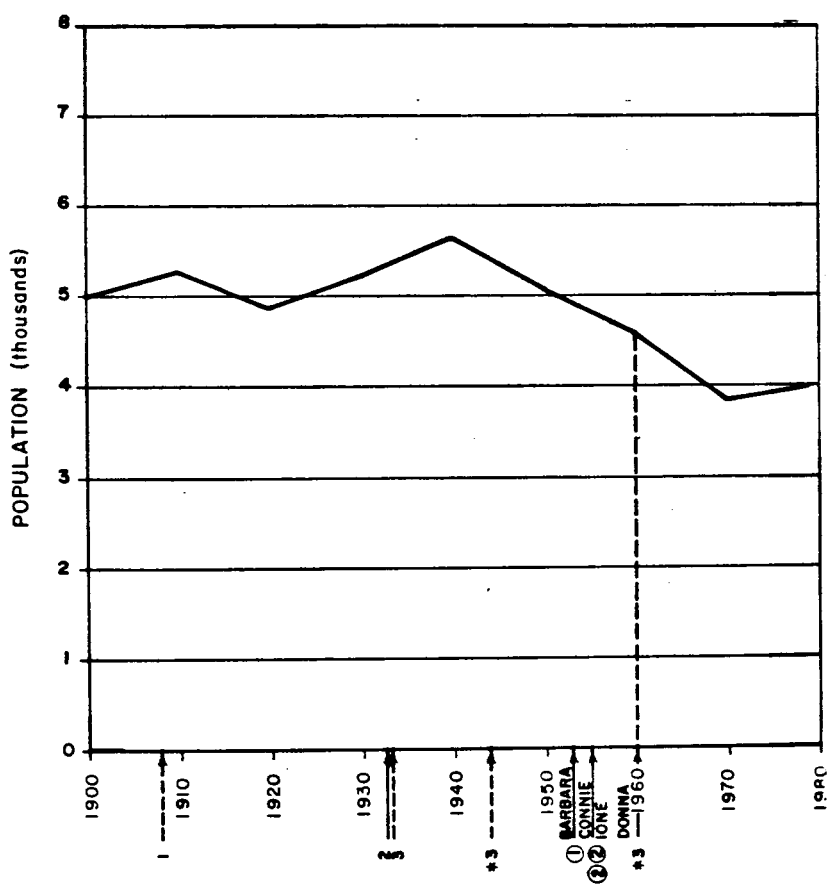
HYDE COUNTY, NC

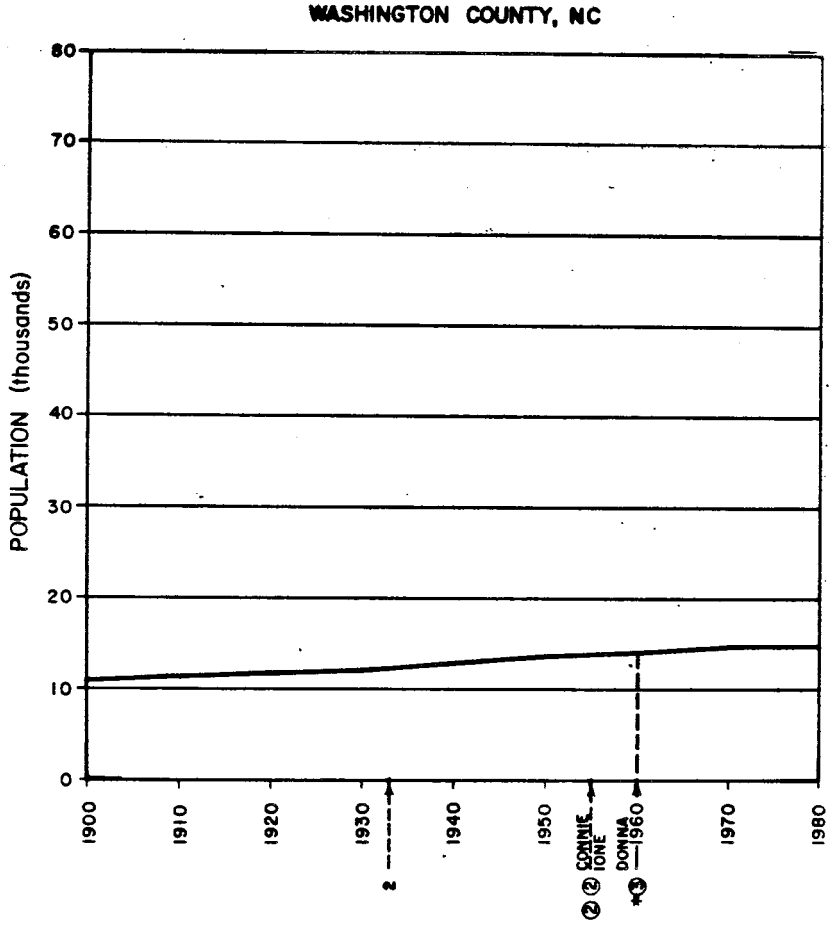


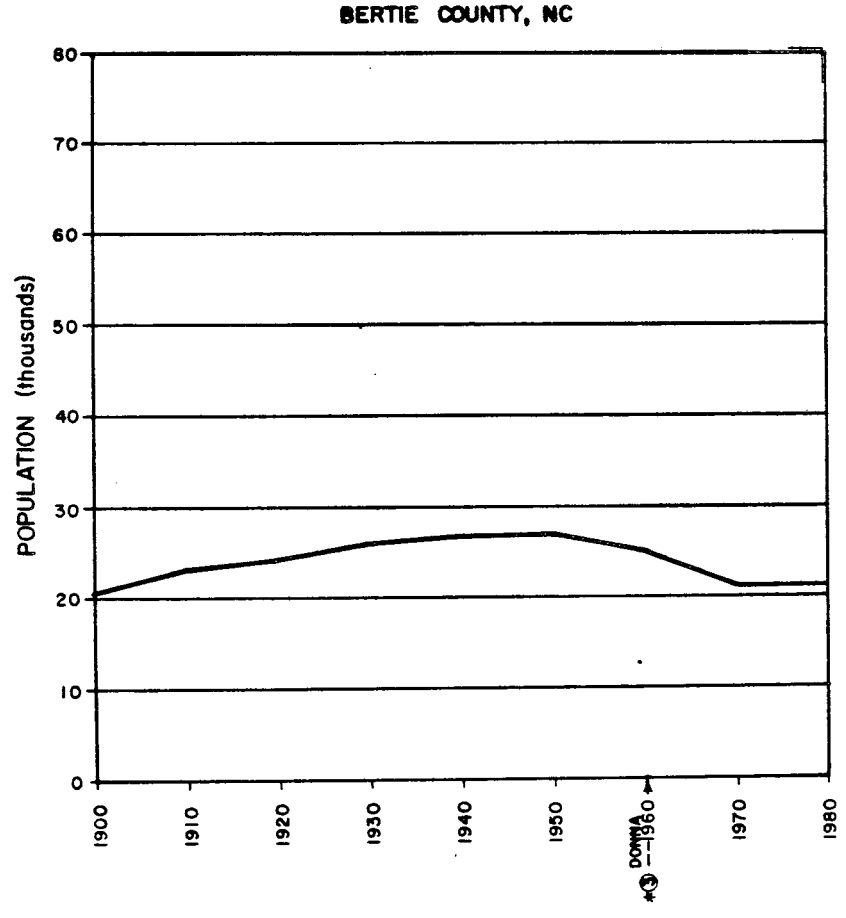
DARE COUNTY, NC



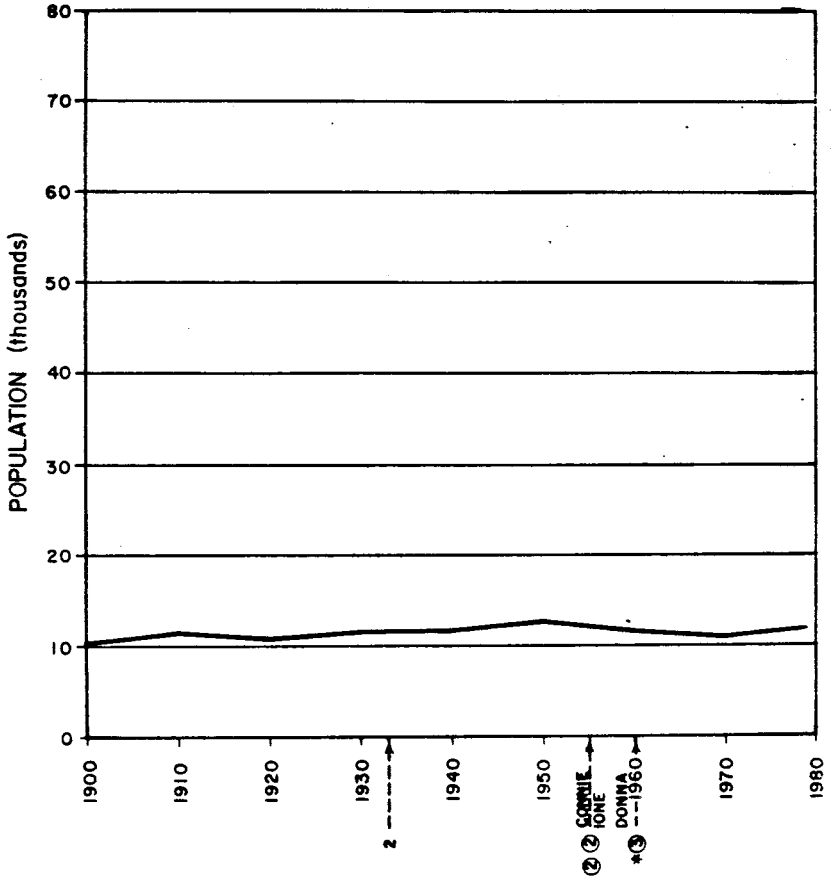
TYRRELL COUNTY, NC



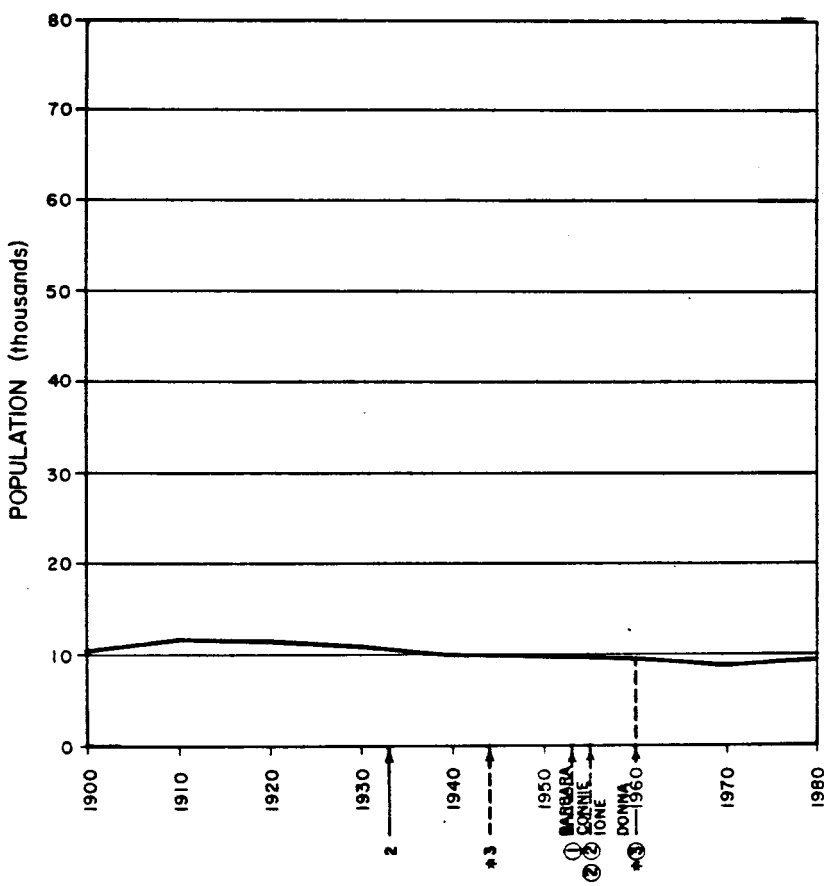

WASHINGTON COUNTY, NC
POPULATION (thousands)
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
CONNIE
IONE
DONNA


BERTIE COUNTY, NC
POPULATION (thousands)
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
DONNA

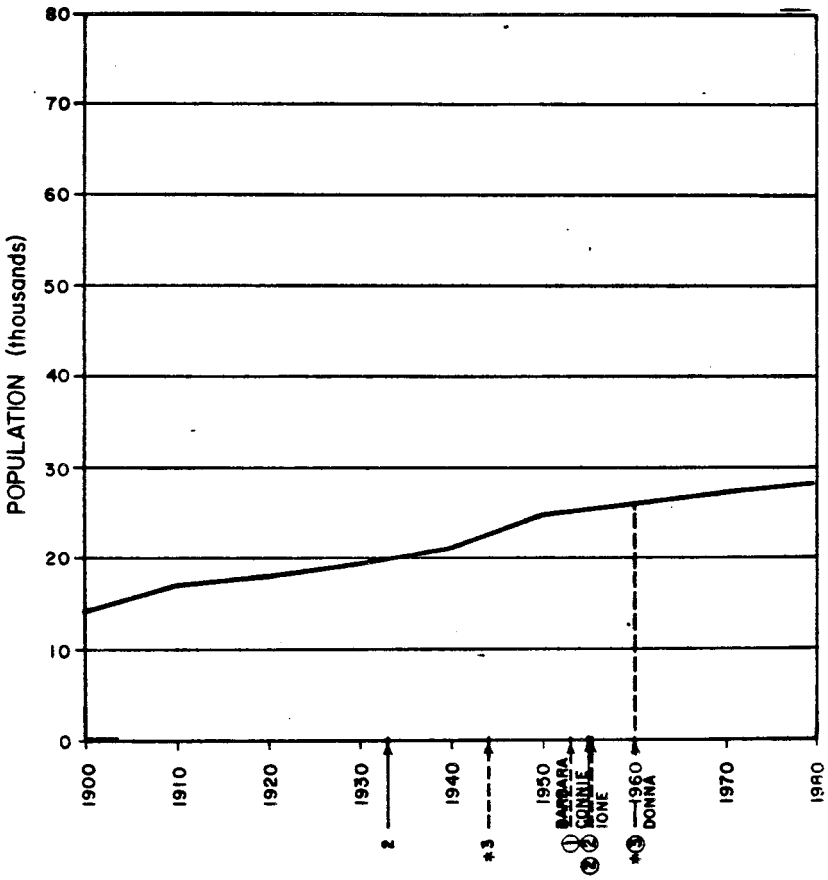
CHOWAN COUNTY, NC



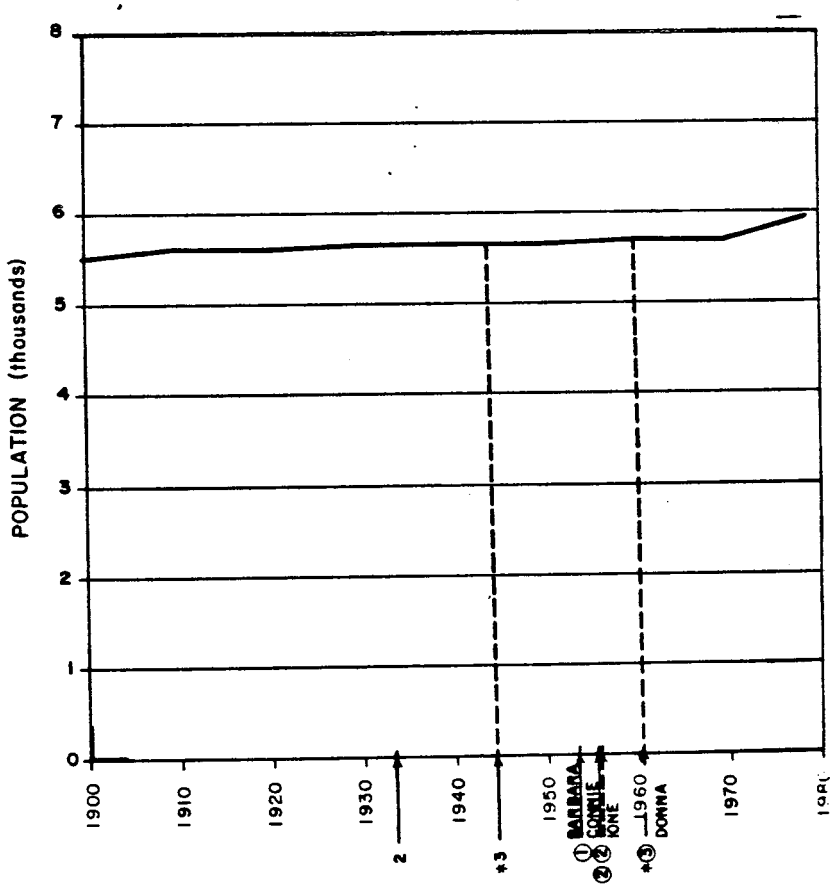
PERQUIMANS COUNTY, NC

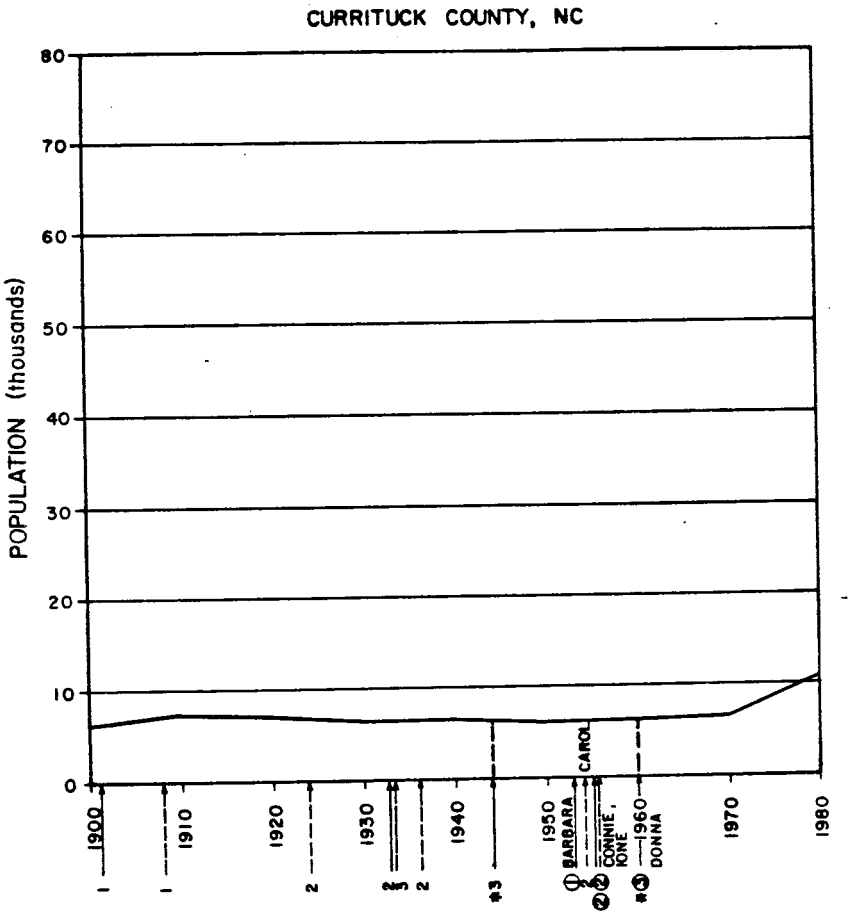


PASQUOTANK COUNTY, NC



CAMDEN COUNTY, NC

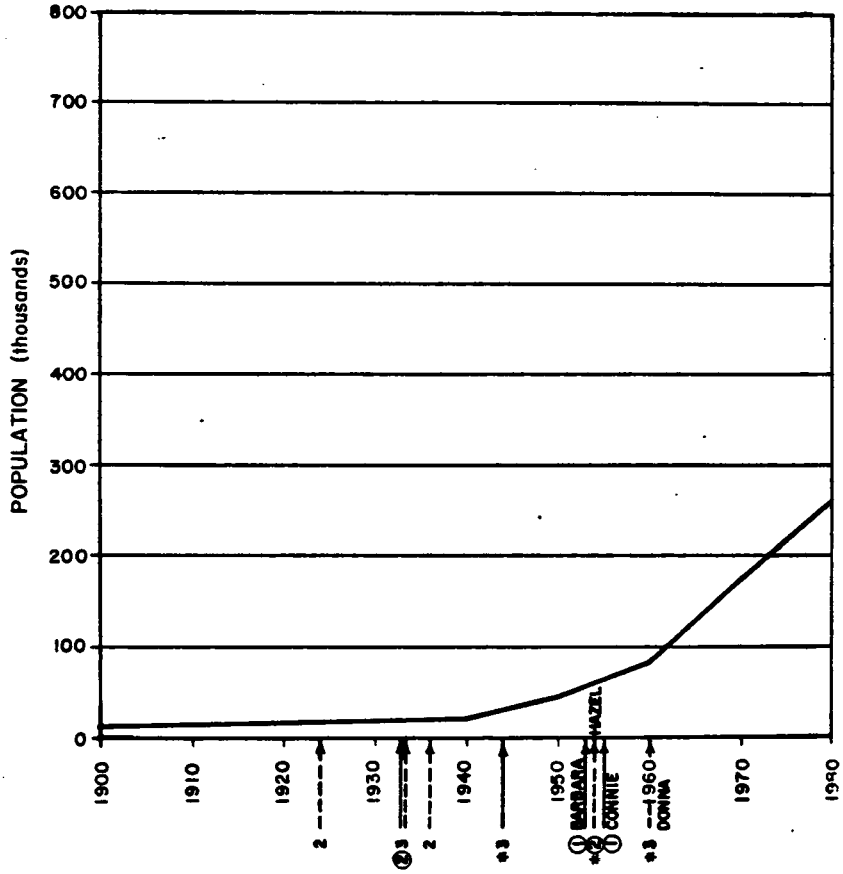




END OF NORTH CAROLINA COUNTIES

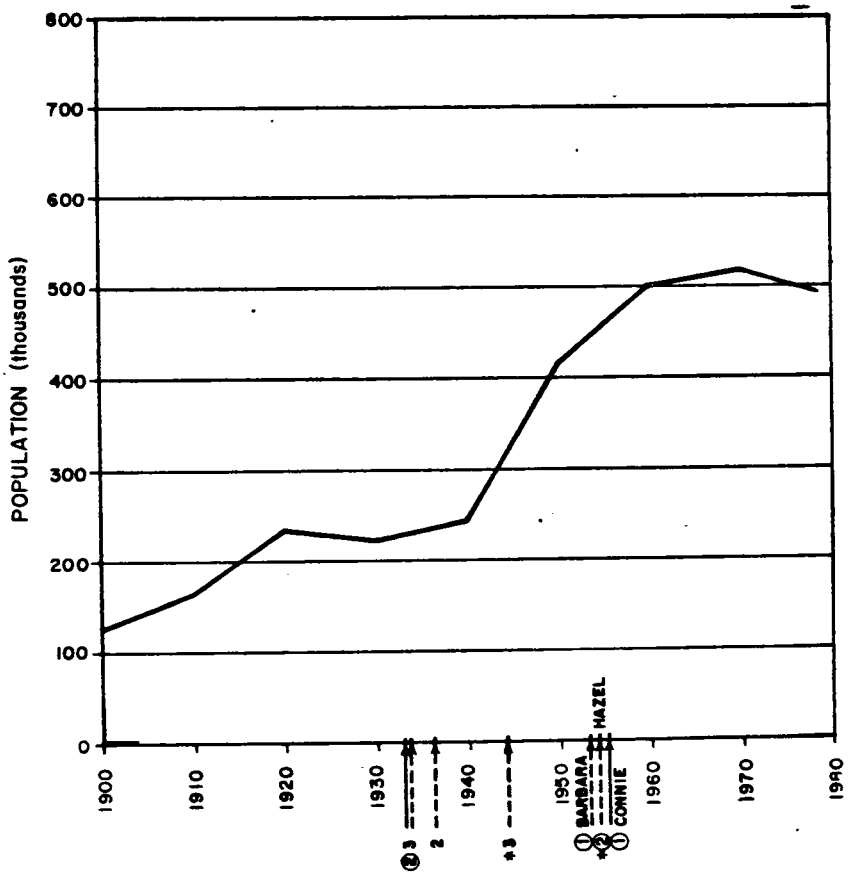
VIRGINIA BEACH, VA

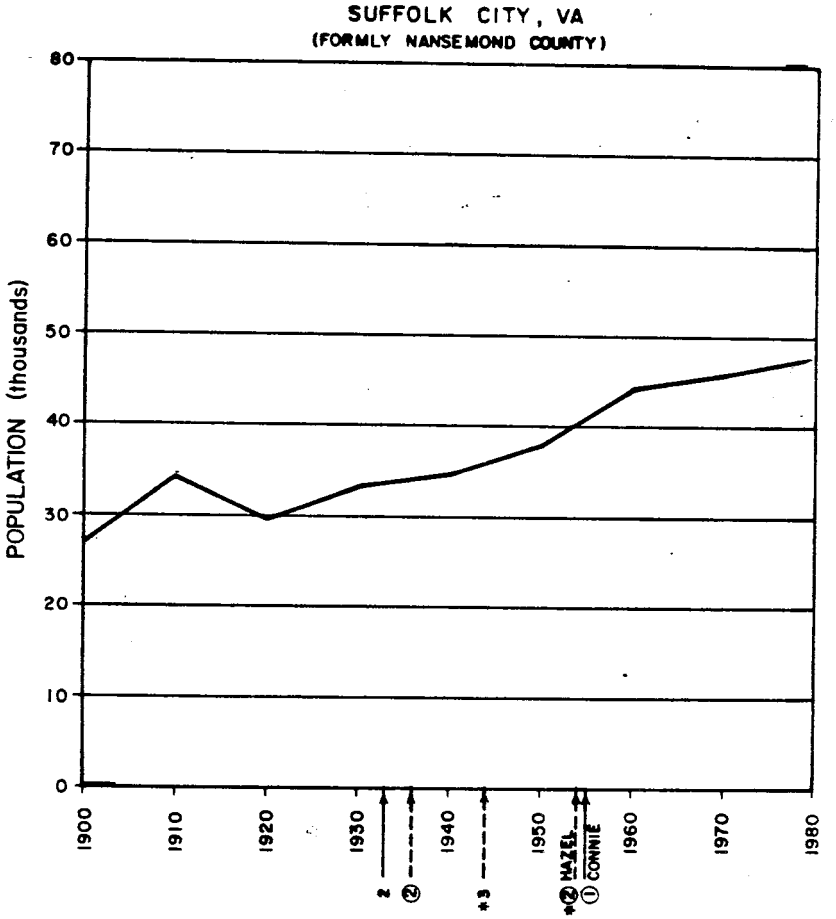
INDEPENDENT CITY, CONSOLIDATED WITH PRINCESS ANNE COUNTY IN 1963.

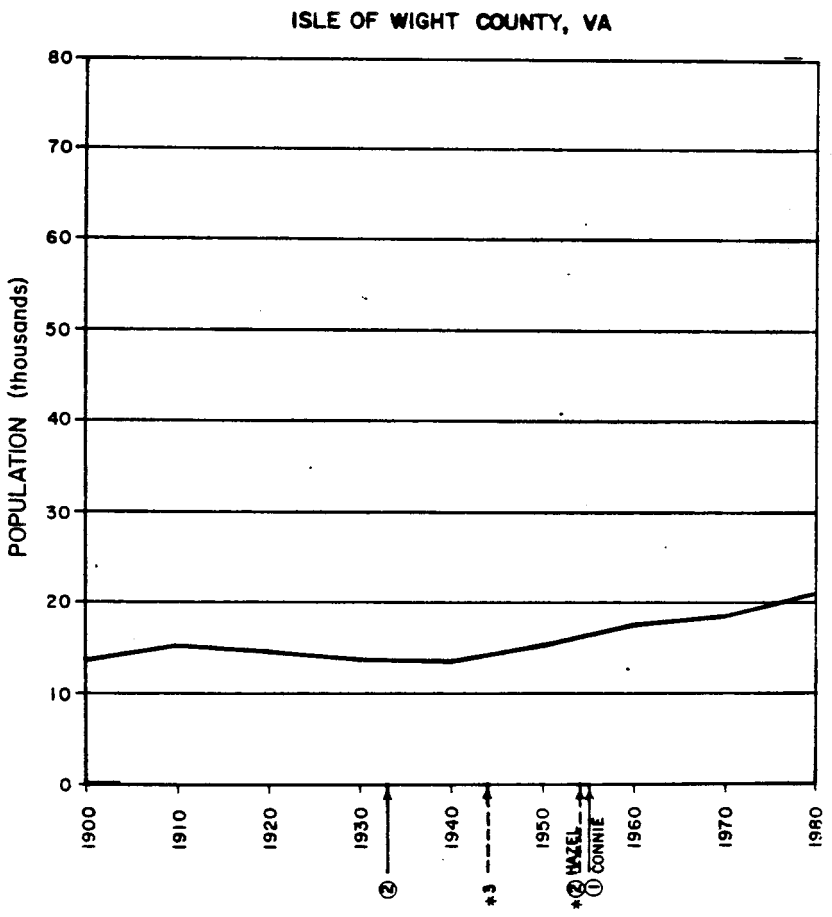


CHESAPEAKE, NORFOLK and PORTSMOUTH, VA

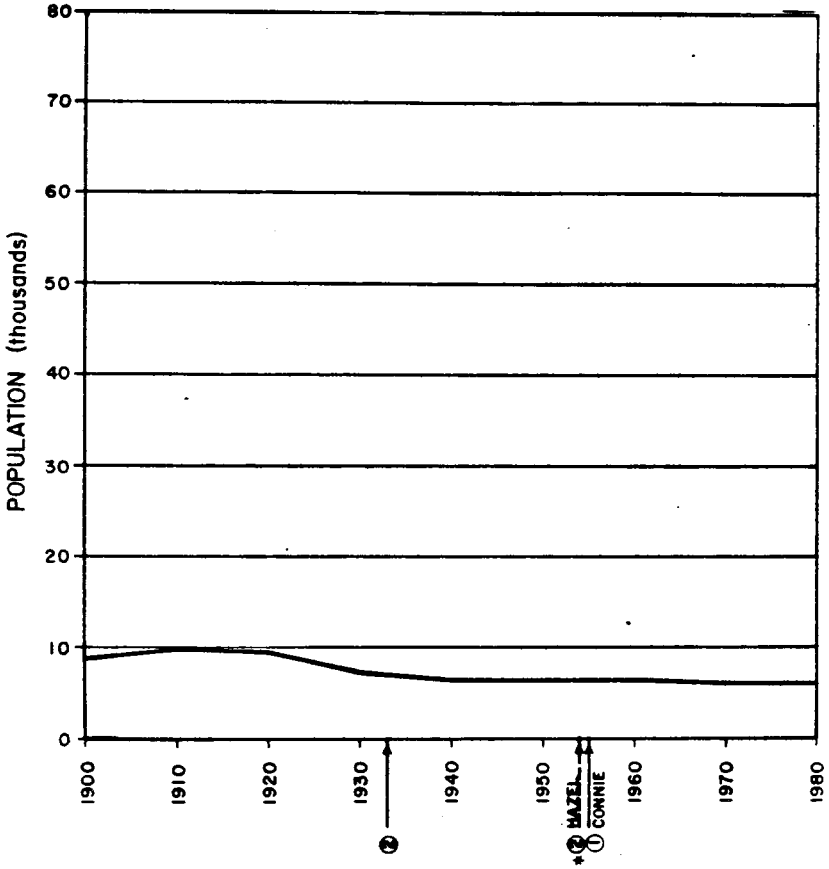
INDEPENDENT CITIES' COMBINED BOUNDARIES INCLUDE WHAT WAS FORMERLY NORFOLK COUNTY AND SOUTH NORFOLK CITY.




SUFFOLK CITY, VA
(FORMLY NANSEMOND COUNTY)
POPULATION (thousands)
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
2
②
*3
*② HAZEL
① CONNIE

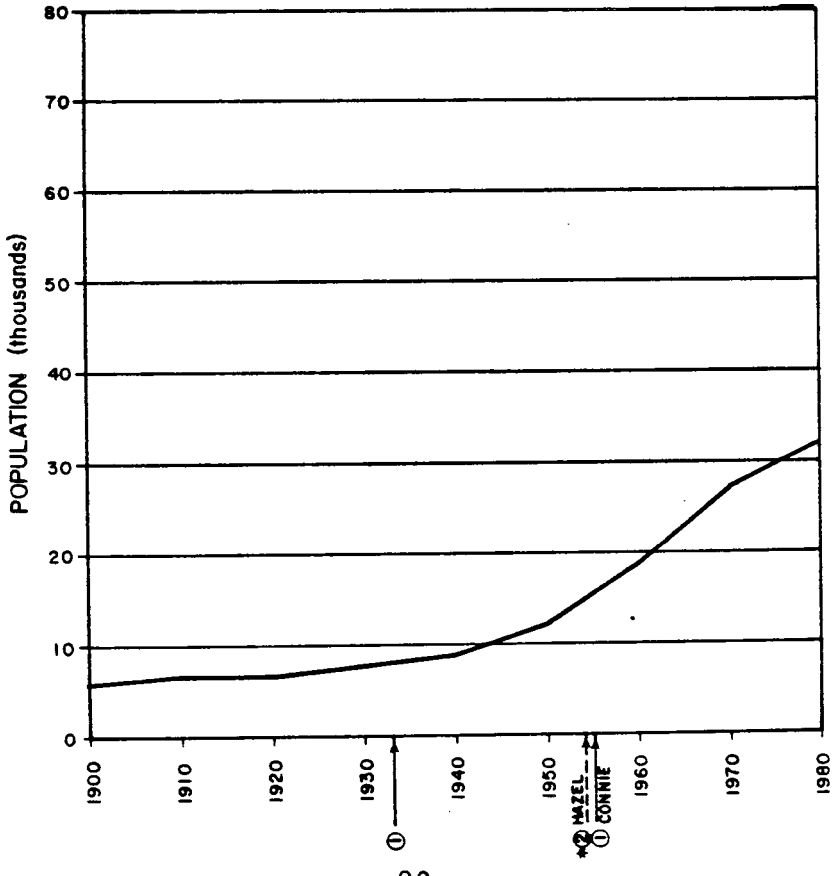

ISLE OF WIGHT COUNTY, VA
POPULATION (thousands)
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
②
*3
*② HAZEL
① CONNIE

SURRY COUNTY, VA



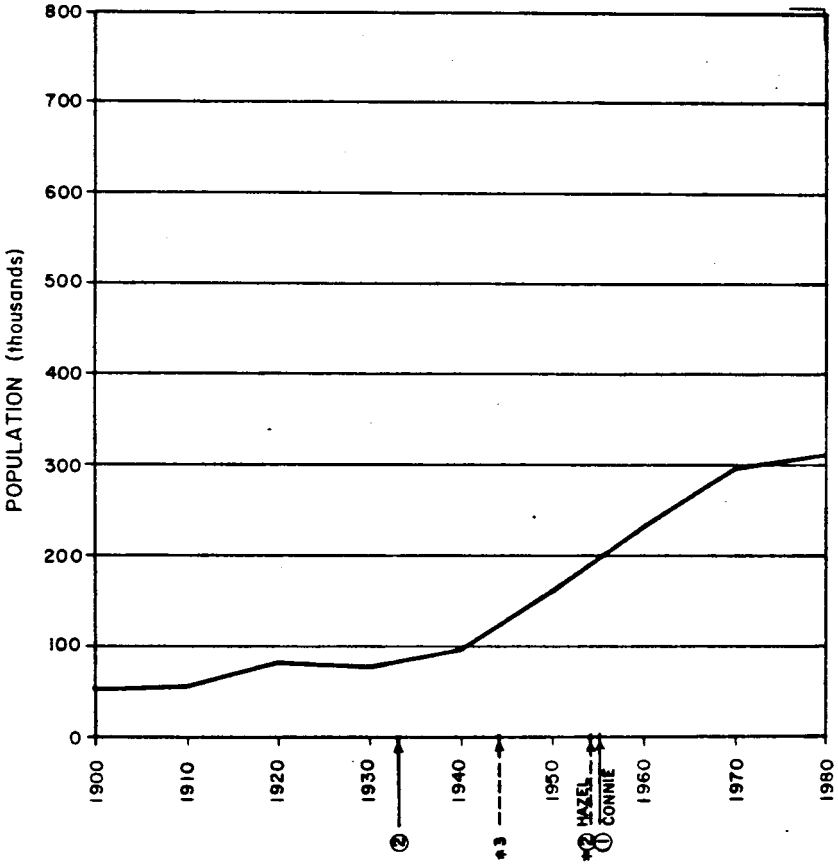
JAMES CITY COUNTY, VA

INCLUDES THE INDEPENDENT CITY OF WILLIAMSBURG.

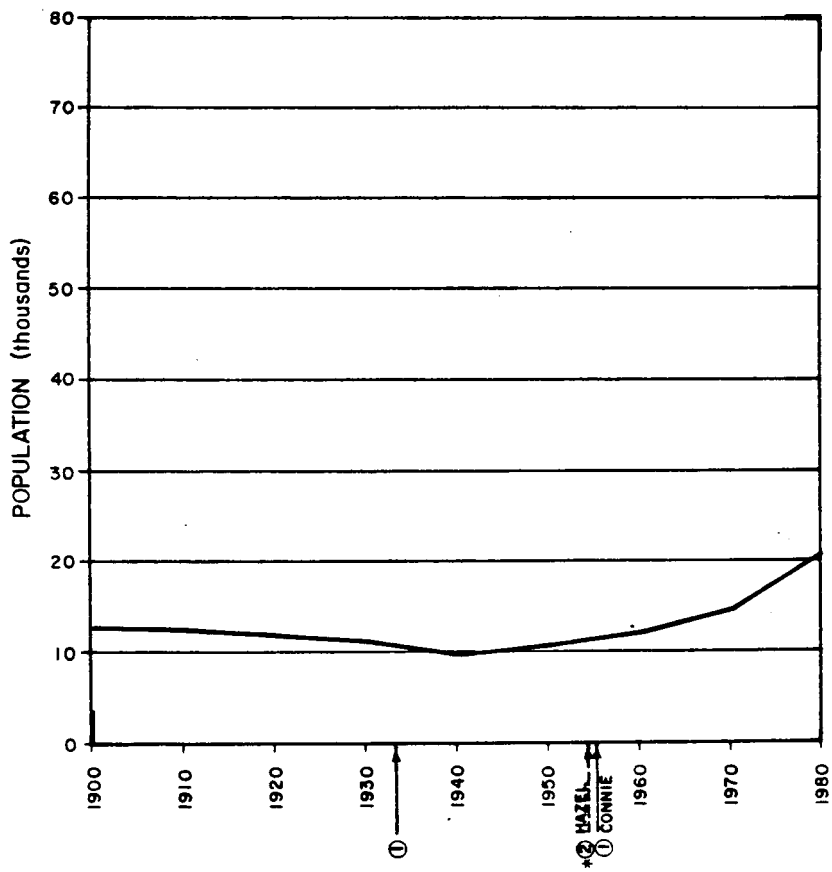


YORK COUNTY, VA

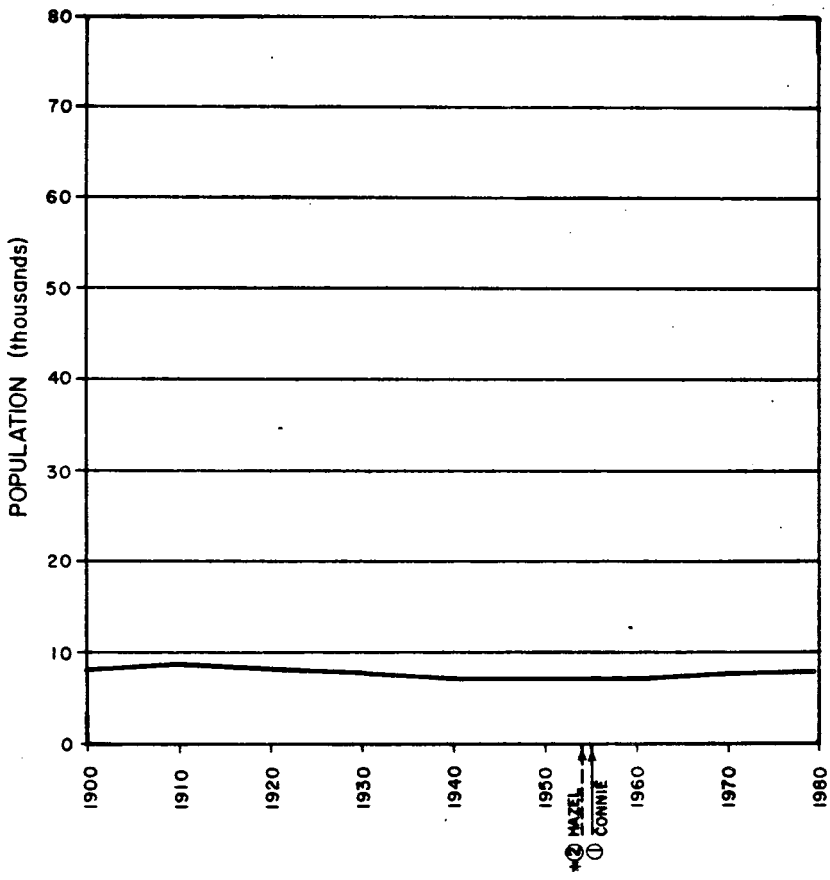
INCLUDES THE INDEPENDENT CITIES OF HAMPTON AND NEWPORT NEWS AND THE FORMER COUNTIES OF ELIZABETH CITY AND WARWICK CITY.



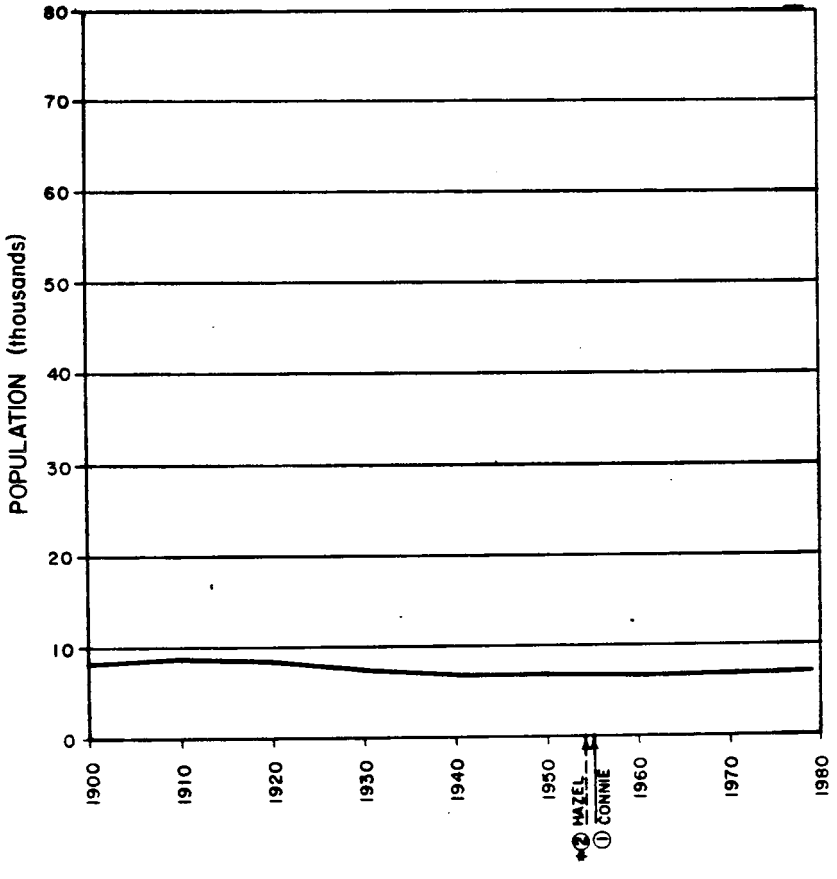
GLOUCESTER COUNTY, VA



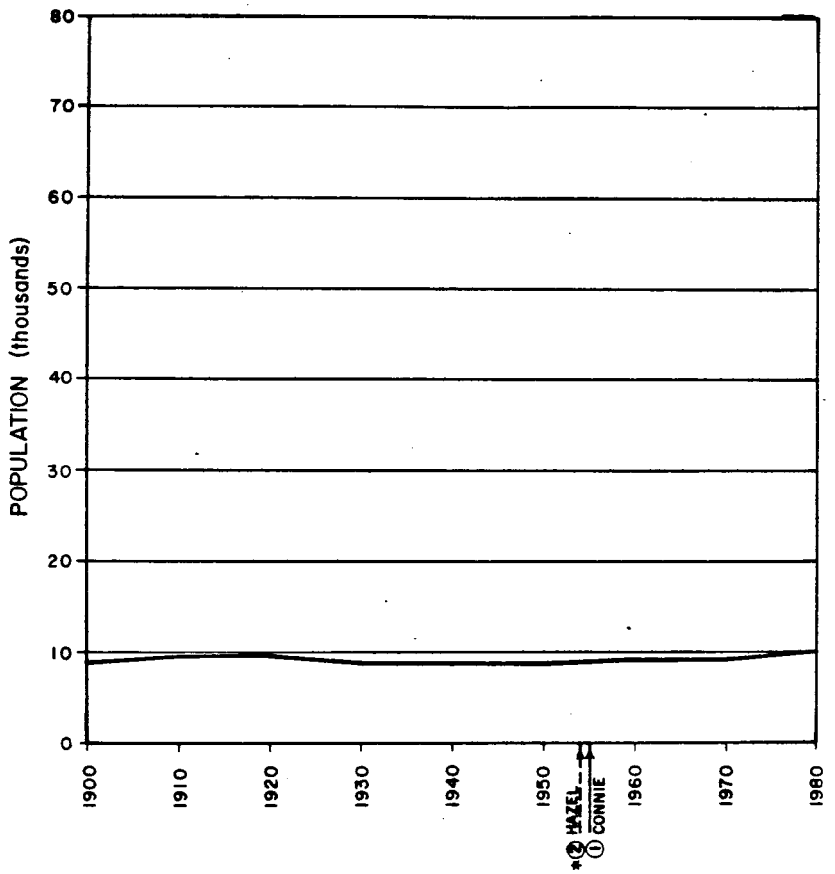
MATHEWS COUNTY, VA



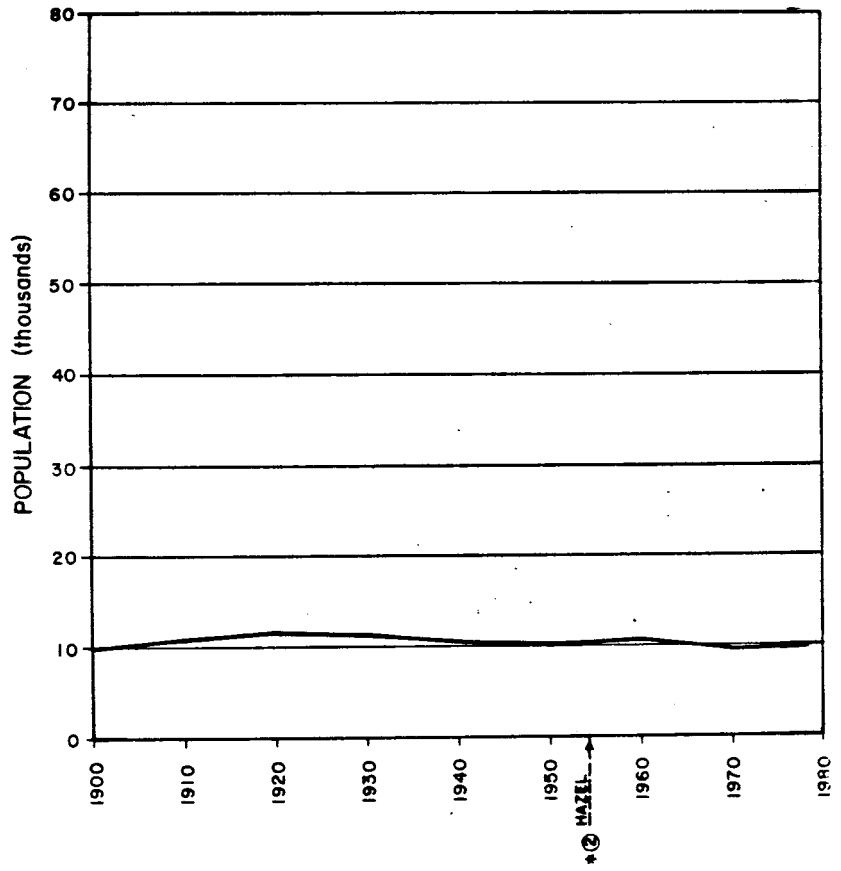
MIDDLESEX COUNTY, VA

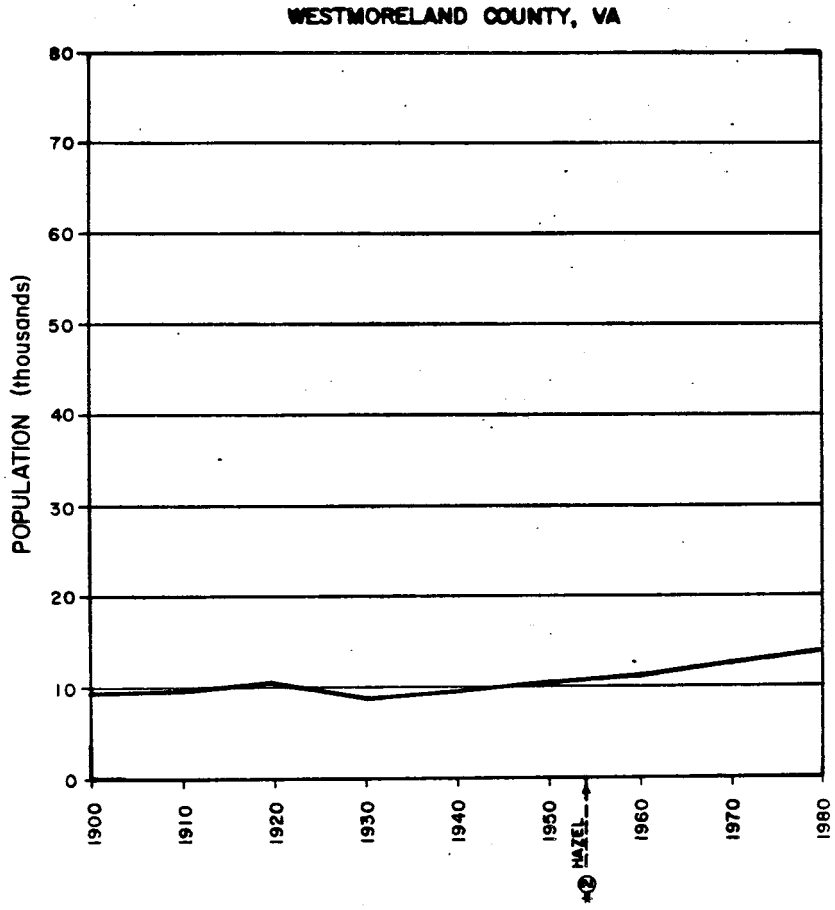


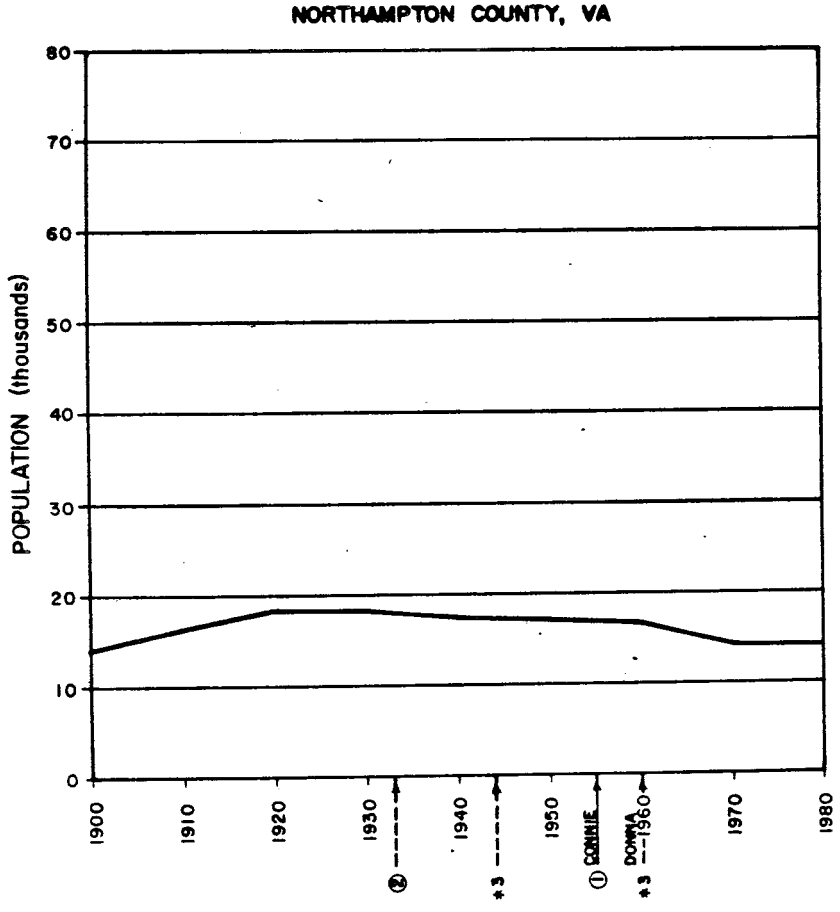
LANCASTER COUNTY, VA

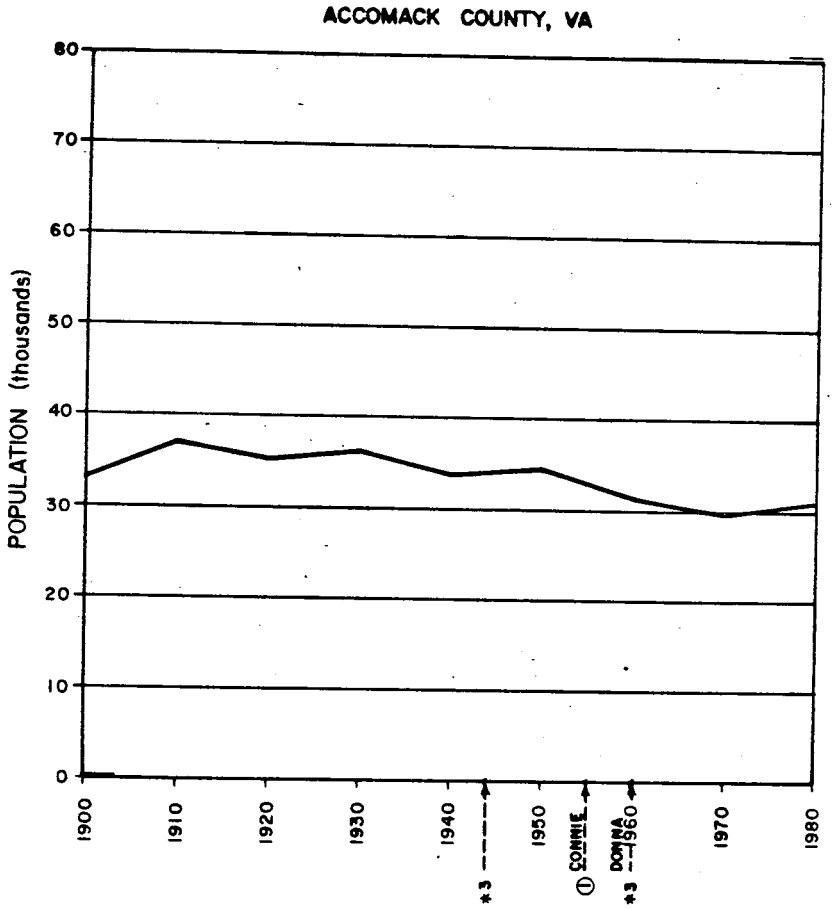


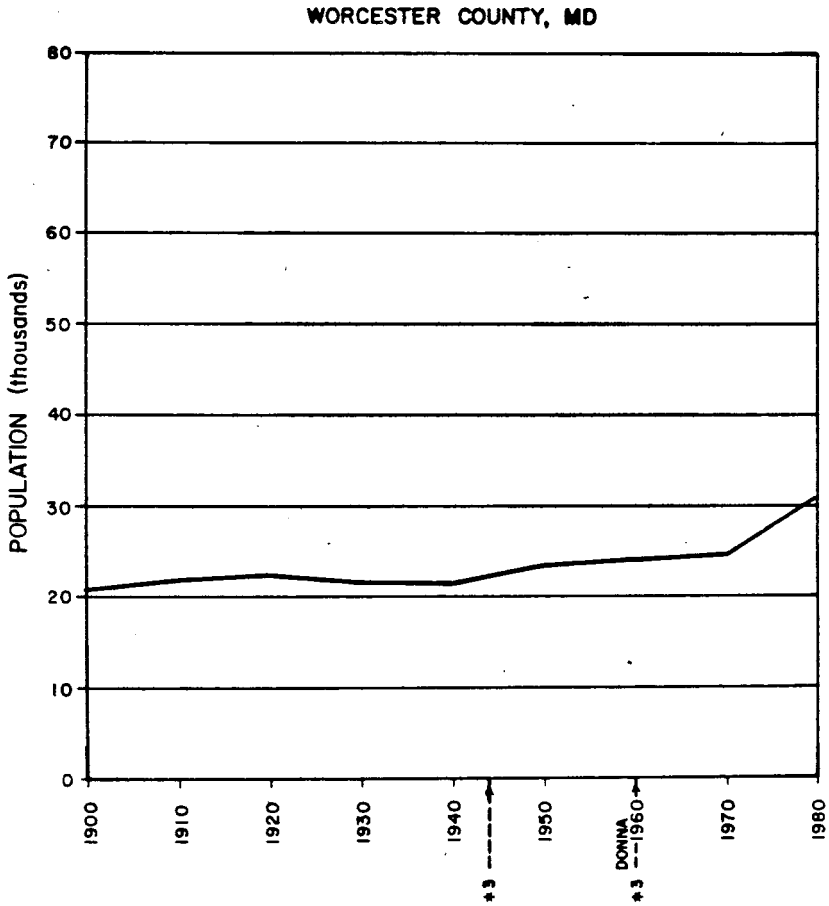
NORTHUMBERLAND COUNTY, VA



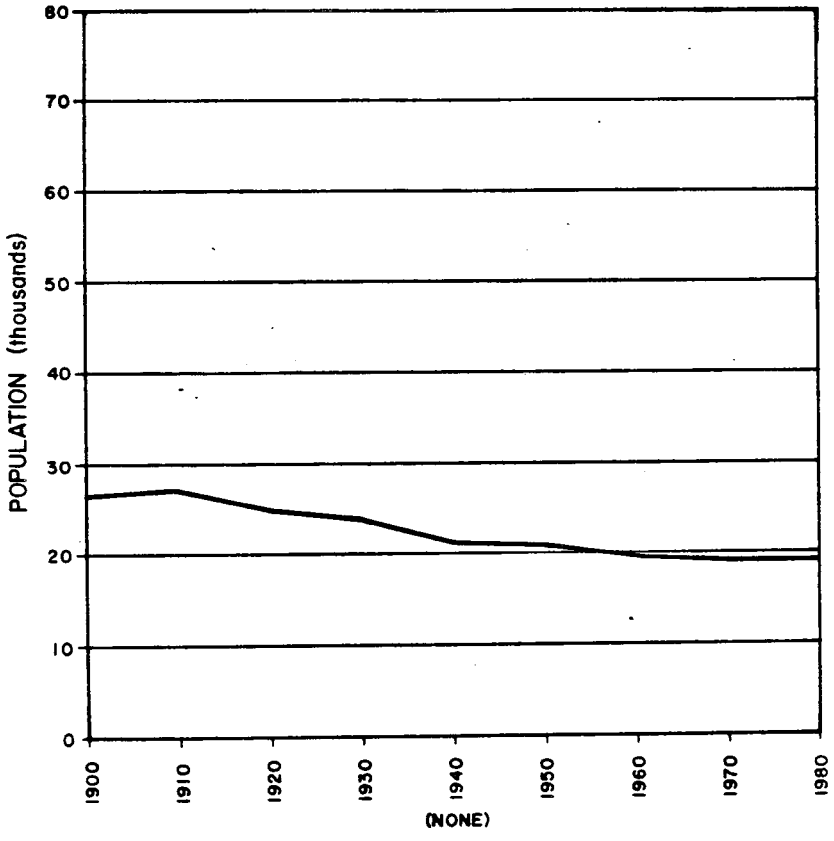

WESTMORELAND COUNTY, VA
POPULATION (thousands)
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
HAZEL
+2


NORTHAMPTON COUNTY, VA
POPULATION (thousands)
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
+3
CONNIE
DONNA
+3

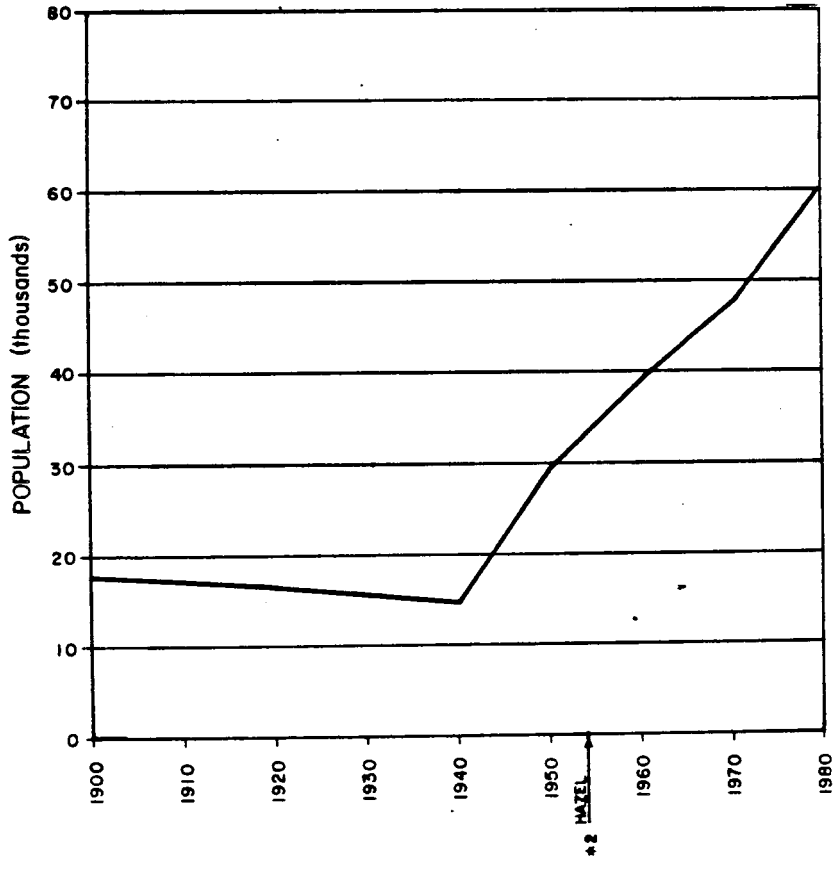

ACCOMACK COUNTY, VA
POPULATION (thousands)
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
#3
CONNIE
DONNA
#3
#3


WORCESTER COUNTY, MD
POPULATION (thousands)
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
#3
DONNA
#3
#3

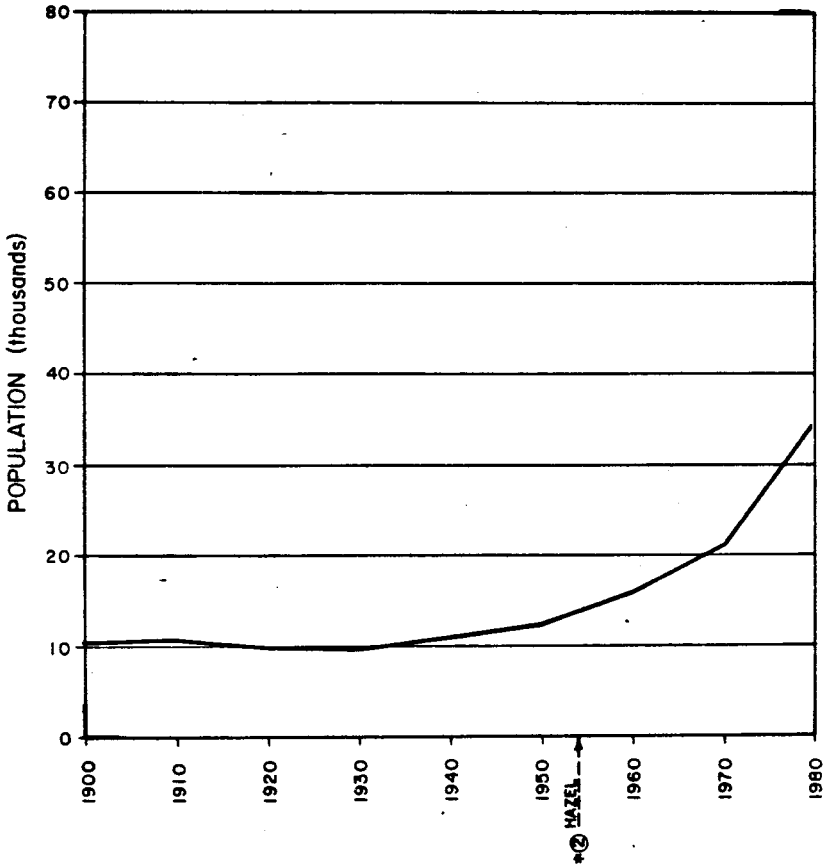
SOMERSET COUNTY, MD



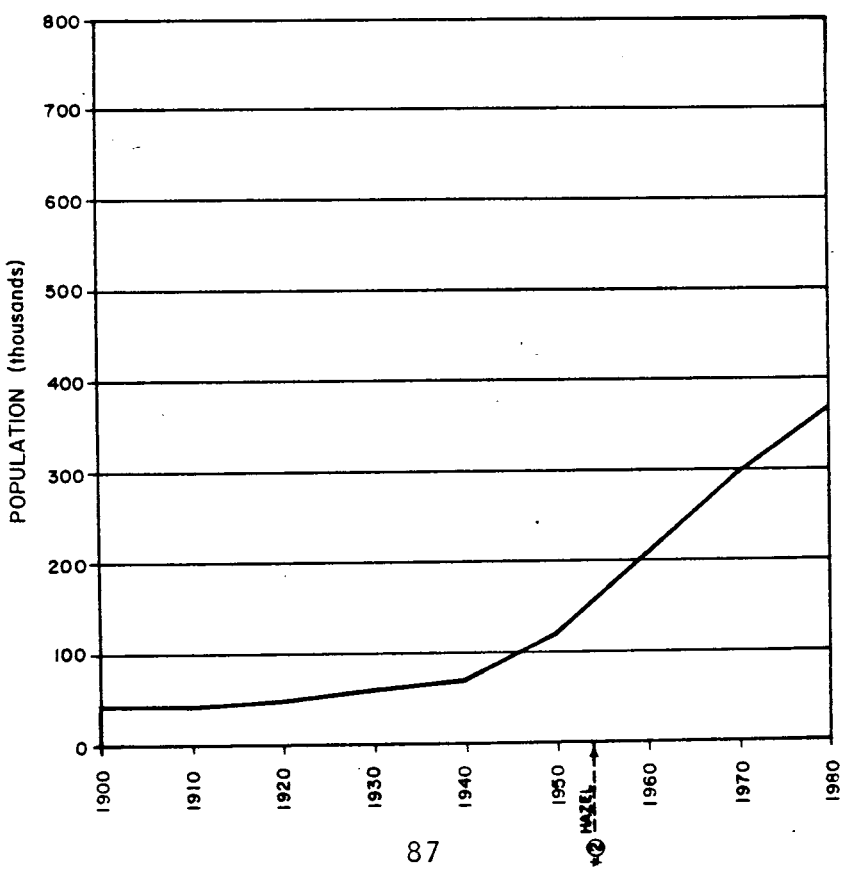
ST. MARYS COUNTY, MD

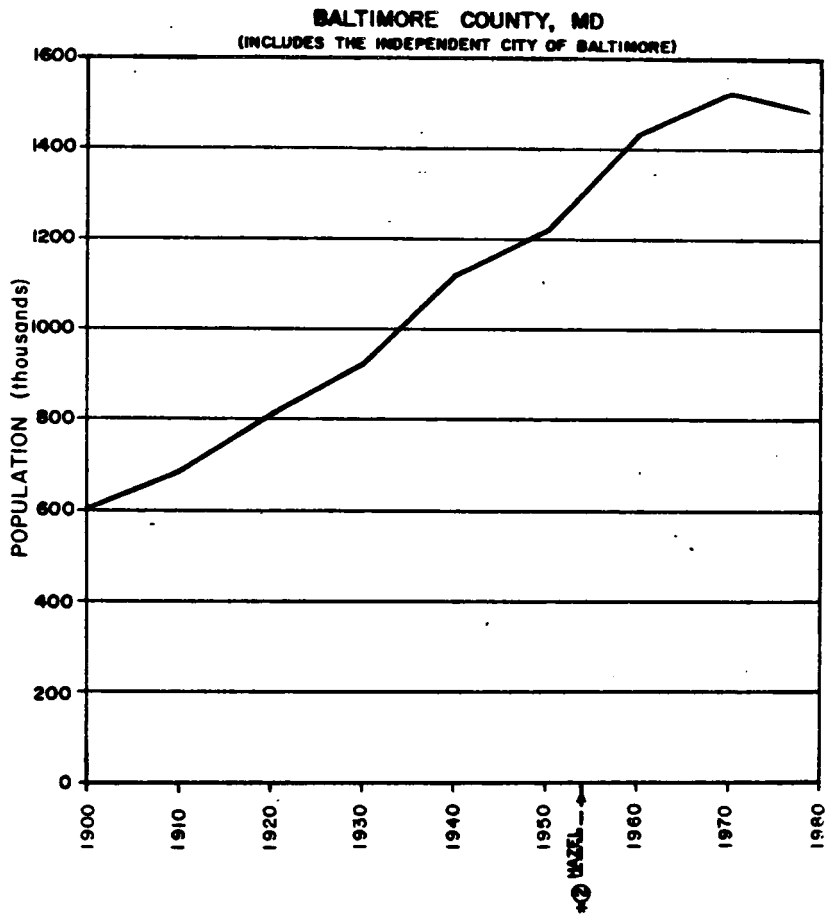


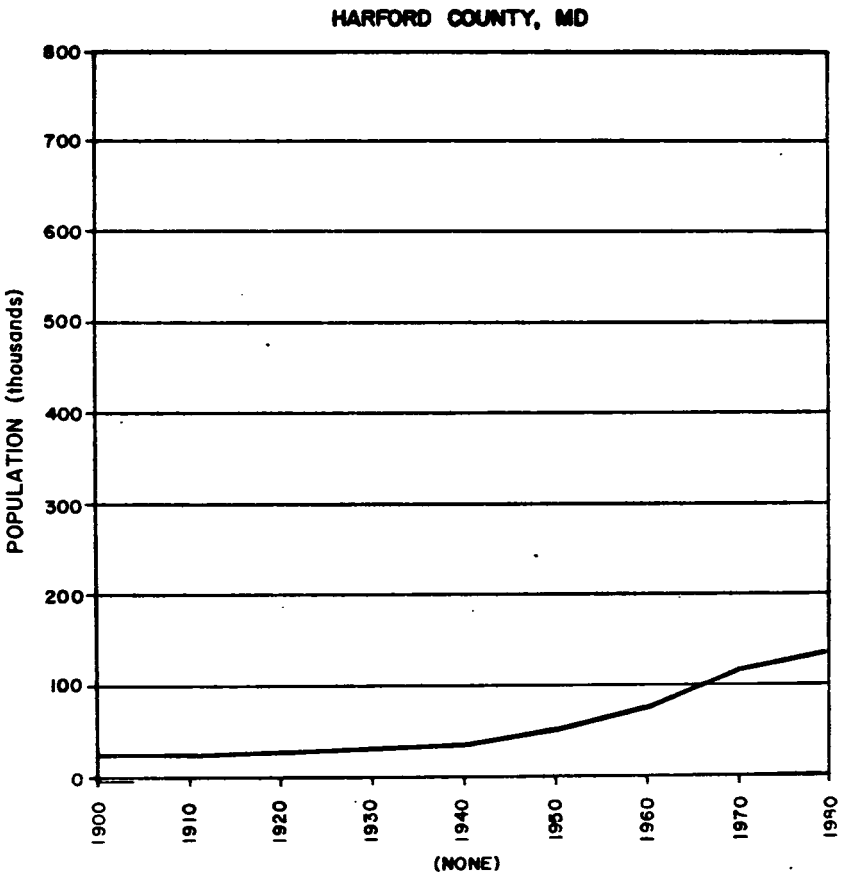
CALVERT COUNTY, MD



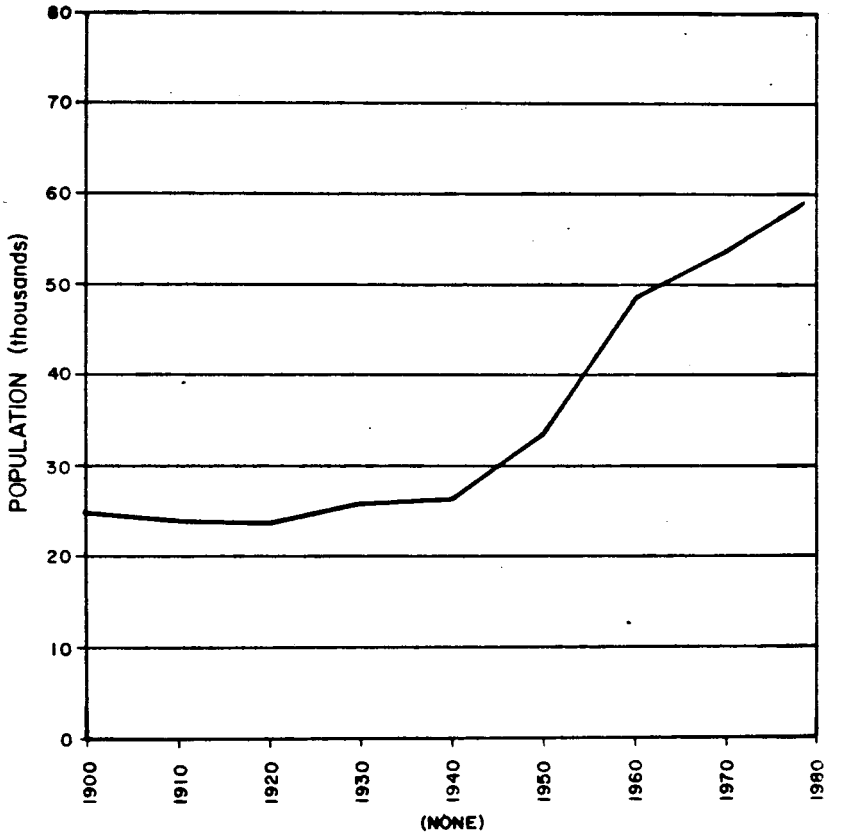
ANNE ARUNDEL COUNTY, MD



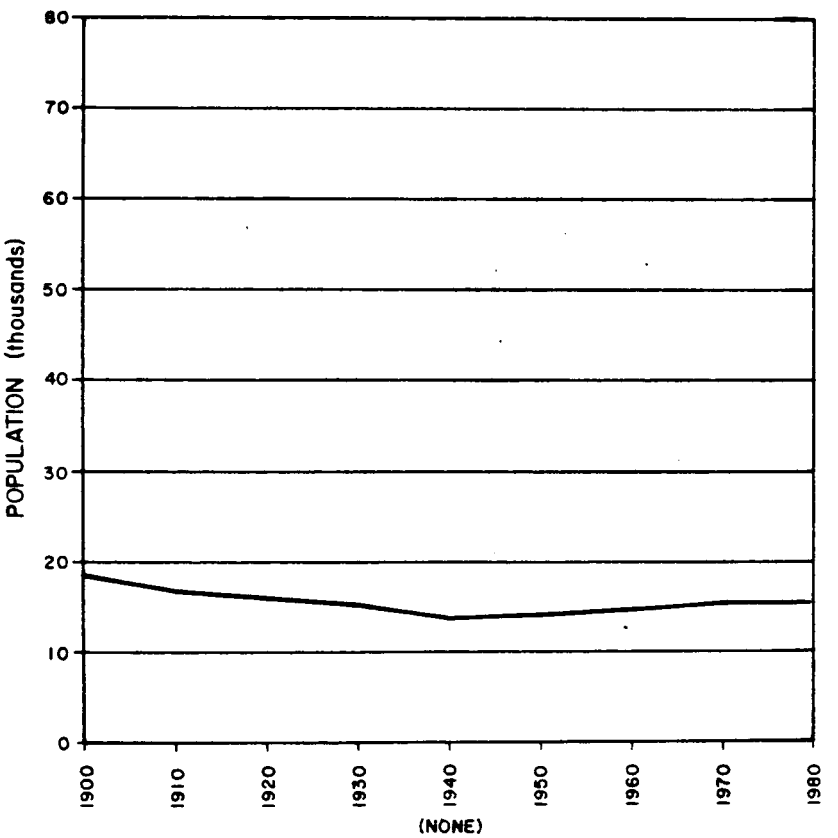

BALTIMORE COUNTY, MD
(INCLUDES THE INDEPENDENT CITY OF BALTIMORE)
POPULATION (thousands)
1600
1400
1200
1000
800
600
400
200
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
HAZEL

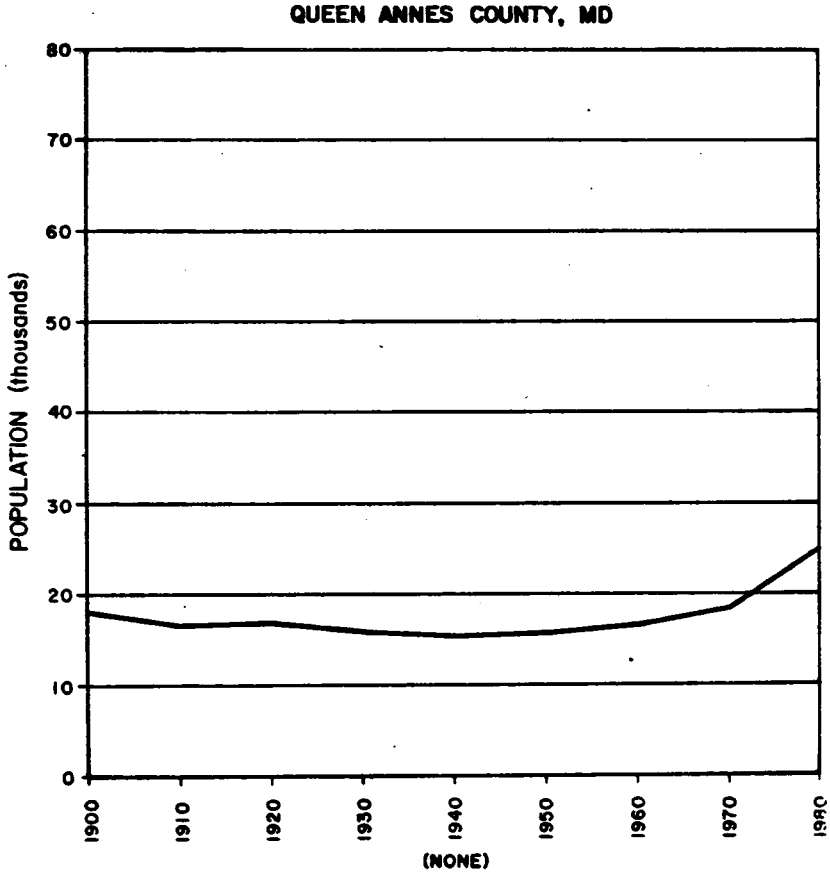

HARFORD COUNTY, MD
POPULATION (thousands)
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
(NONE)

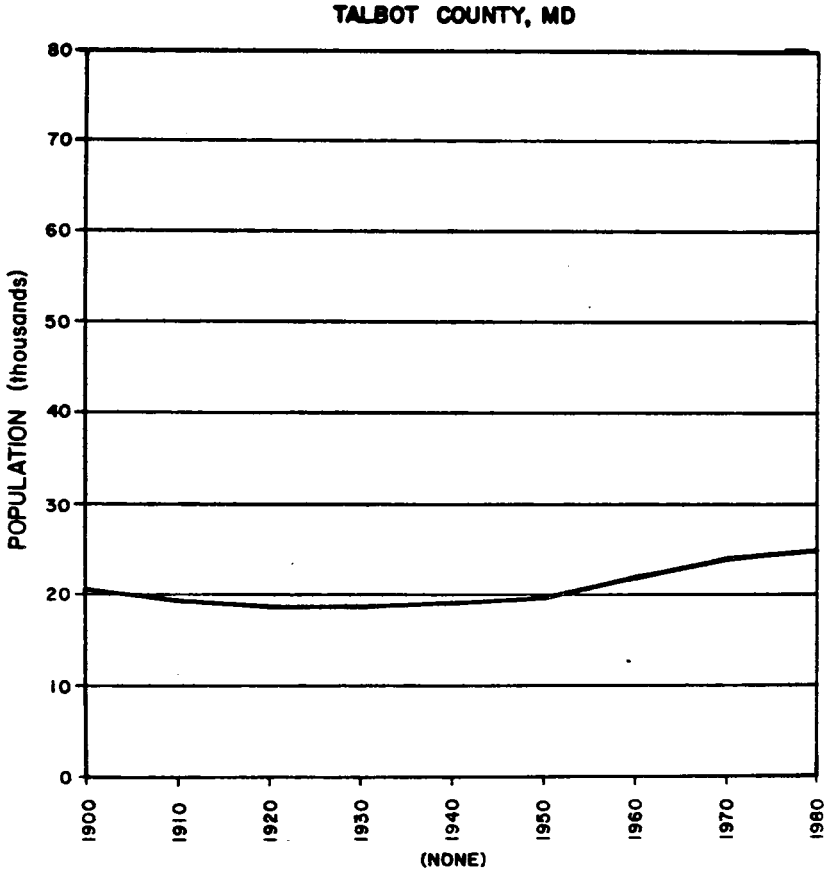
CECIL COUNTY, MD



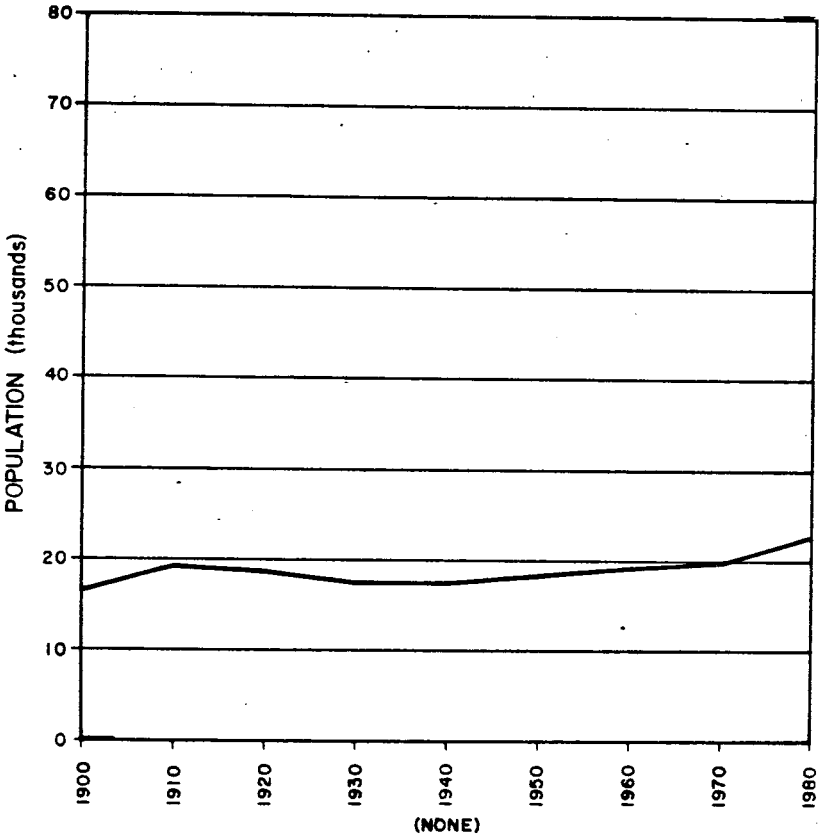
KENT COUNTY, MD



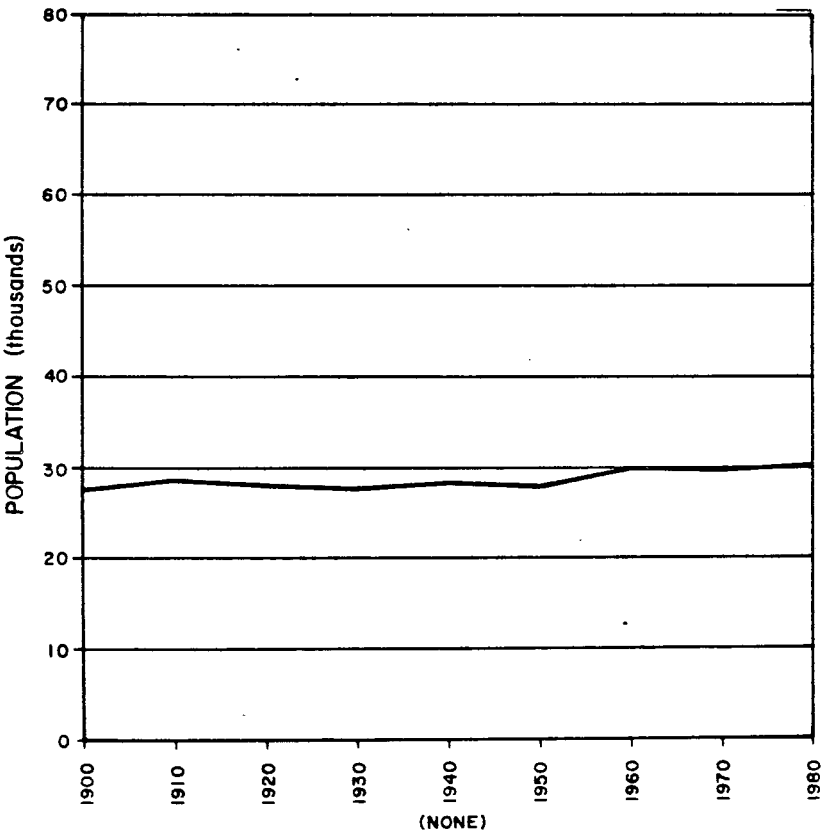

QUEEN ANNES COUNTY, MD
POPULATION (thousands)
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
(NONE)

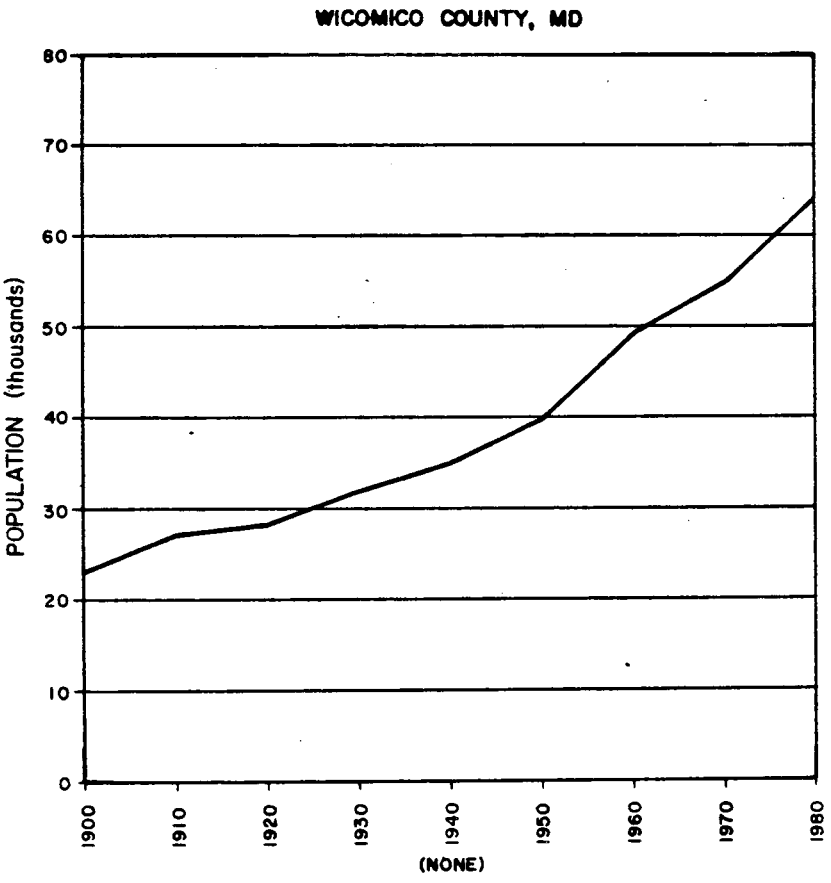

TALBOT COUNTY, MD
POPULATION (thousands)
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
(NONE)

CAROLINE COUNTY, MD



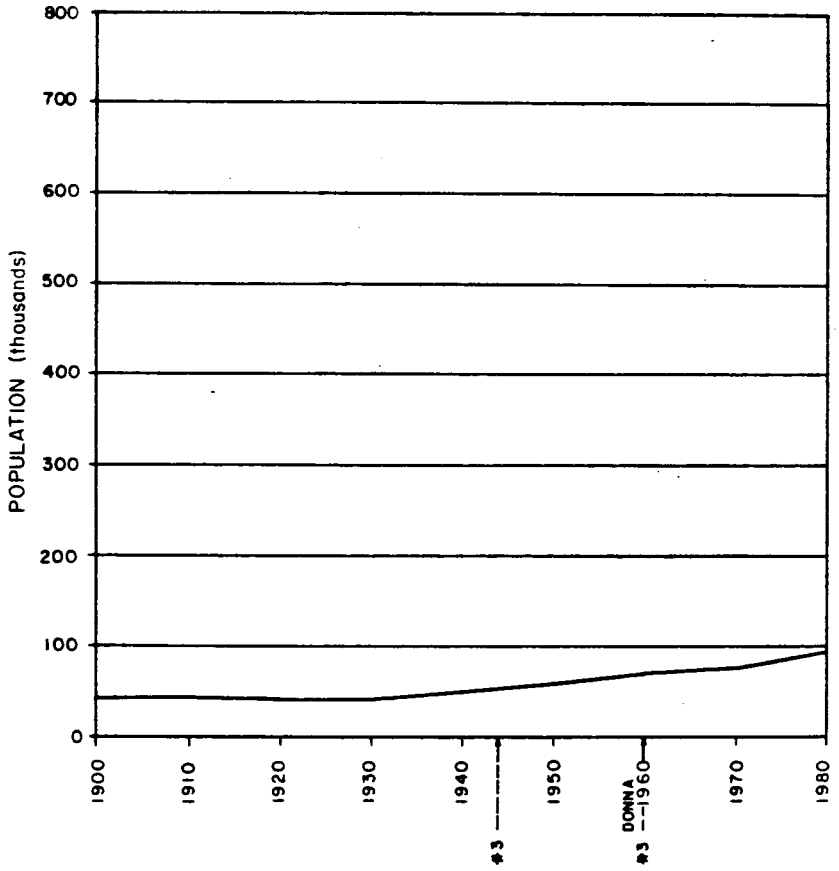
DORCHESTER COUNTY, MD



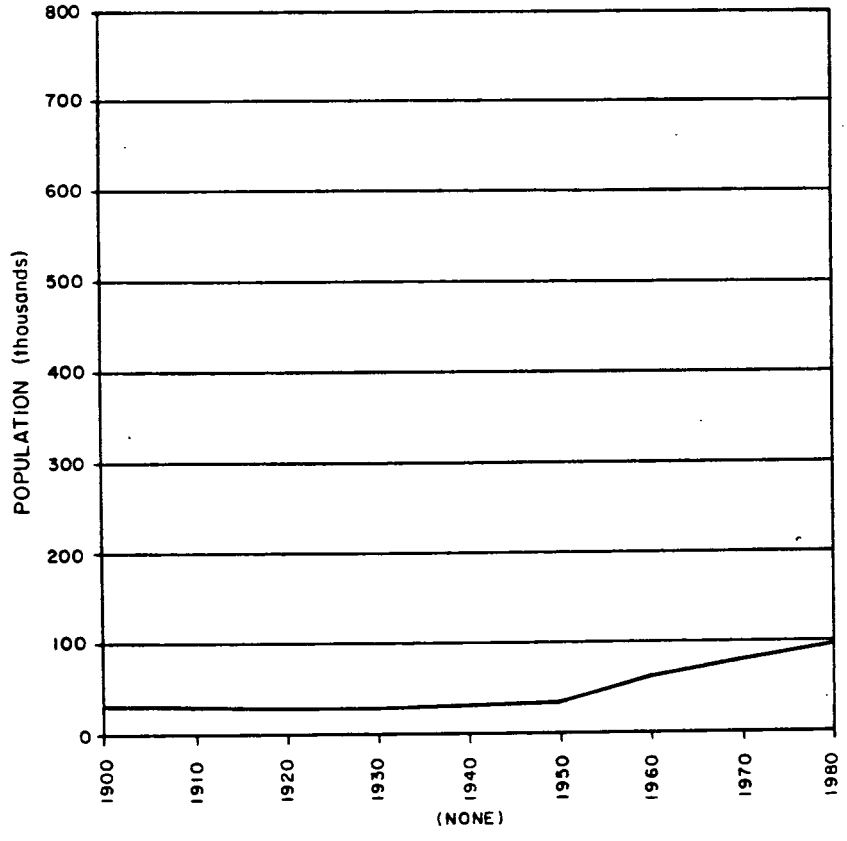


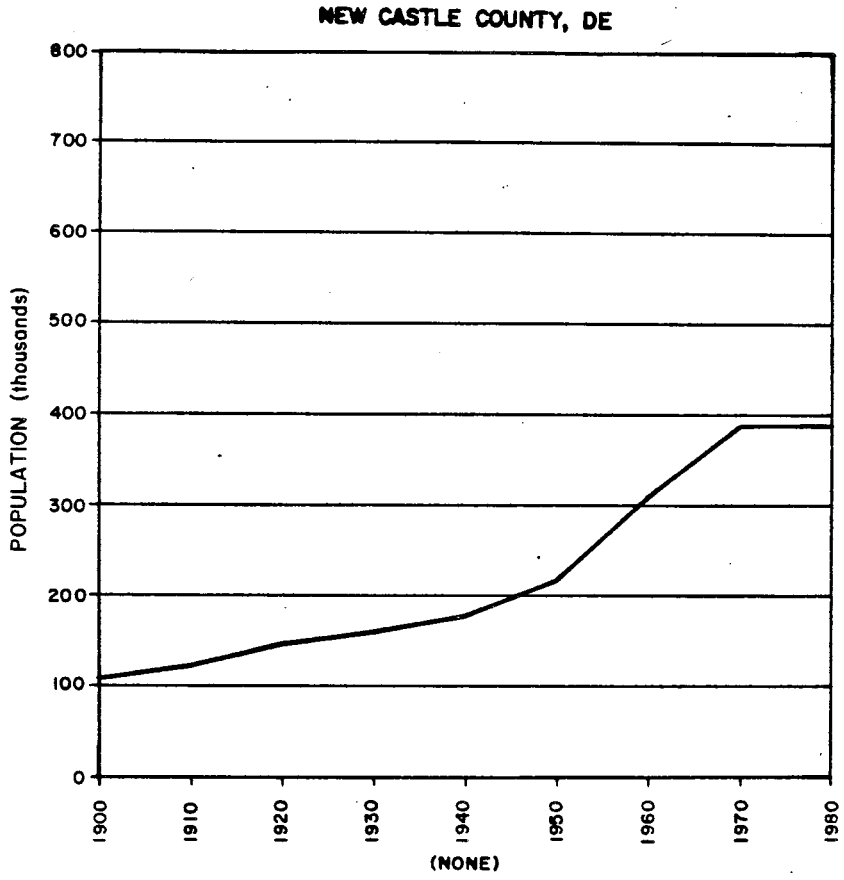
END OF MARYLAND COUNTIES

SUSSEX COUNTY, DE



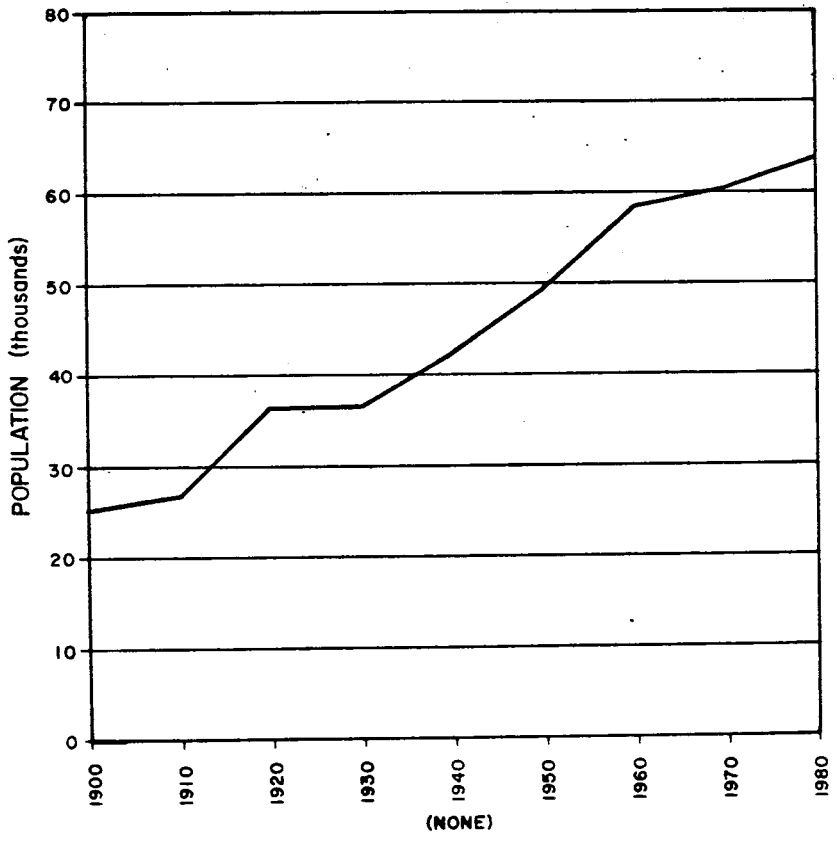
KENT COUNTY, DE



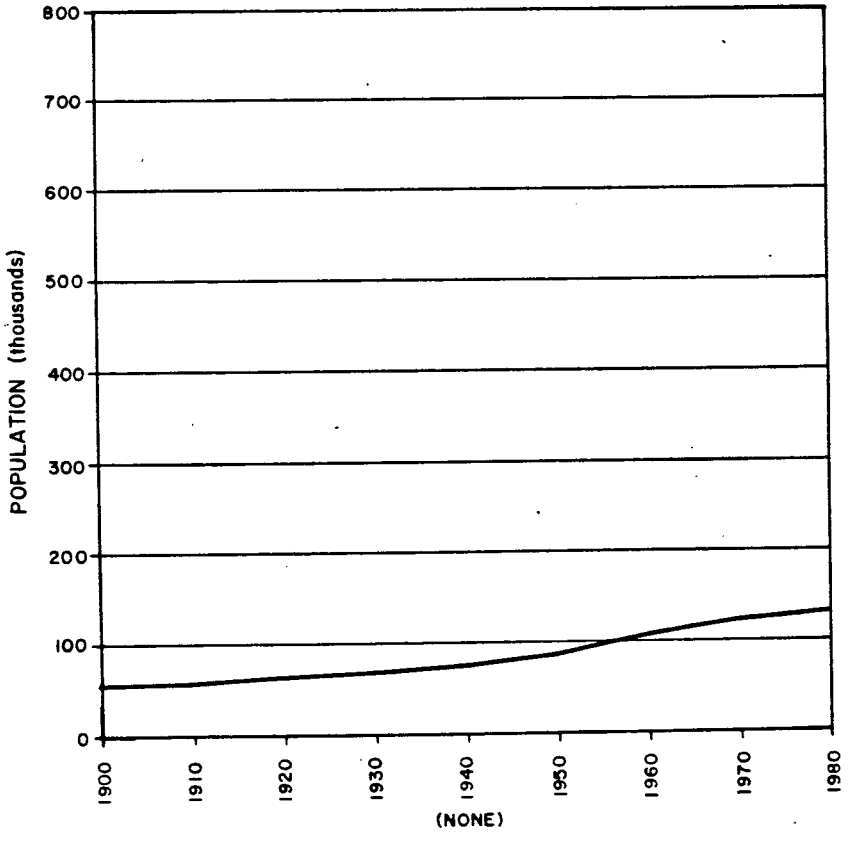


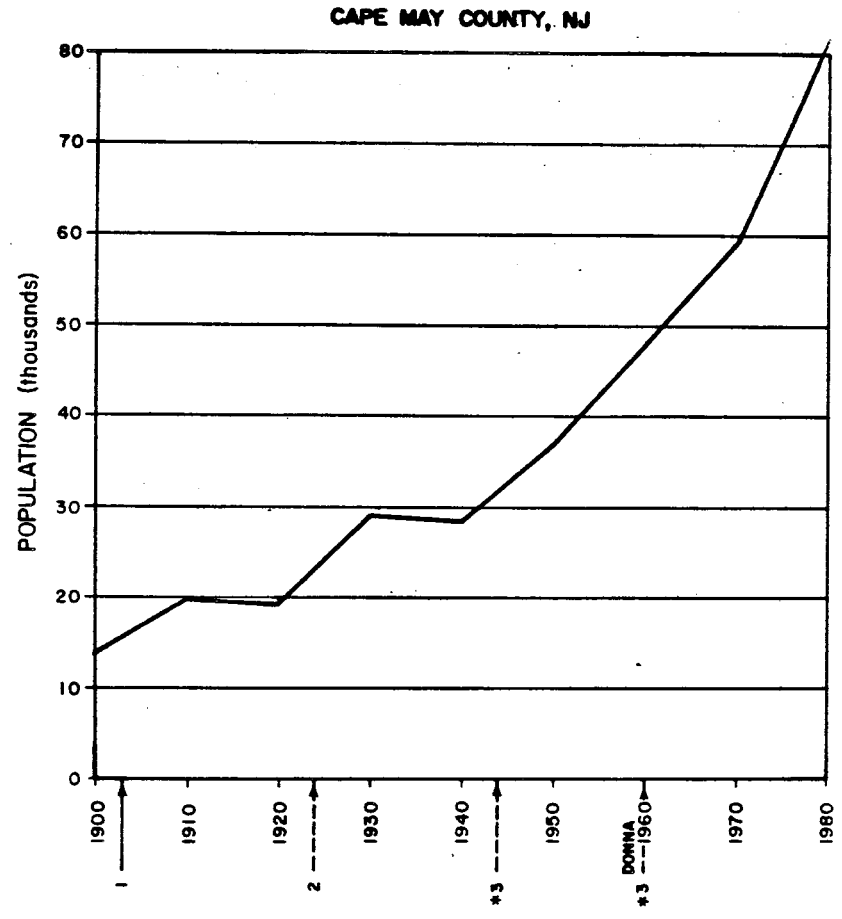
END OF DELAWARE COUNTIES

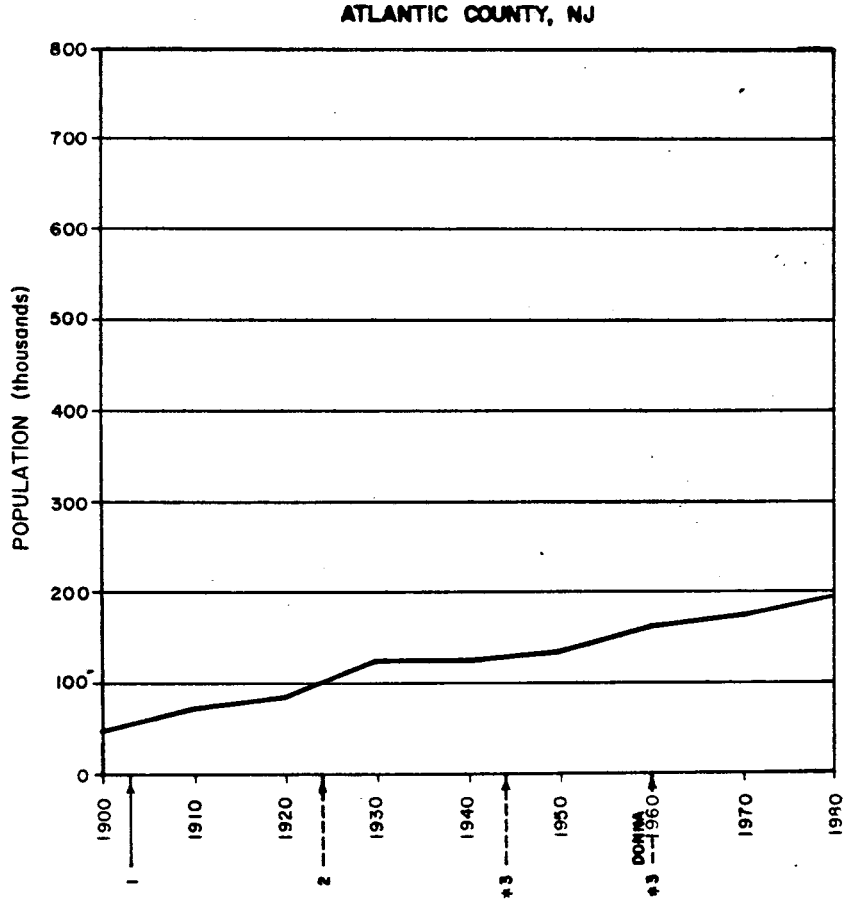
SALEM COUNTY, NJ



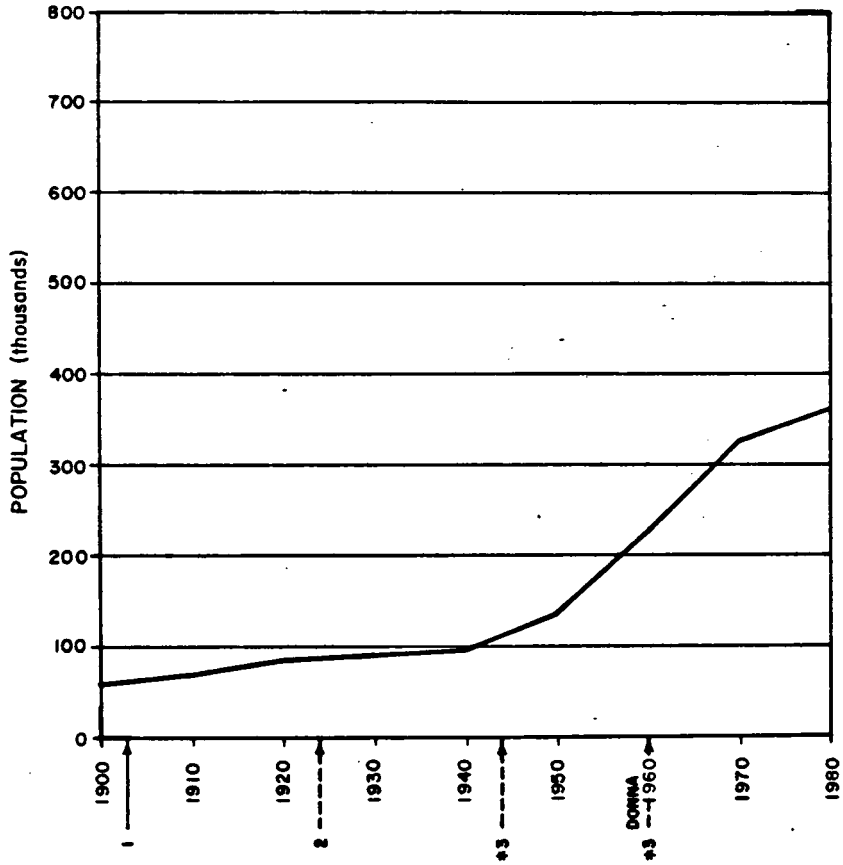
CUMBERLAND COUNTY, NJ



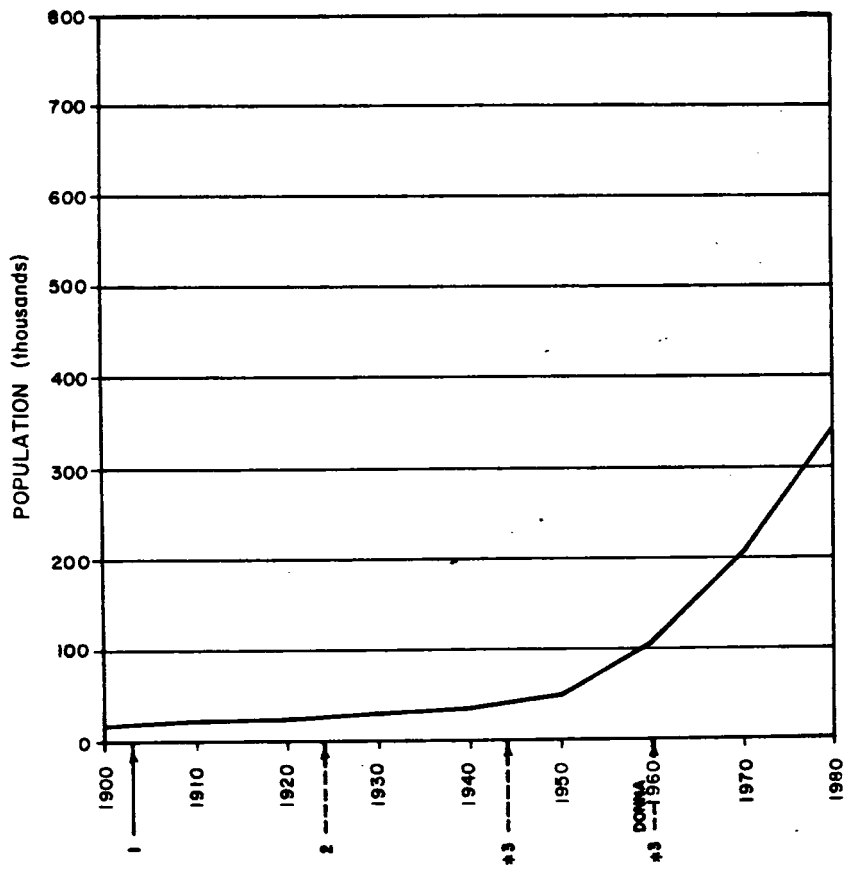

CAPE MAY COUNTY, NJ
POPULATION (thousands)
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1
2
*3
DONNA
*3
1960

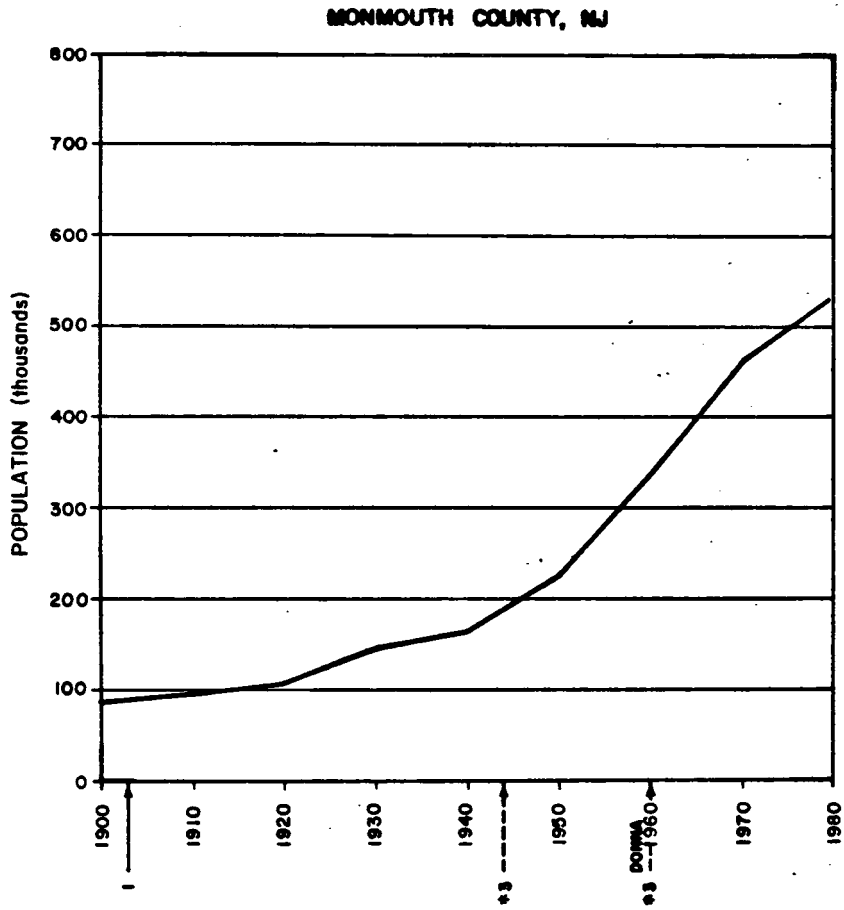

ATLANTIC COUNTY, NJ
POPULATION (thousands)
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1
2
*3
DONNA
*3
1960

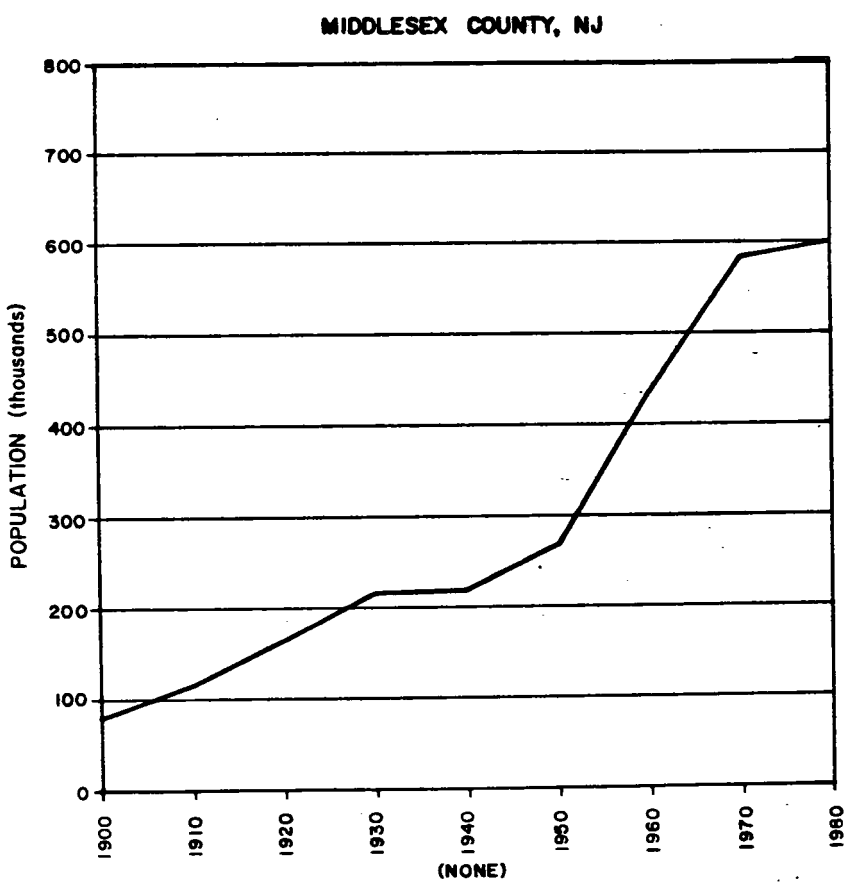
BURLINGTON COUNTY, NJ

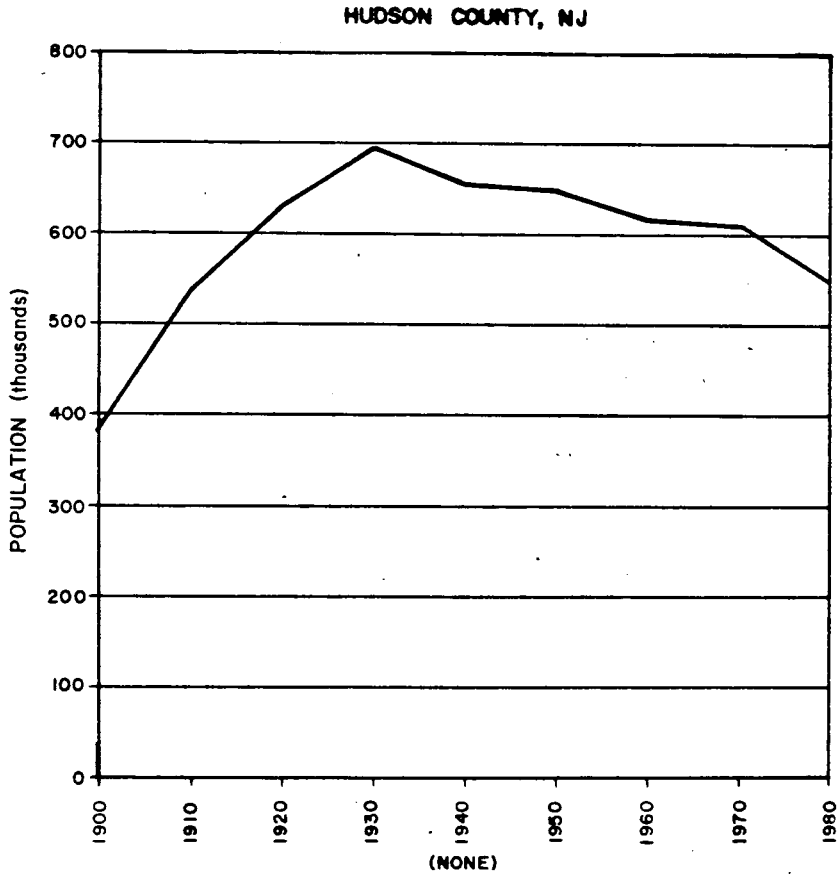


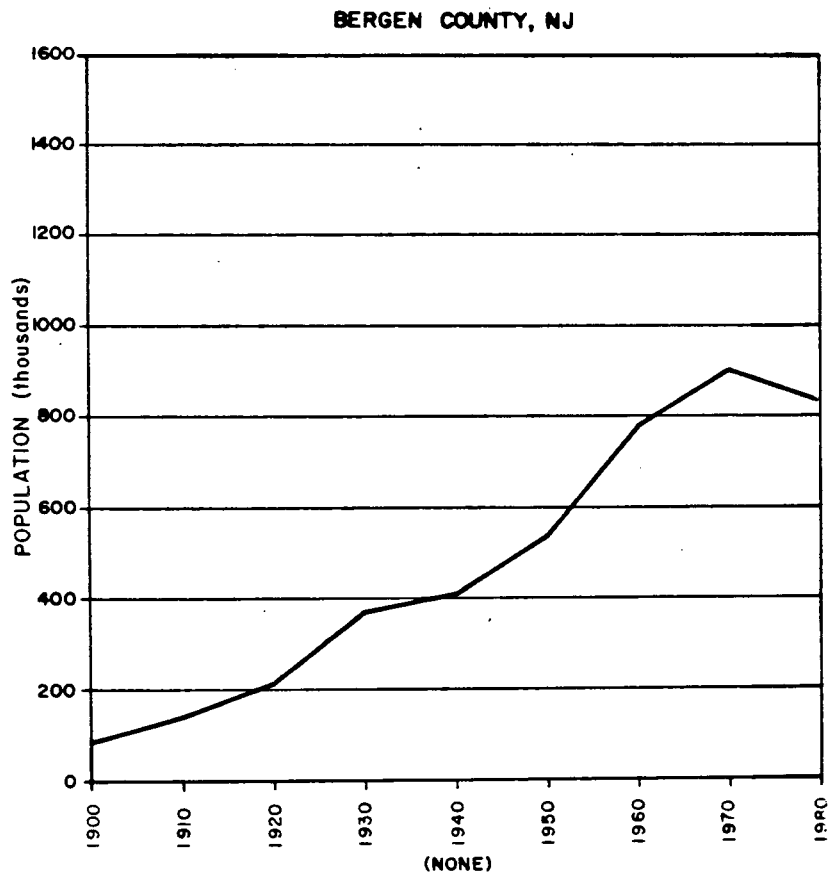
OCEAN COUNTY, NJ



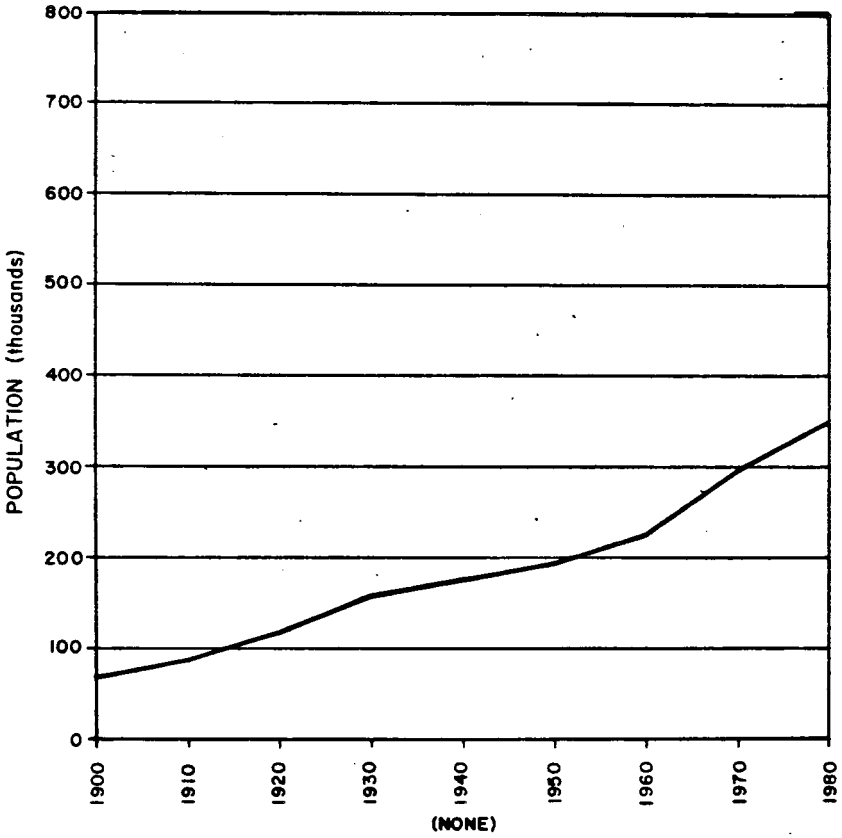

MONMOUTH COUNTY, NJ
POPULATION (thousands)
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
DONNA
#3 — 1960


MIDDLESEX COUNTY, NJ
POPULATION (thousands)
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
(NONE)


HUDSON COUNTY, NJ
POPULATION (thousands)
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
(NONE)

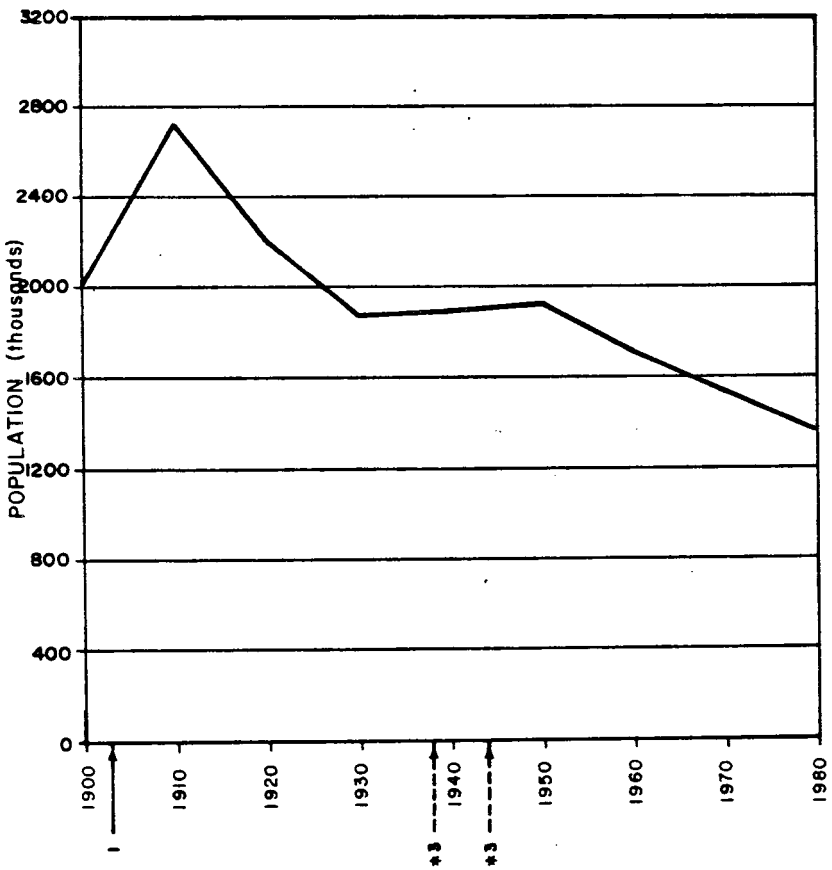

BERGEN COUNTY, NJ
POPULATION (thousands)
1600
1400
1200
1000
800
600
400
200
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
(NONE)

RICHMOND COUNTY, NY

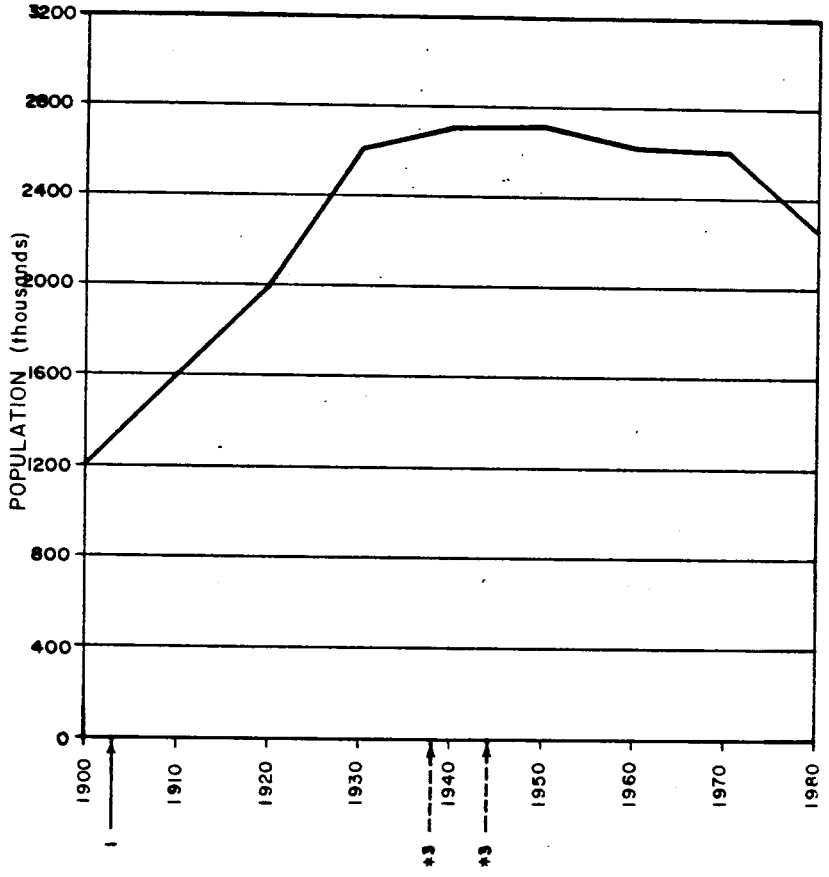


(NONE)

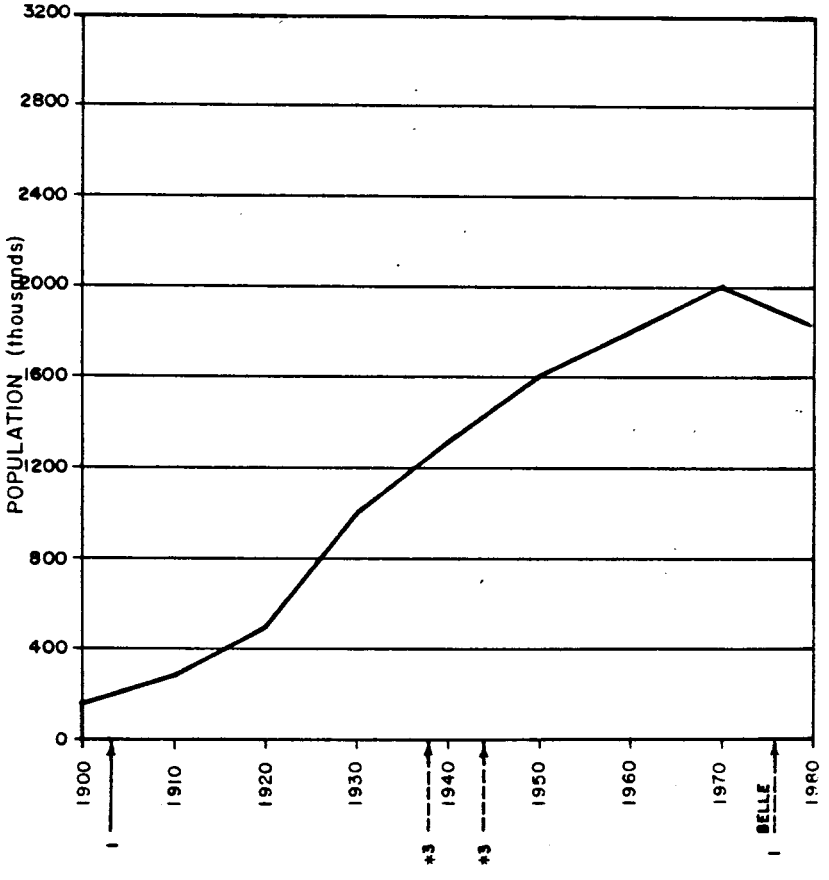
NEW YORK COUNTY, NY



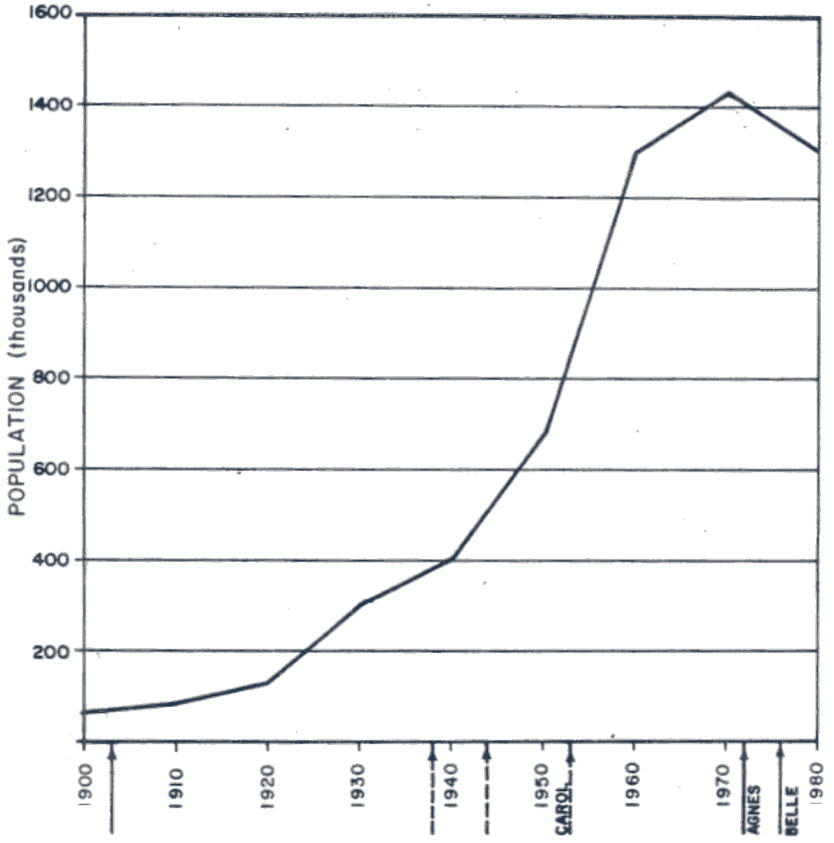
KINGS COUNTY, NY



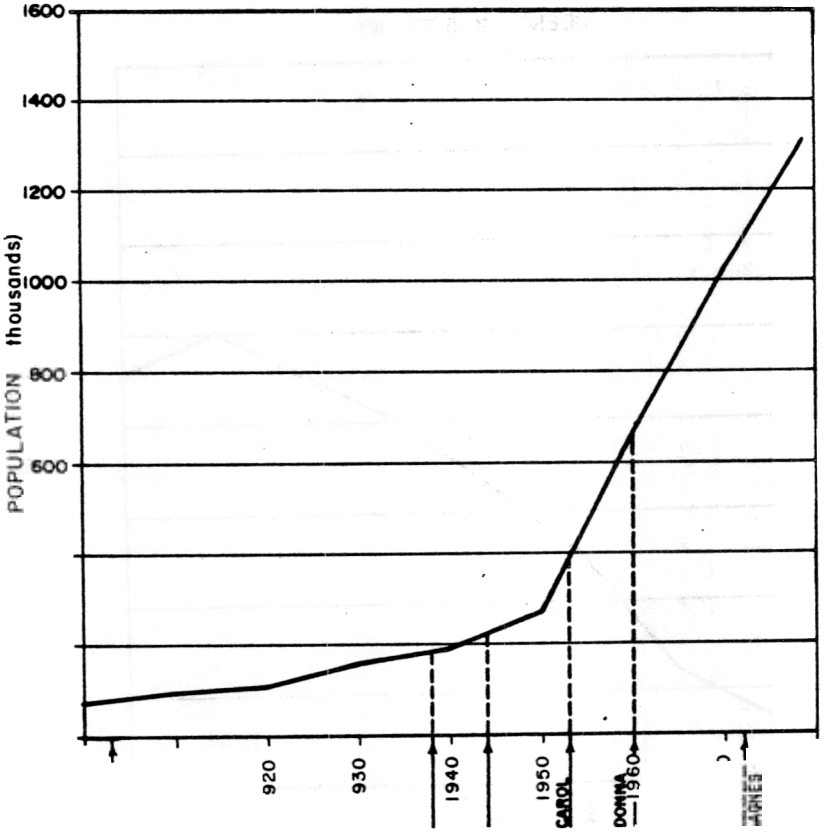
QUEENS COUNTY, NY

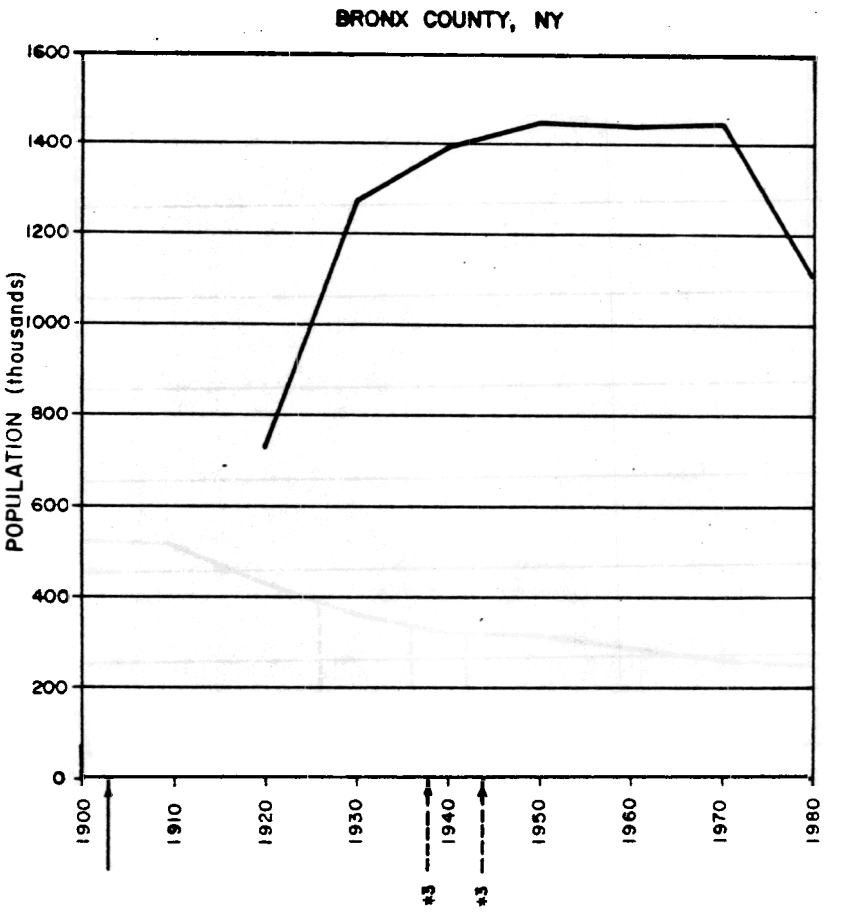


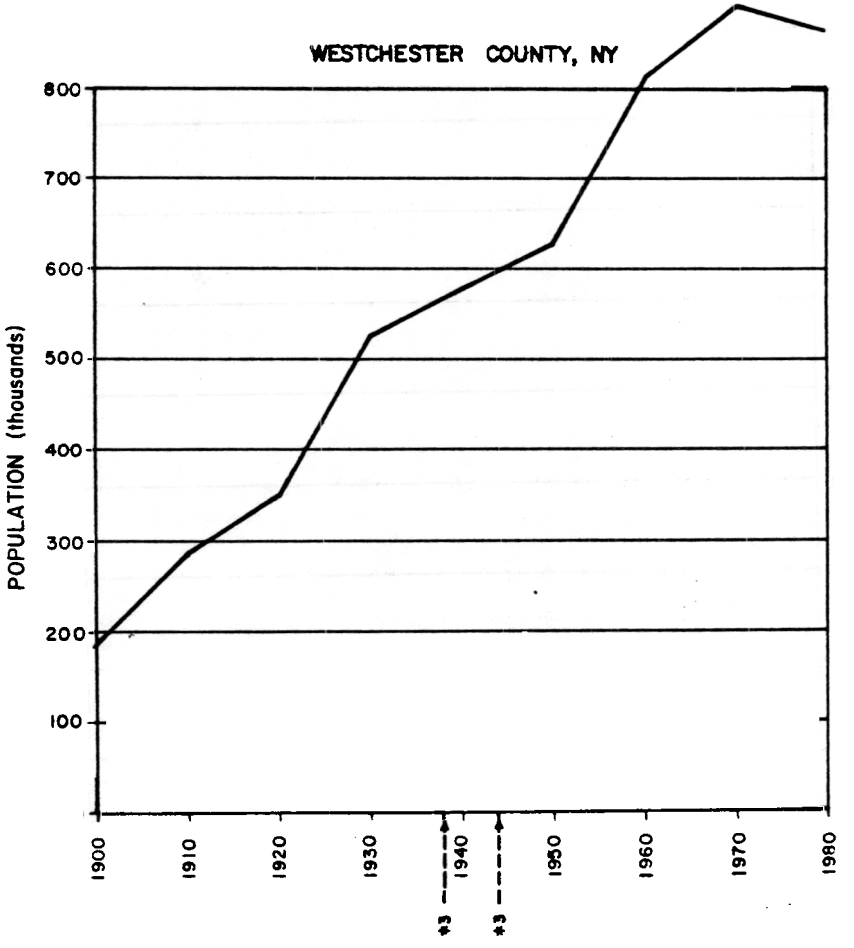
NASSAU COUNTY,



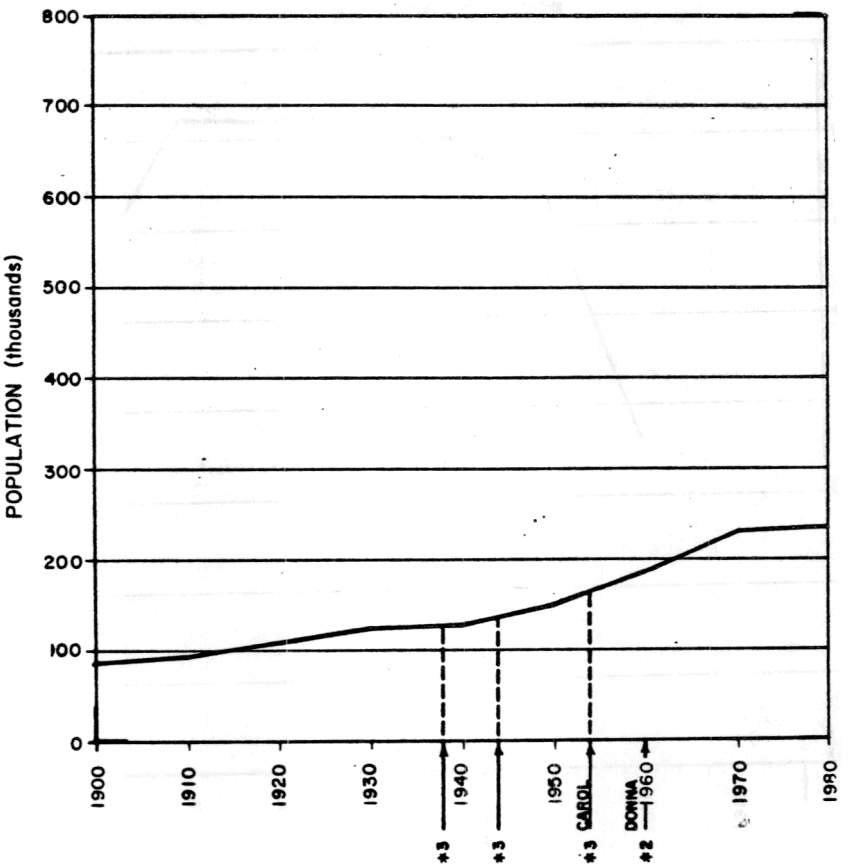
SUFFOLK COUNTY,



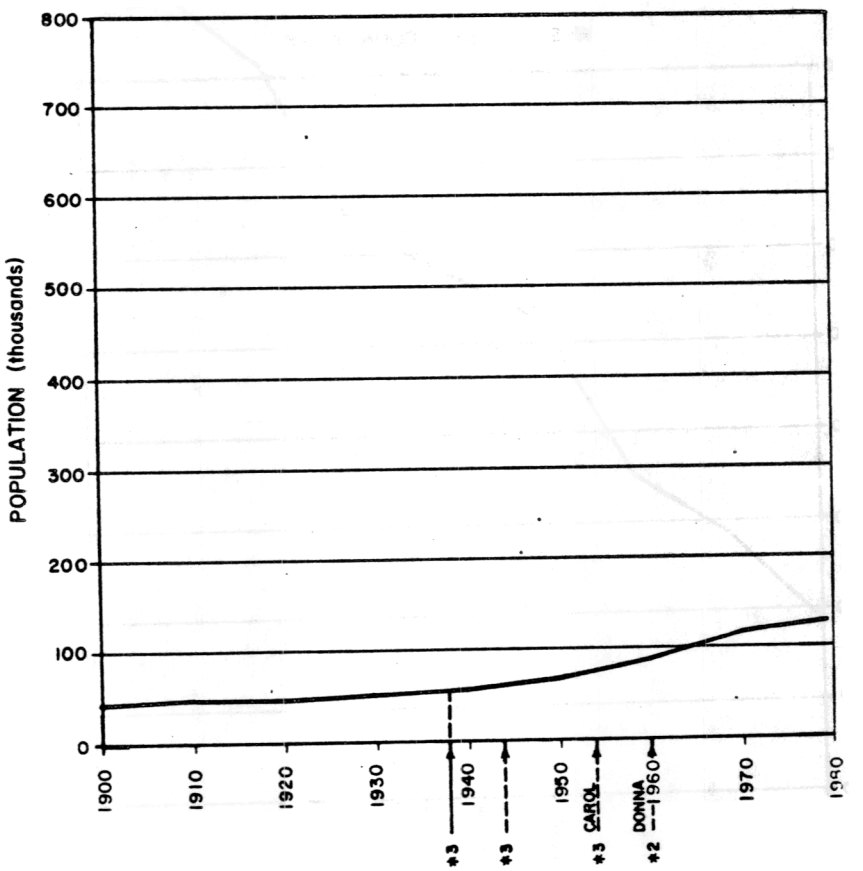

BRONX COUNTY, NY
POPULATION (thousands)
1600
1400
1200
1000
800
600
400
200
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
+3
+3

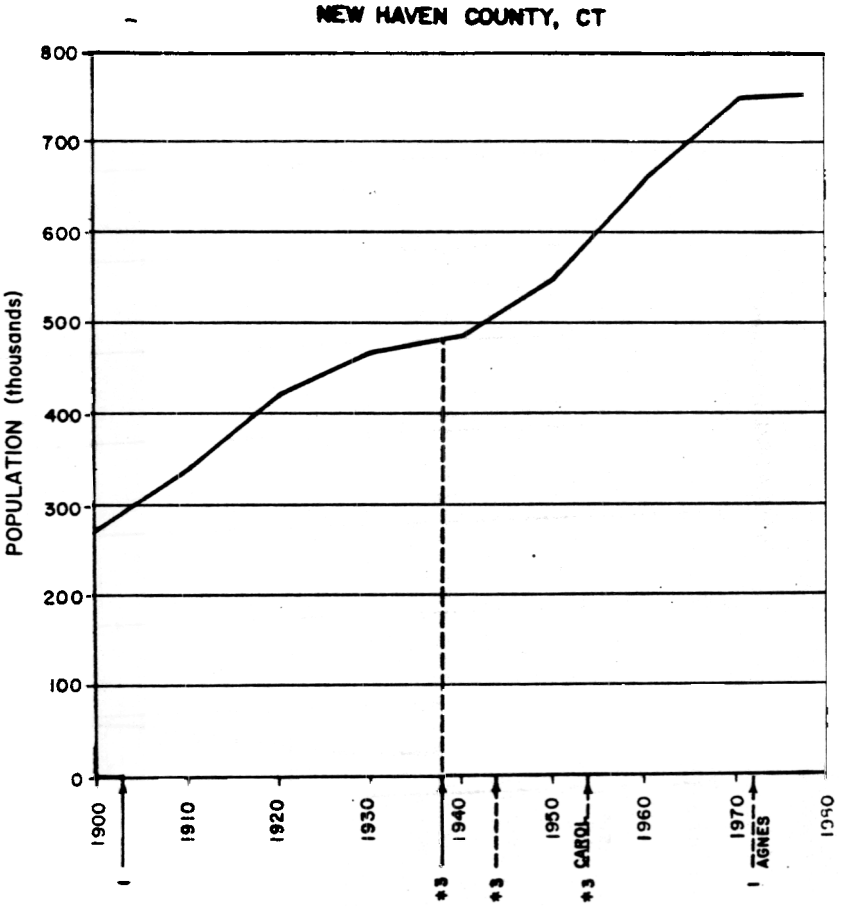

WESTCHESTER COUNTY, NY
POPULATION (thousands)
800
700
600
500
400
300
200
100
1900
1910
1920
1930
1940
1950
1960
1970
1980
+3
+3

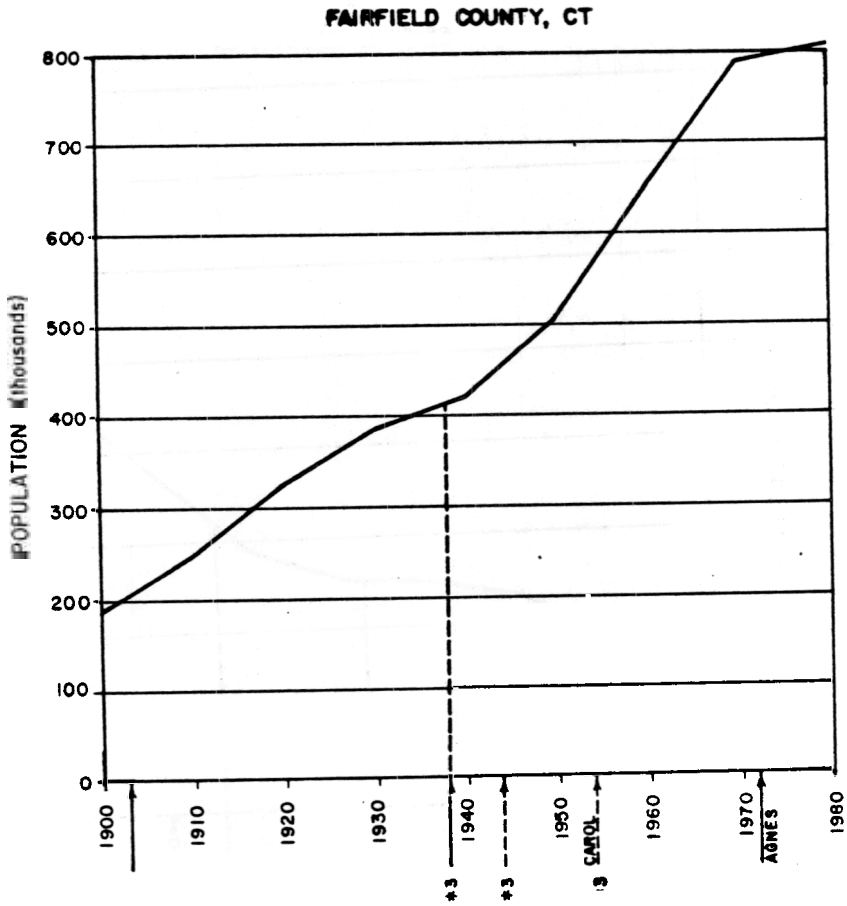
NEW LONDON COUNTY, CT

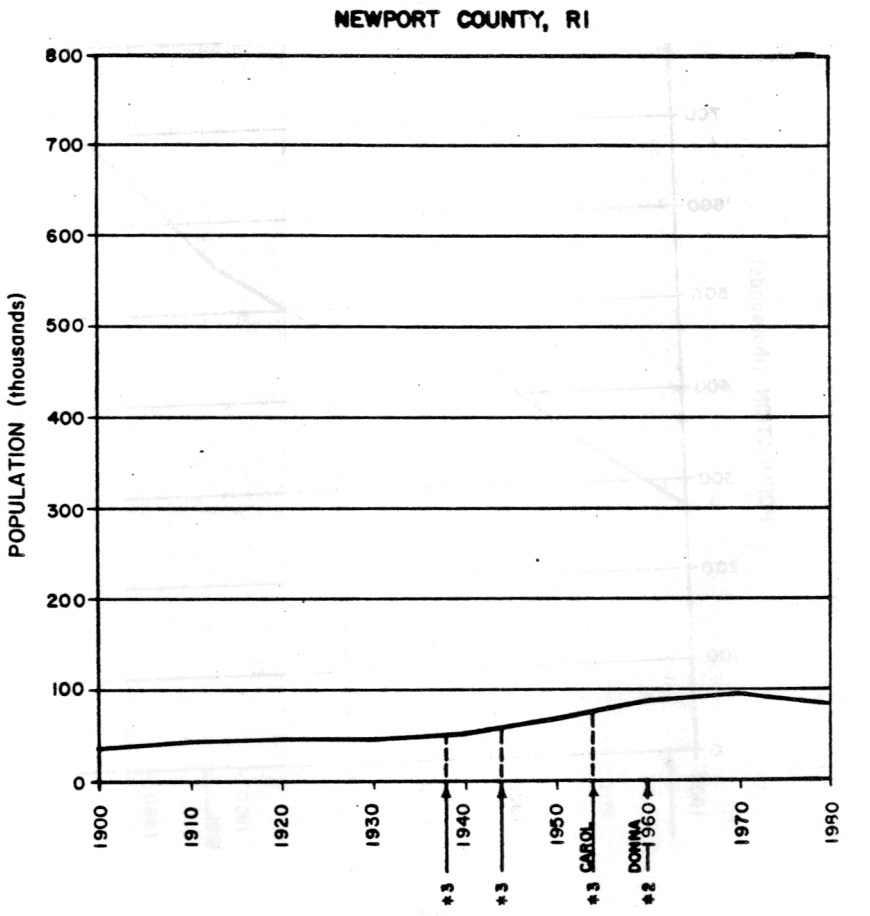


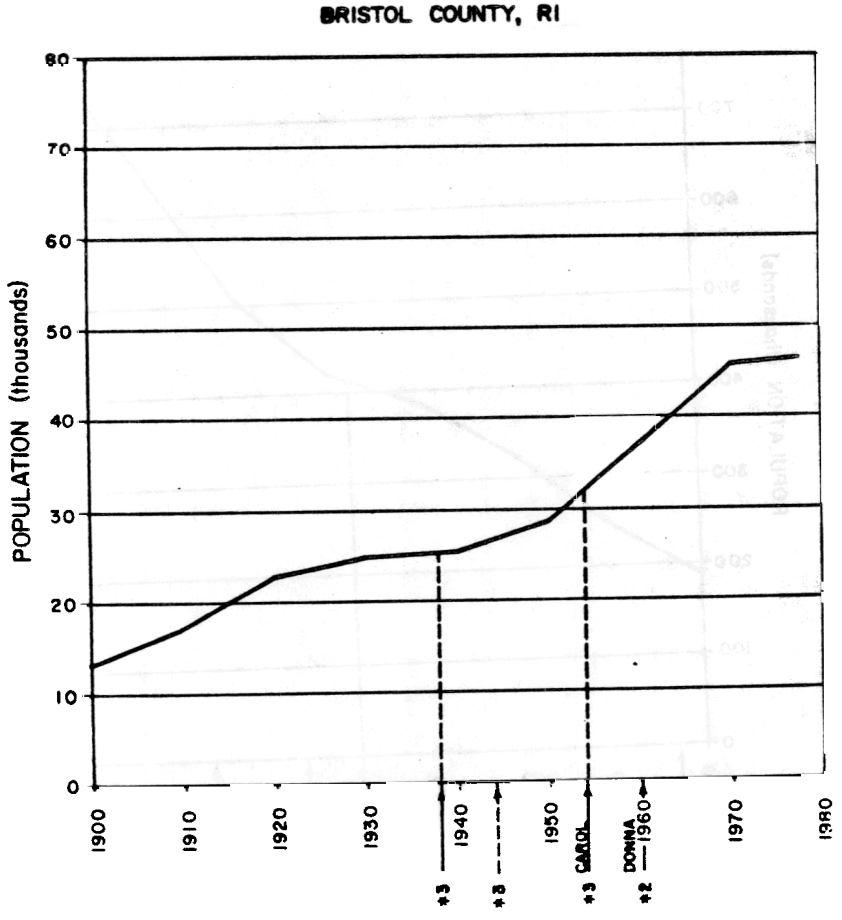
MIDDLESEX COUNTY, CT



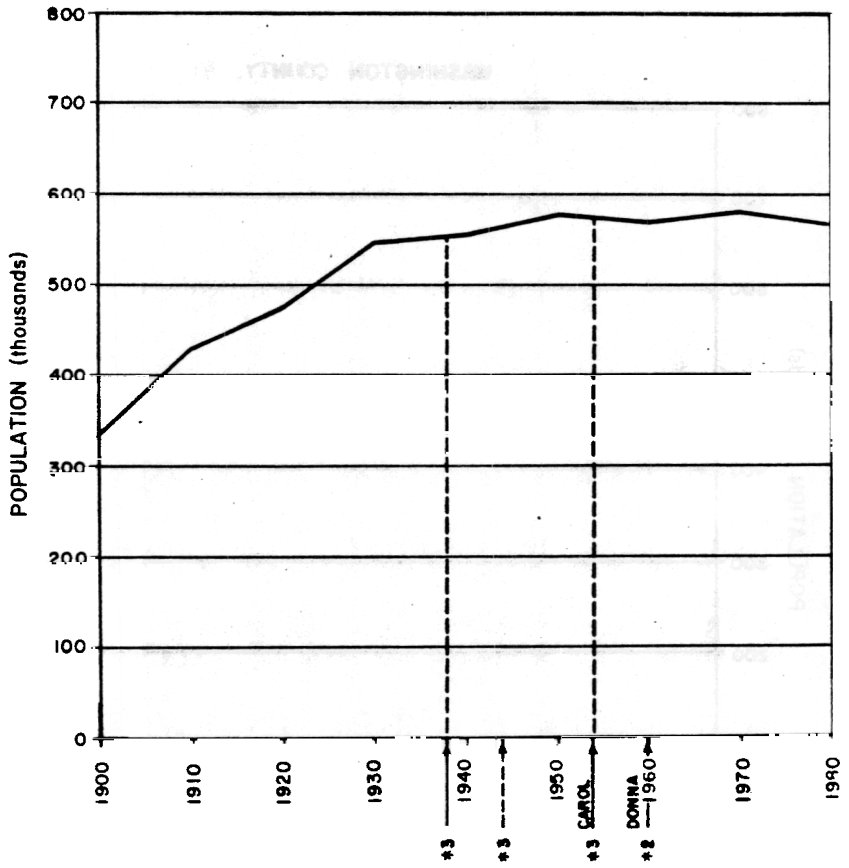

NEW HAVEN COUNTY, CT
POPULATION (thousands)
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1990
CAROL
AGNES


FAIRFIELD COUNTY, CT
POPULATION (thousands)
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
CAROL
AGNES

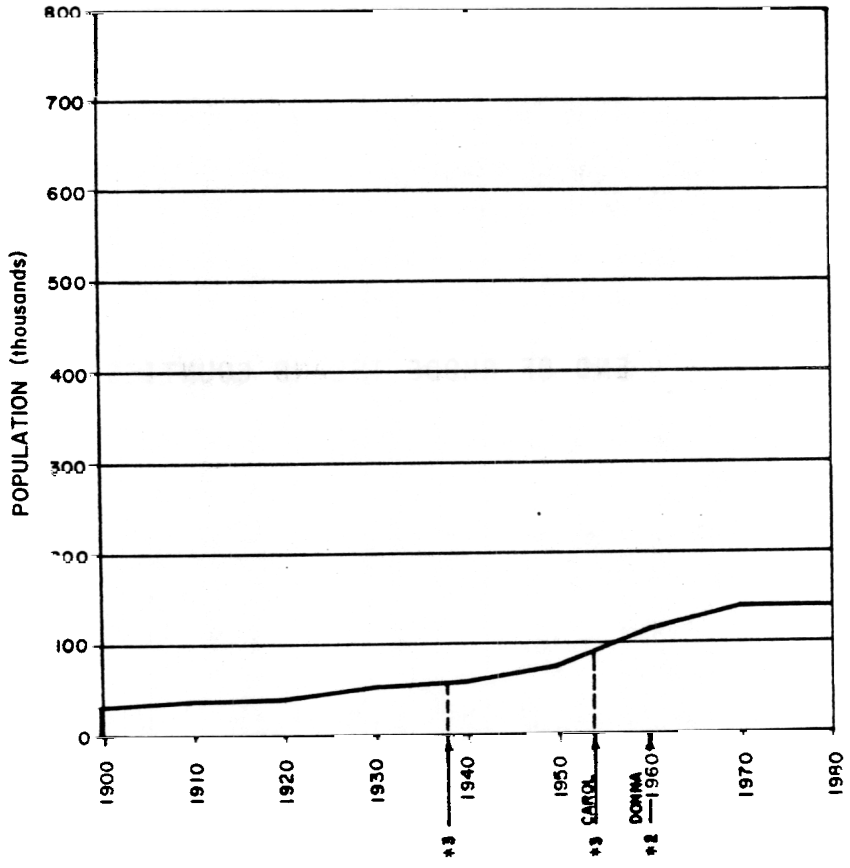

NEWPORT COUNTY, RI
POPULATION (thousands)
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1990
#3
#3
#3
#2
CAROL
DONNA

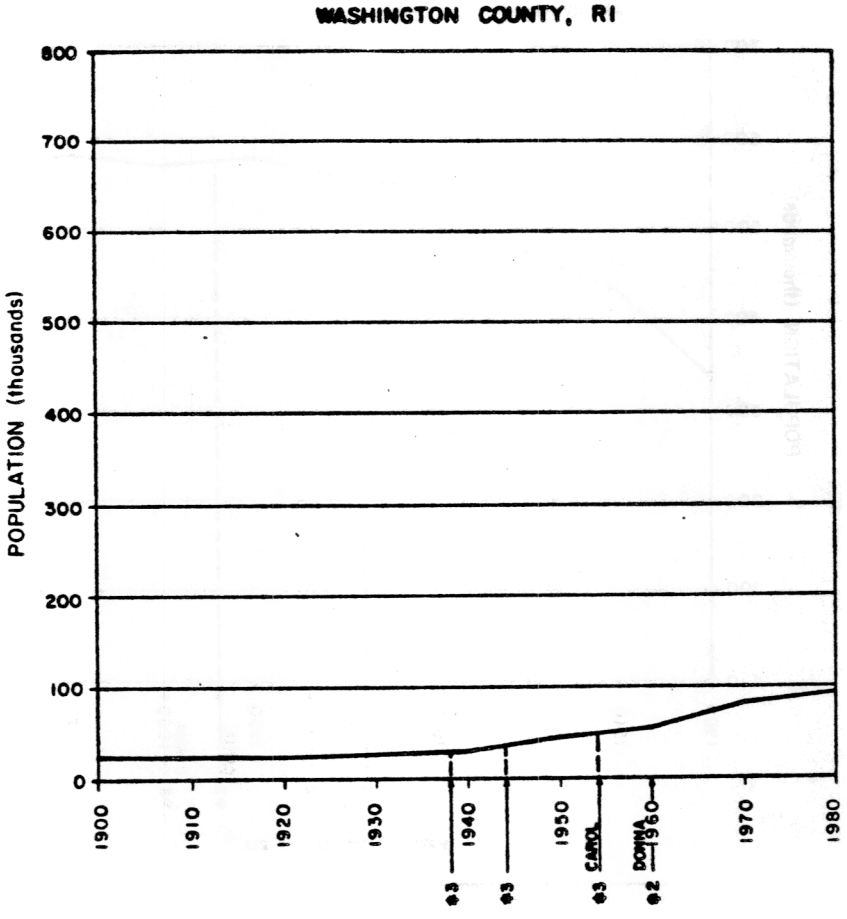

BRISTOL COUNTY, RI
POPULATION (thousands)
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
#3
#3
#3
#2
CAROL
DONNA

PROVIDENCE COUNTY, RI

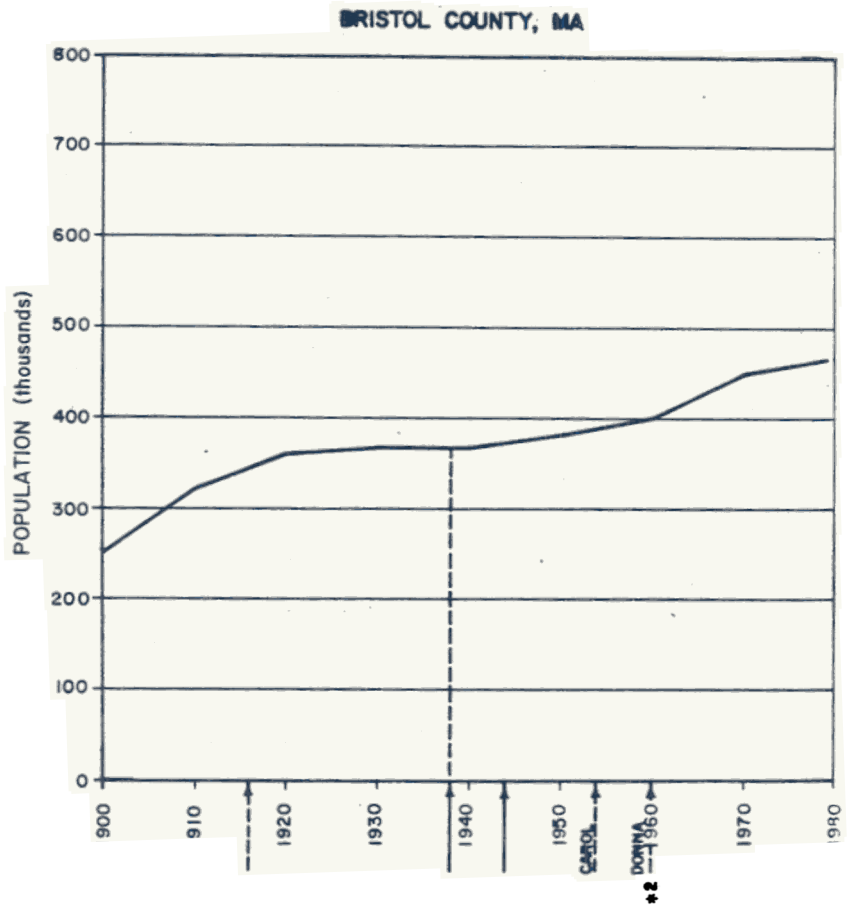


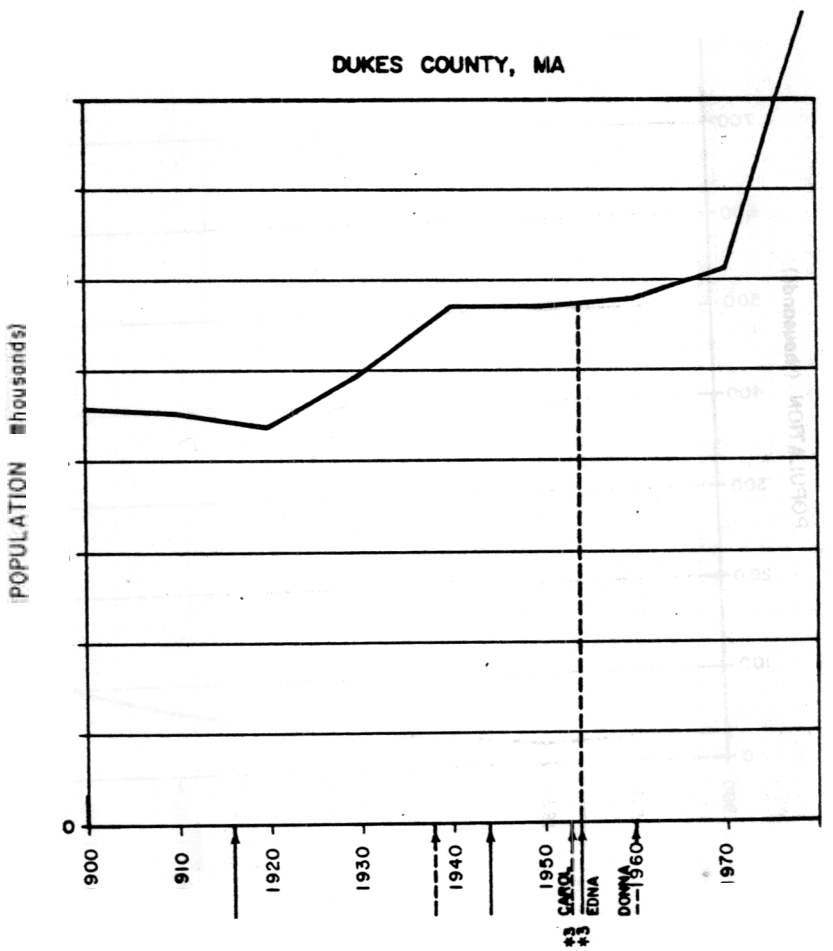
KENT COUNTY, RI

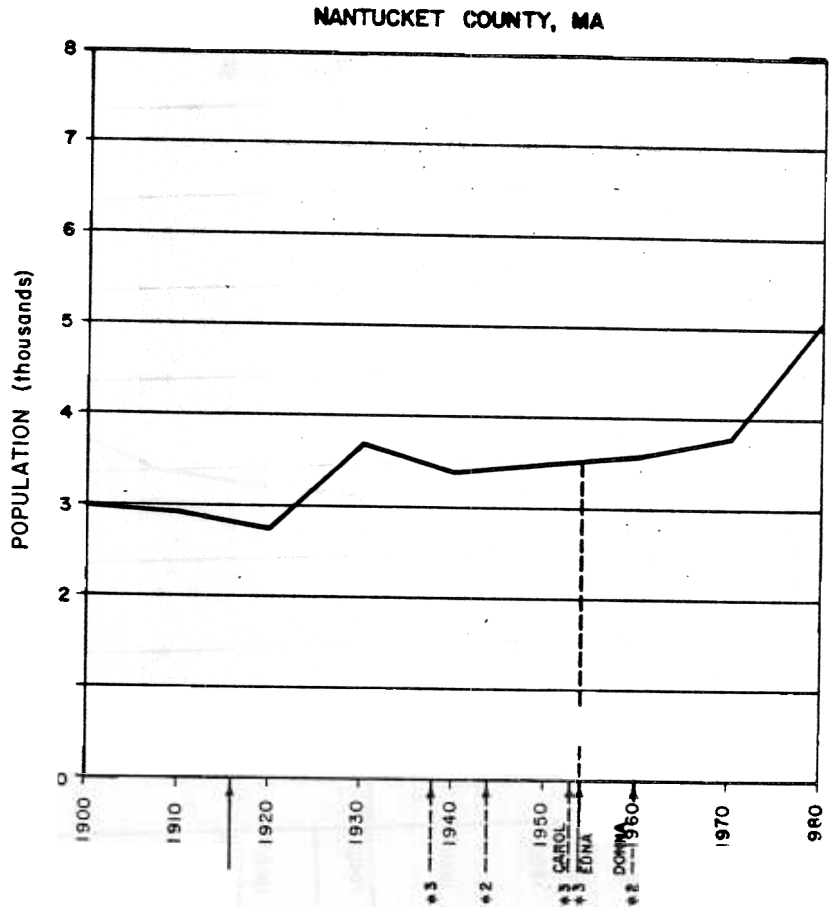


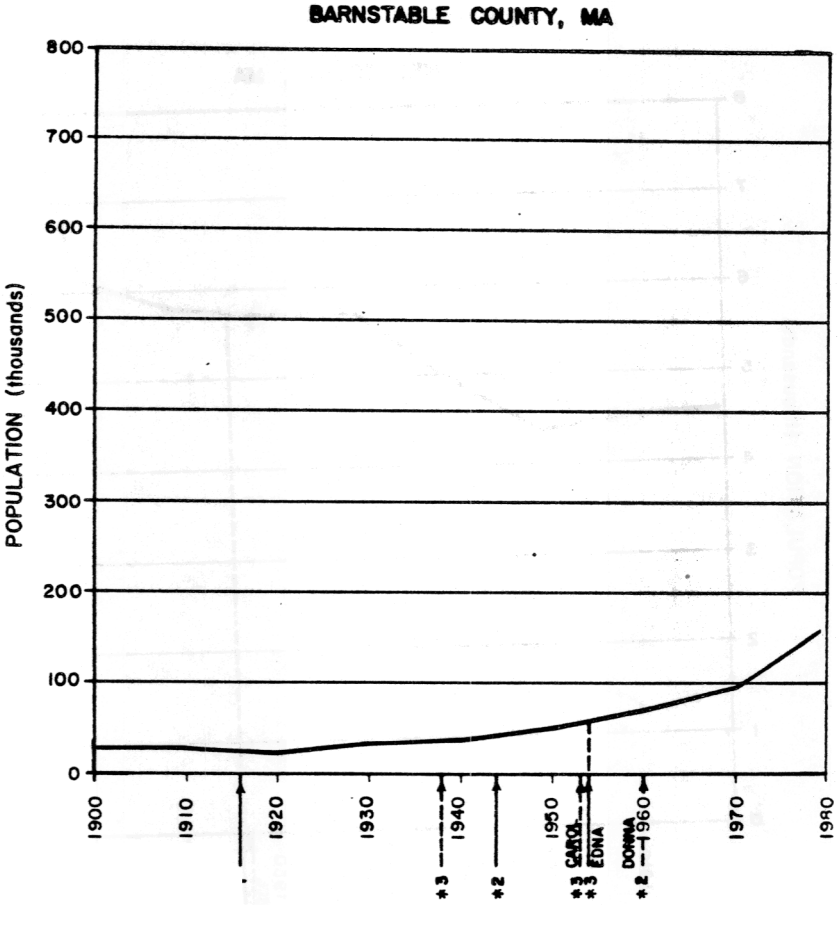


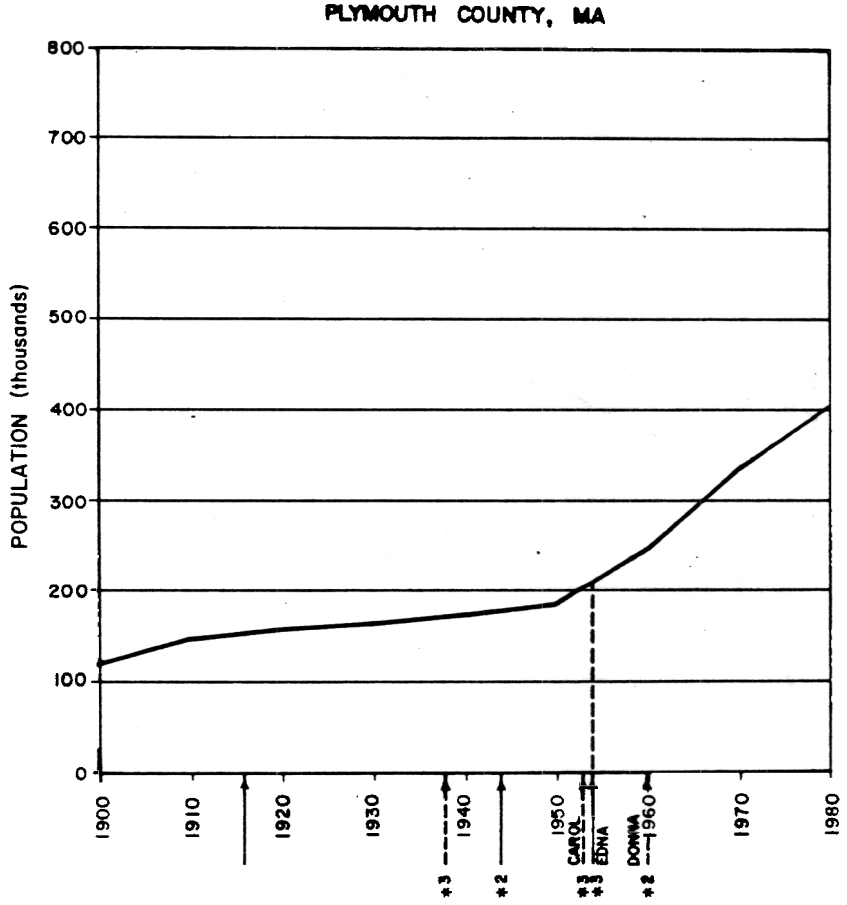
END OF RHODE ISLAND COUNTIES

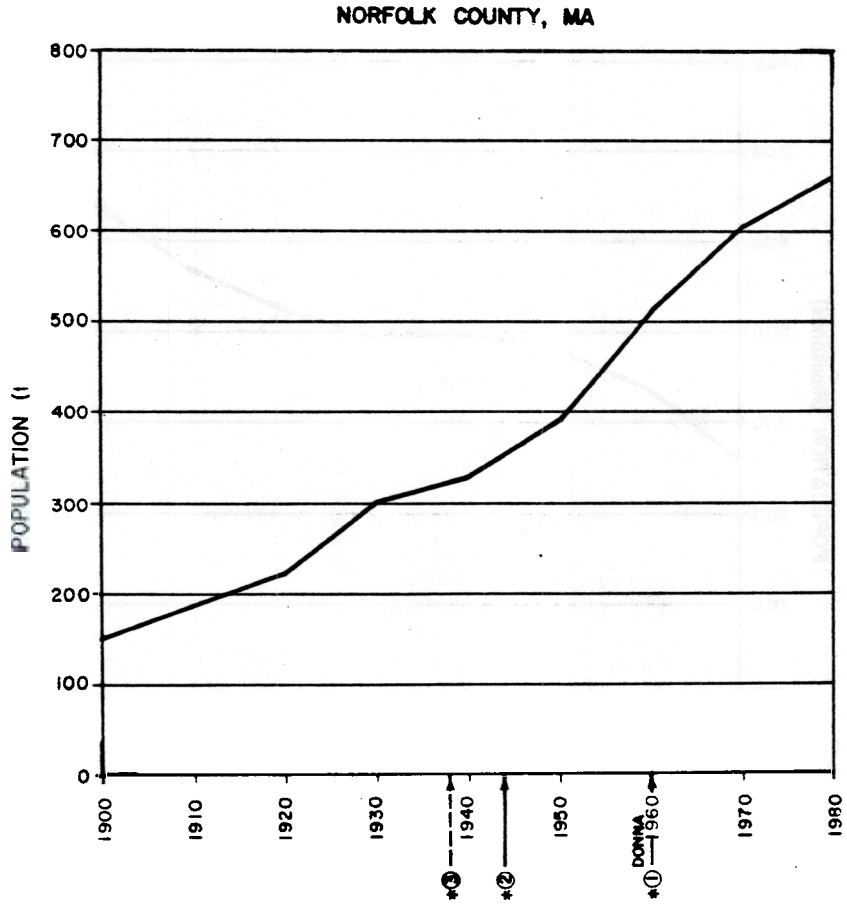

BRISTOL COUNTY, MA
POPULATION (thousands)
800
700
600
500
400
300
200
100
0
900
910
1920
1930
1940
1950
CAROL
1960
DONNA
1970
1980
#2

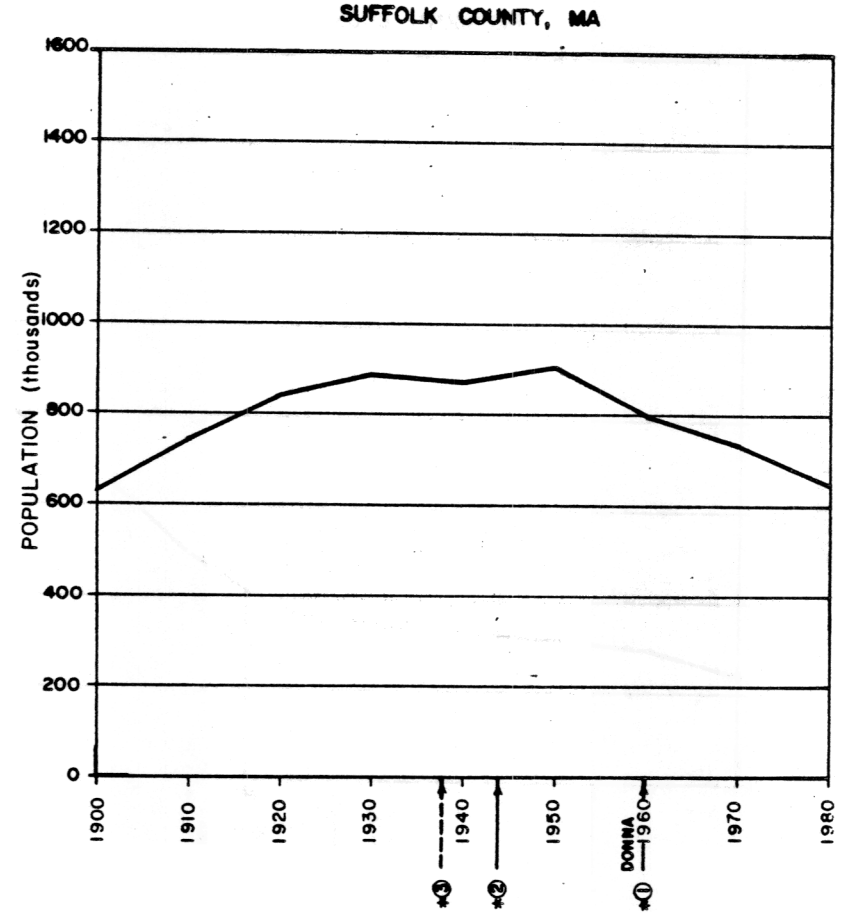

DUKES COUNTY, MA
POPULATION (thousands)
0
900
910
1920
1930
1940
1950
CAROL
EDNA
#3
#3
1960
DONNA
1970

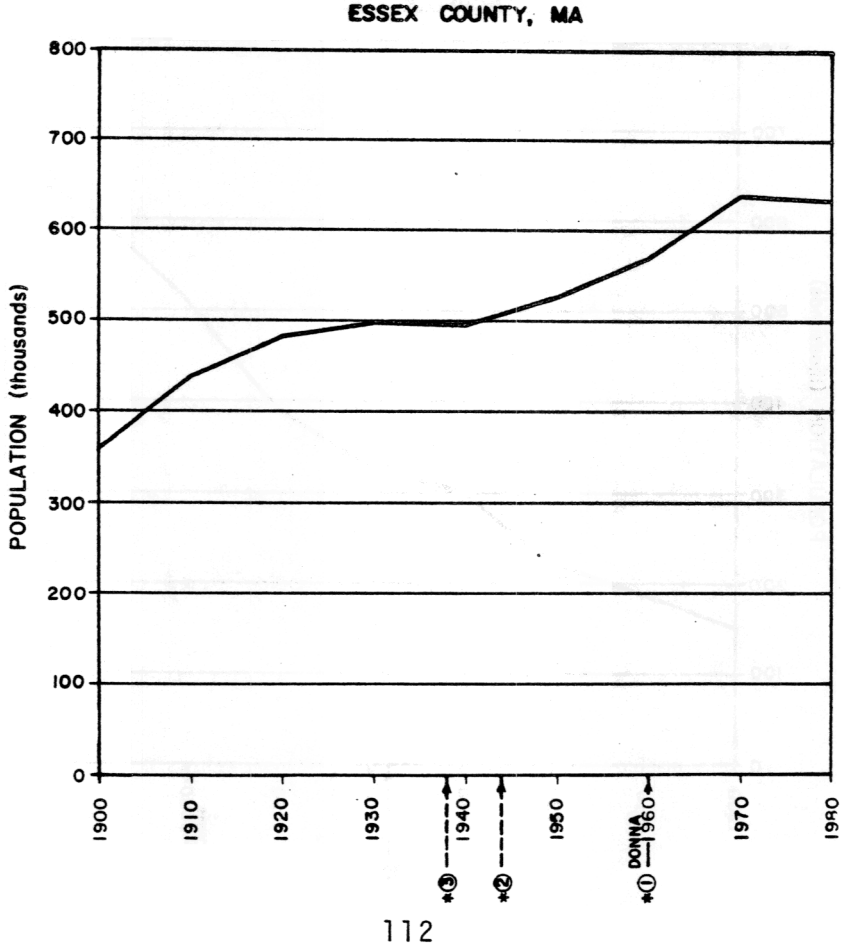

NANTUCKET COUNTY, MA
POPULATION (thousands)
8
7
6
5
4
3
2
0
1900
1910
1920
1930
1940
1950
1960
1970
980
#3
#2
CAROL
#3
EDNA
DONNA
#2

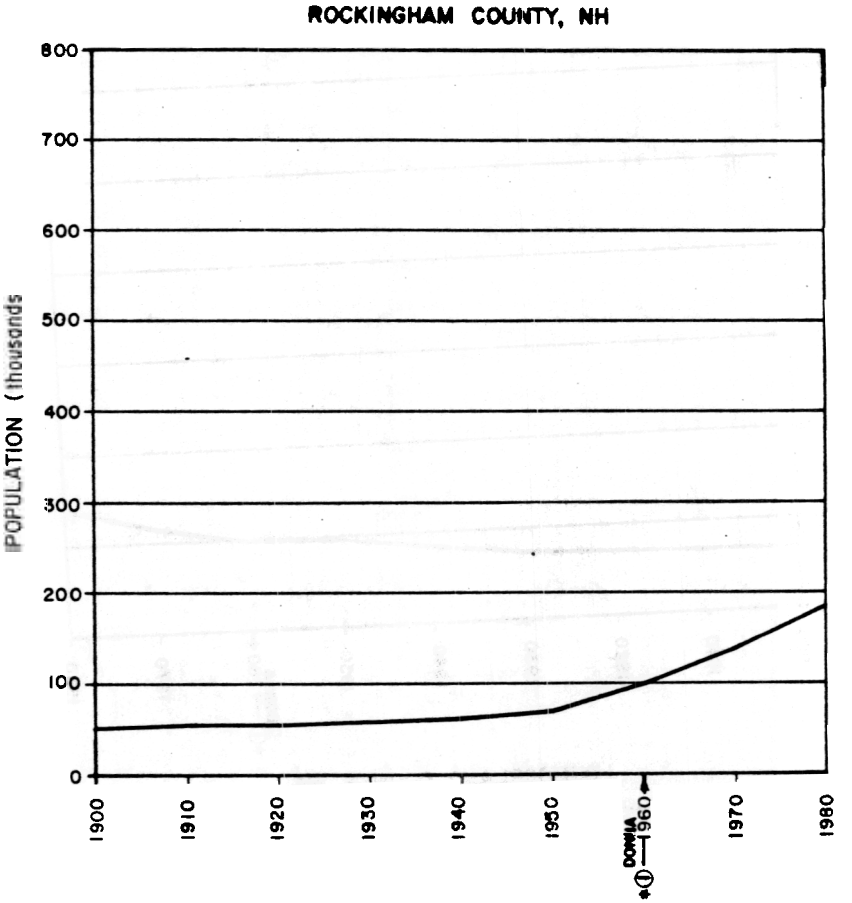

BARNSTABLE COUNTY, MA
POPULATION (thousands)
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
#3
#2
CAROL
#3
EDNA
DONNA
#2


PLYMOUTH COUNTY, MA
POPULATION (thousands)
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
#3
#2
CAROL
#3
EDNA
DONNA
#2


NORFOLK COUNTY, MA
POPULATION (
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
DONNA
#1

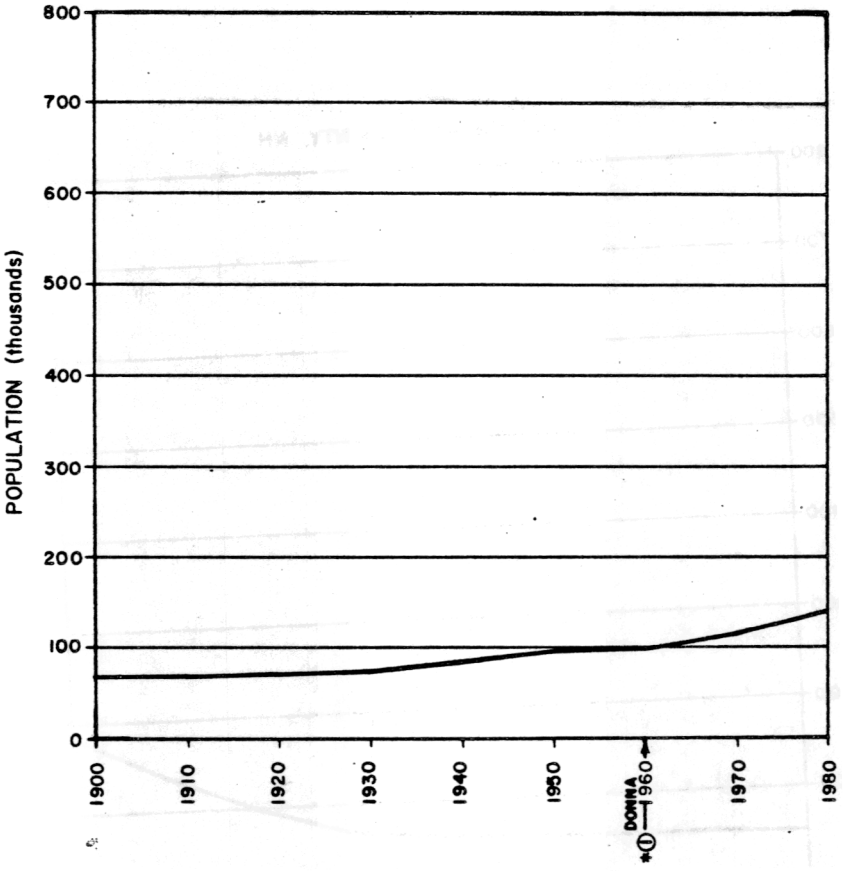

SUFFOLK COUNTY, MA
POPULATION (thousands)
1600
1400
1200
1000
800
600
400
200
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
DONNA
③
②
①


ESSEX COUNTY, MA
POPULATION (thousands)
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
DONNA
③
②
①

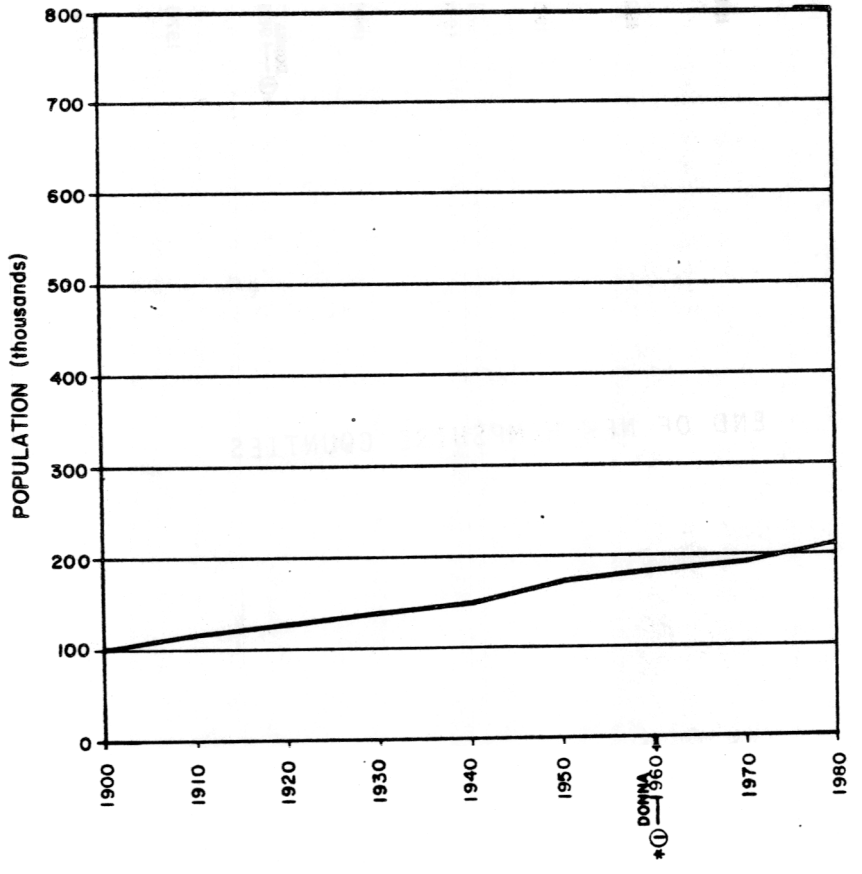


END OF NEW HAMPSHIRE COUNTIES

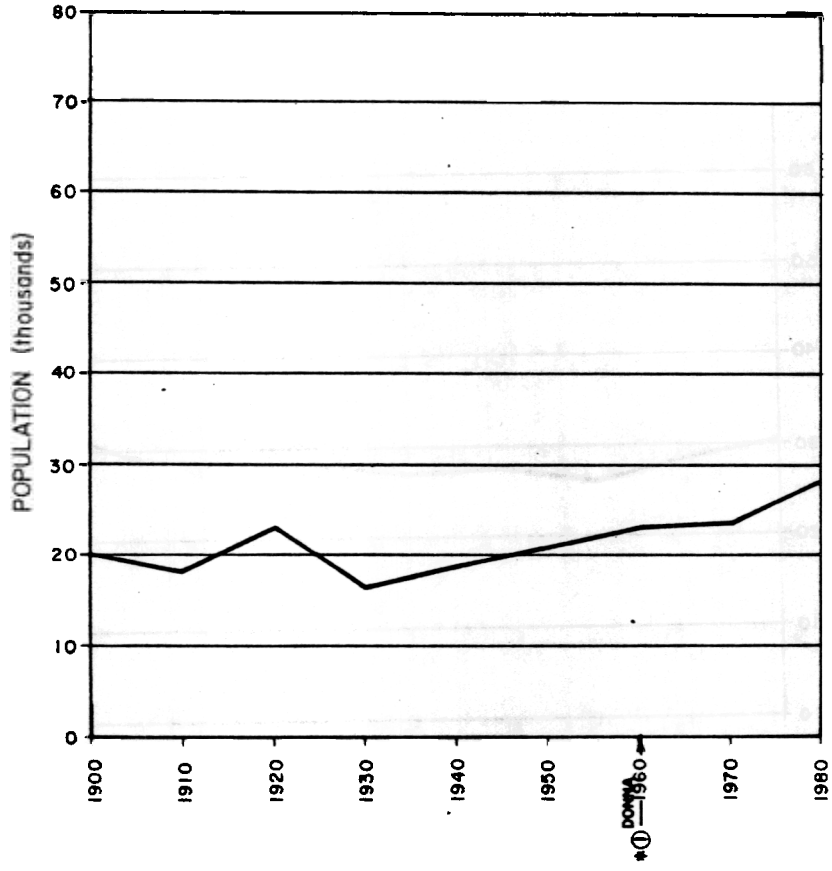
YORK COUNTY, ME



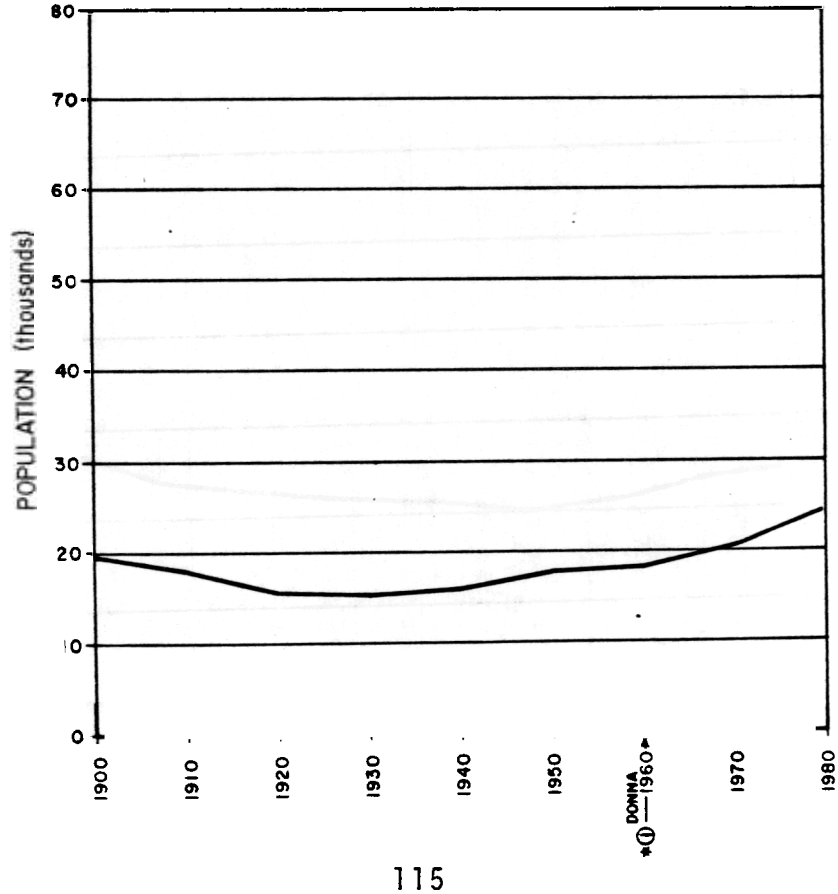
CUMBERLAND COUNTY, ME



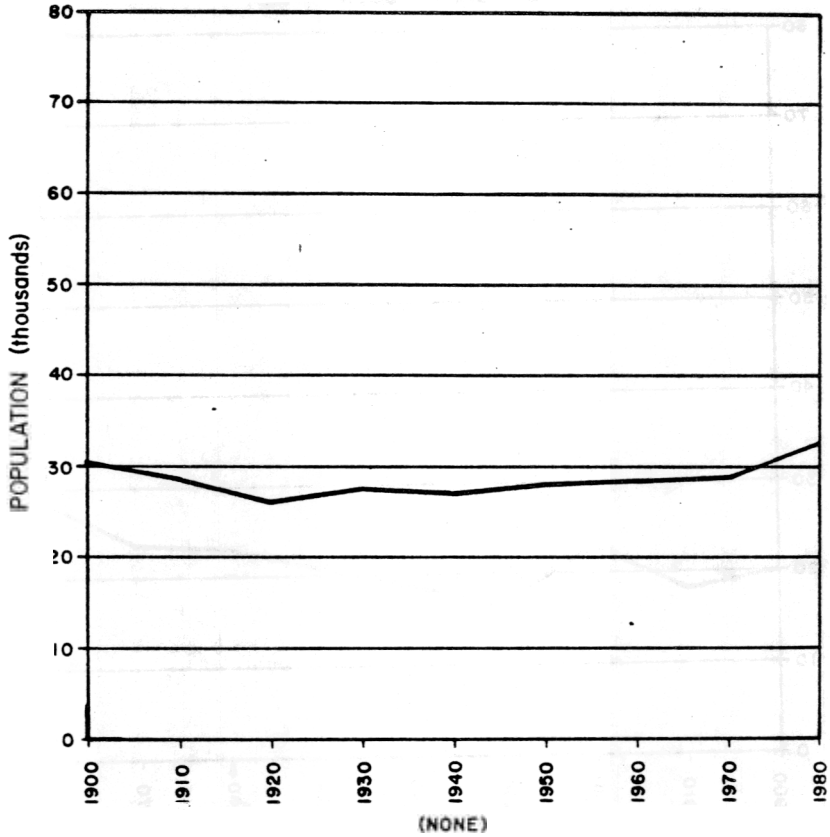
SAGADAHOC COUNTY, ME



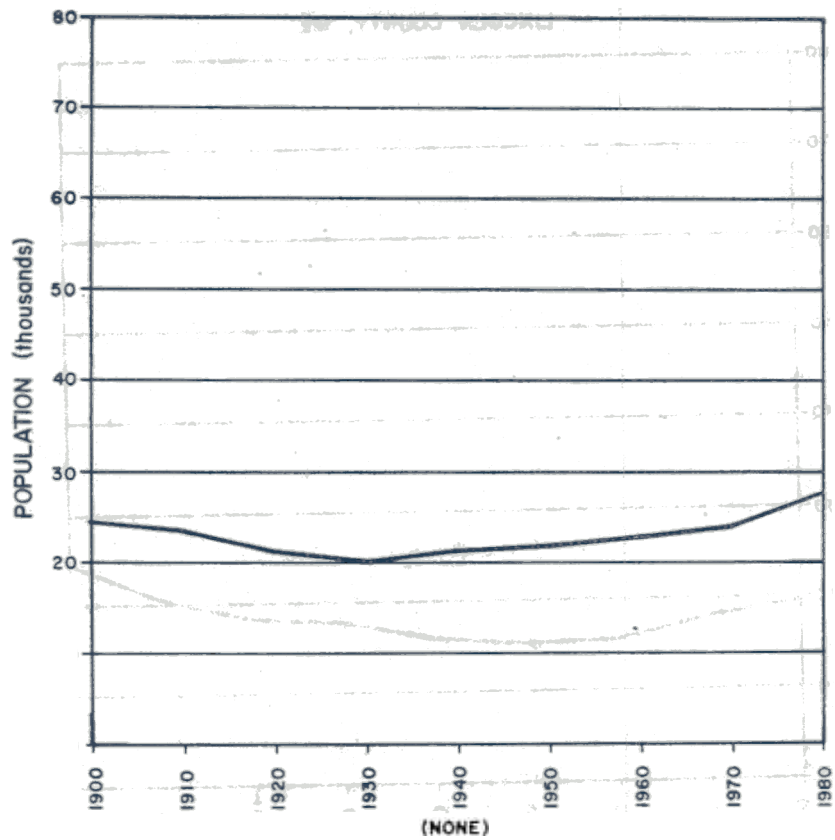
LINCOLN COUNTY, ME

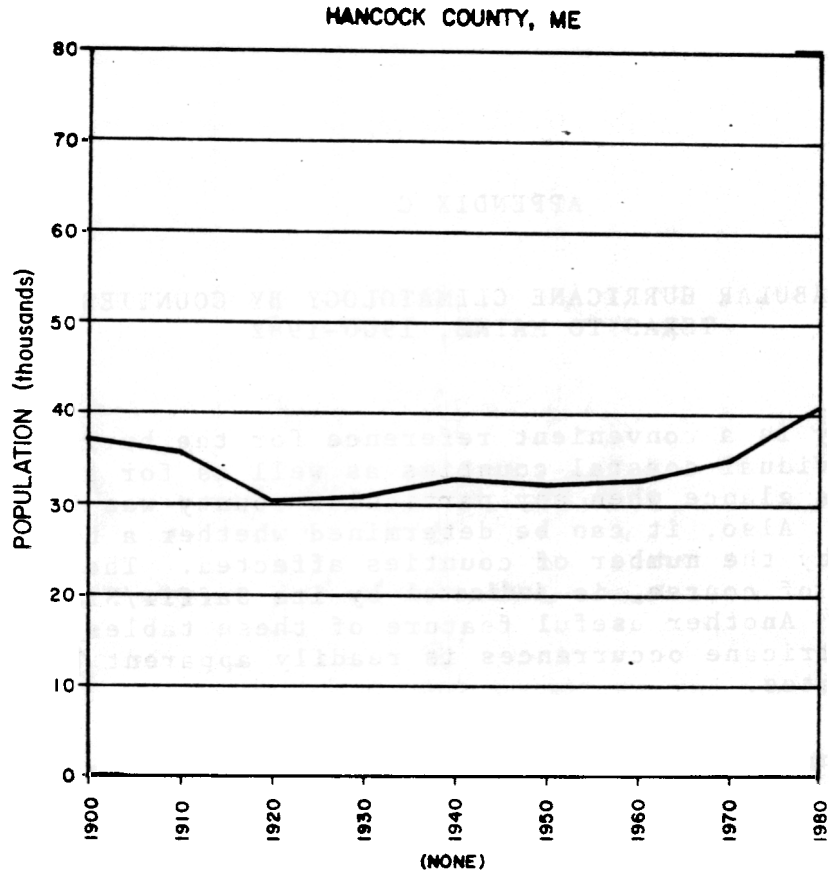


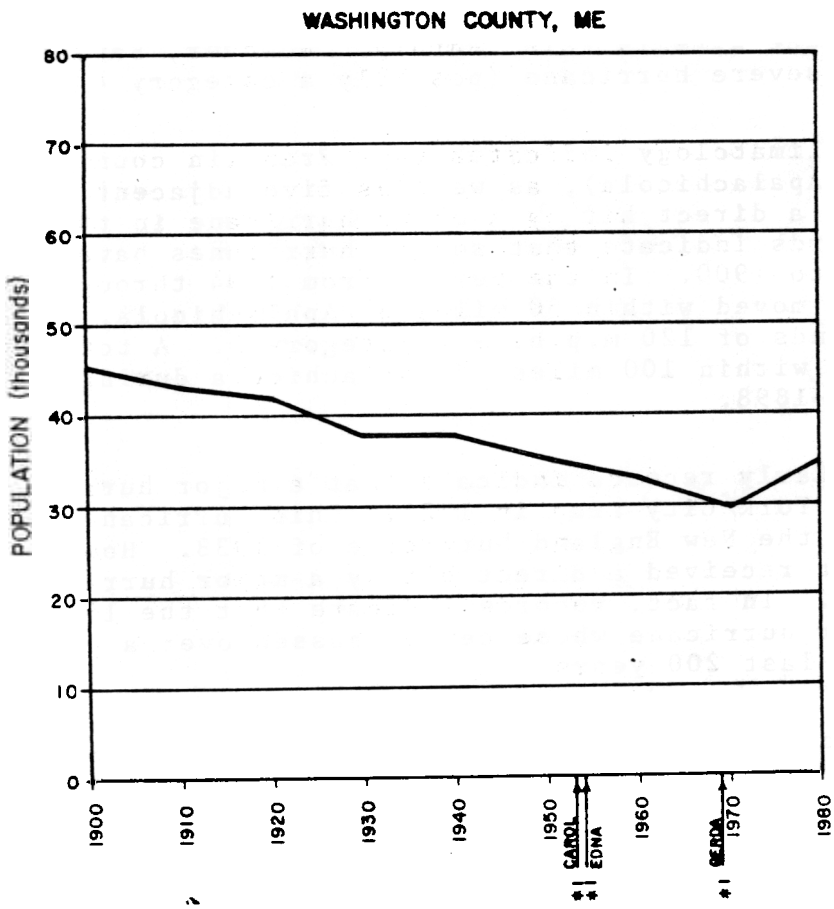
KNOX COUNTY, ME



WALDO COUNTY, ME




HANCOCK COUNTY, ME
POPULATION (thousands)
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
(NONE)


WASHINGTON COUNTY, ME
POPULATION (thousands)
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
CAROL
#1
EDNA
#1
BERDA
#1

APPENDIX C

A TABULAR HURRICANE CLIMATOLOGY BY COUNTIES, TEXAS TO MAINE, 1900-1982

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 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, Apalachicola, and New York 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.

Apalachicola: Climatology indicates that Franklin county, Florida (which includes Apalachicola), as well as five 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. In the period from 1894 through 1898, three hurricanes moved within 50 miles of Apalachicola. The 1894 hurricane had winds of 120 m.p.h. - a category 3. A total of nine hurricanes moved within 100 miles of Apalachicola 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.

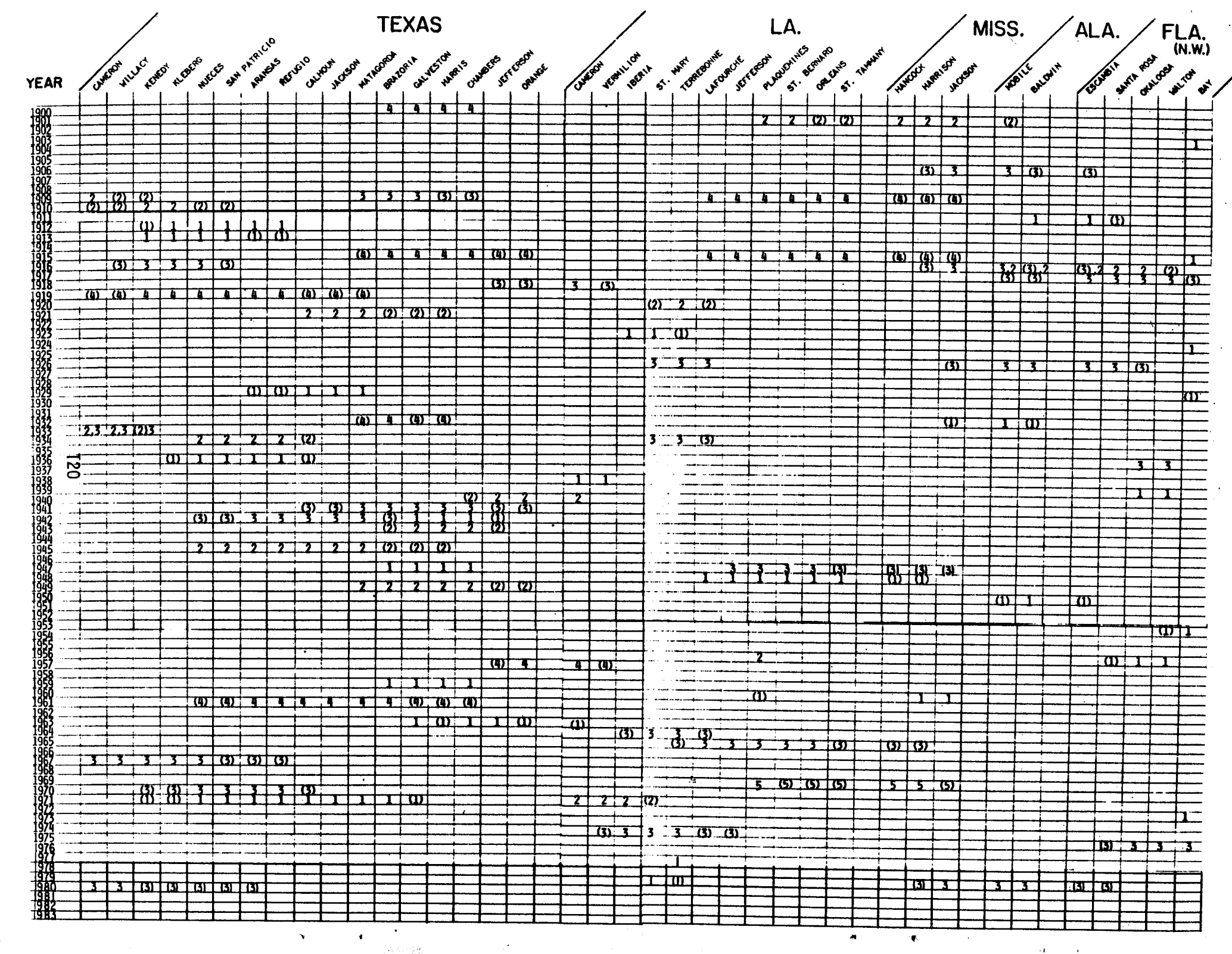
As indicated in Appendix B, dual symbols were necessary in illustrating the hurricane climatology. Arrows were used with the graphs in Appendix B, while arrows were not appropriate in a tabular presentation such as in this appendix. The key for symbols (non-arrows) is repeated below along with examples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

Key for Symbols

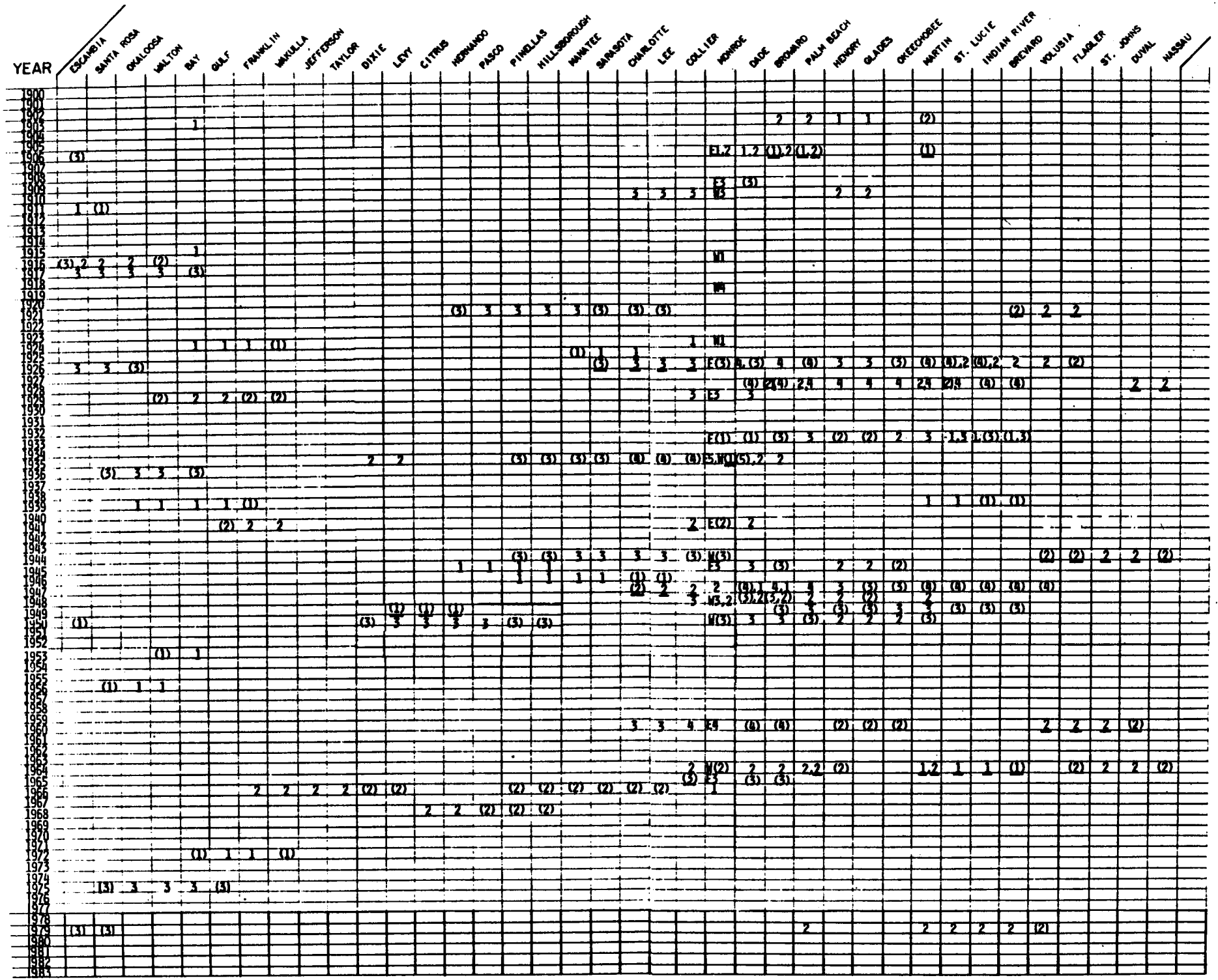
Plain Number	Direct Hit
(	Indirect Hit
	Exiting or Inland
*	Forward Speed 30 mph or Greater

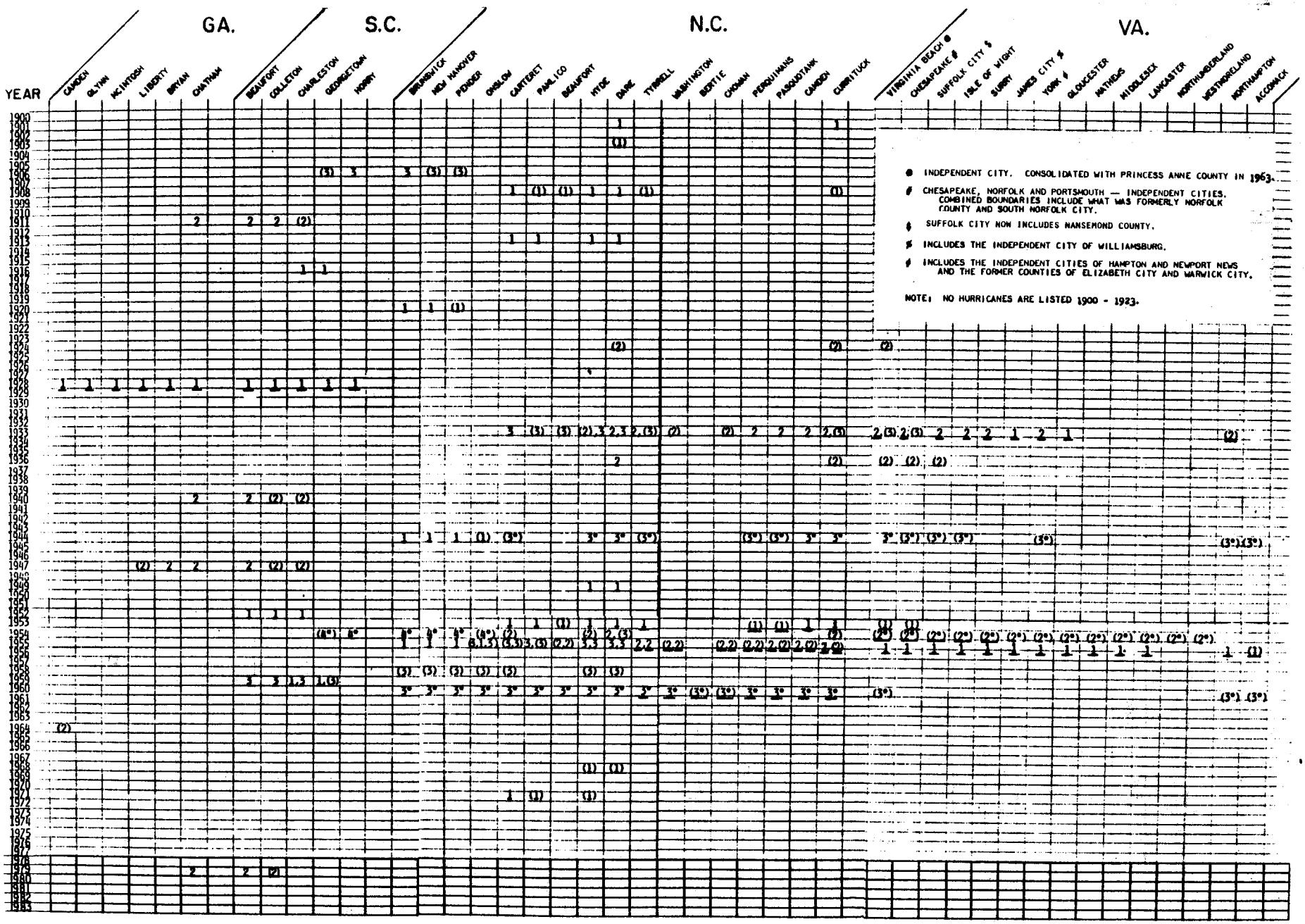
Examples

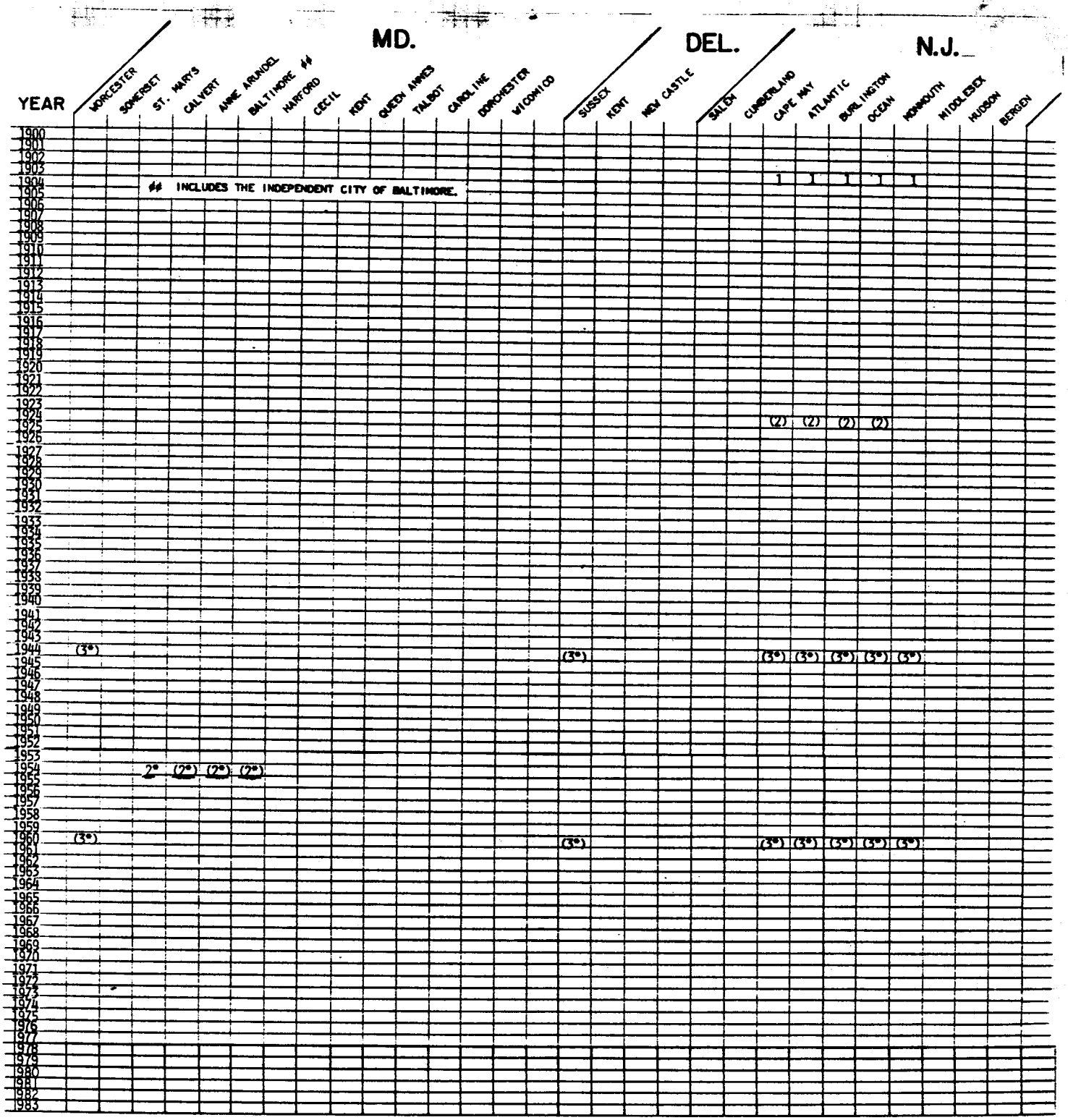
1	Direct Hit by a Category 1 Hurricane
	Indirect Hit (or fringe hit) by a Category 1 Hurricane
2	Direct Hit by an Inland or Exiting (moving from land to water) Category 2 Hurricane
3*	Direct Hit by a Category 3 Hurricane moving 30 mph or more
	Indirect Hit by an exiting Category 3 Hurricane moving 30 mph or more
	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)


TEXAS
LA.
MISS.
ALA.
FLA. (N.W.)
YEAR
CAMERON
WILLACY
KENEDY
KLEBERG
NUECES
SAN PATRICIO
ARANSAS
REFUGIO
CALHOUN
JACKSON
MATAGORDA
BRAZORIA
GALVESTON
HARRIS
CHAMBERS
JEFFERSON
ORANGE
CAMERON
VERMILLION
IBERIA
ST. MARY
TERREBONNE
LAFOURCHE
JEFFERSON
PLAQUEMINES
ST. BERNARD
ORLEANS
ST. TAMMANY
HANCOCK
HARRISON
JACKSON
MOBILE
BALDWIN
ESCAMBIA
SANTA ROSA
OKALOOSA
WALTON
BAY
120

FLORIDA


YEAR
ESCAMBIA
SANTA ROSA
OKALOOSA
WALTON
BAY
GULF
FRANKLIN
WAKULLA
JEFFERSON
TAYLOR
DIXIE
LEVY
CITRUS
HERNANDO
PASCO
PINELLAS
HILLSBOROUGH
MANATEE
SARASOTA
CHARLOTTE
LEE
COLLIER
MONROE
DADE
BROWARD
PALM BEACH
HENDRY
GLADES
OKEECHOBEE
MARTIN
ST. LUCIE
INDIAN RIVER
BREVARD
VOLUSIA
FLAGLER
ST. JOHNS
DUVAL
NASSAU


GA.
S.C.
N.C.
VA.
YEAR
CAMDEN
GLYNN
MCINTOSH
LIBERTY
BRYAN
CHATHAM
BEAUFORT
COLLETON
CHARLESTON
GEORGETOWN
HORRY
BRUNSWICK
NEW HANOVER
PENDER
ONSLOW
CARTERET
PAMLICO
BEAUFORT
HYDE
DARE
TYRRELL
WASHINGTON
BERTIE
CHOWAN
PERQUIMANS
PASQUOTANK
CAMDEN
CURRITUCK
VIRGINIA BEACH ●
CHESAPEAKE #
SUFFOLK CITY $
ISLE OF WIGHT
SURRY
JAMES CITY ¥
YORK ¥
GLOUCESTER
MATHEWS
MIDDLESEX
LANCASTER
NORTHUMBERLAND
WESTMORELAND
NORTHAMPTON
ACCOMACK
● INDEPENDENT CITY. CONSOLIDATED WITH PRINCESS ANNE COUNTY IN 1963.
CHESAPEAKE, NORFOLK AND PORTSMOUTH — INDEPENDENT CITIES. COMBINED BOUNDARIES INCLUDE WHAT WAS FORMERLY NORFOLK COUNTY AND SOUTH NORFOLK CITY.
$ SUFFOLK CITY NOW INCLUDES NANSEMOND COUNTY.
¥ INCLUDES THE INDEPENDENT CITY OF WILLIAMSBURG.
¥ INCLUDES THE INDEPENDENT CITIES OF HAMPTON AND NEWPORT NEWS AND THE FORMER COUNTIES OF ELIZABETH CITY AND WARWICK CITY.
NOTE: NO HURRICANES ARE LISTED 1900 - 1923.


MD.
DEL.
N.J.
YEAR
WORCESTER
SOMERSET
ST. MARYS
CALVERT
ANNE ARUNDEL
BALTIMORE ##
HARFORD
CECIL
KENT
QUEEN ANNES
TALBOT
CAROLINE
DORCHESTER
WICOMICO
SUSSEX
KENT
NEW CASTLE
SALEM
CUMBERLAND
CAPE MAY
ATLANTIC
BURLINGTON
OCEAN
MONMOUTH
MIDDLESEX
HUDSON
BERGEN
INCLUDES THE INDEPENDENT CITY OF BALTIMORE.
1900
1901
1902
1903
1904
1905
1906
1907
1908
1909
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
1920
1921
1922
1923
1924
1925
1926
1927
1928
1929
1930
1931
1932
1933
1934
1935
1936
1937
1938
1939
1940
1941
1942
1943
1944
1945
1946
1947
1948
1949
1950
1951
1952
1953
1954
1955
1956
1957
1958
1959
1960
1961
1962
1963
1964
1965
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1
1
1
1
1
(2)
(2)
(2)
(2)
(3*)
(3*)
(3*)
(3*)
(3*)
(3*)
(3*)
(3*)
(3*)
(3*)
(3*)
2*
(2*)
(2*)
(2*)
(3*)
(3*)
(3*)
(3*)
(3*)
(3*)

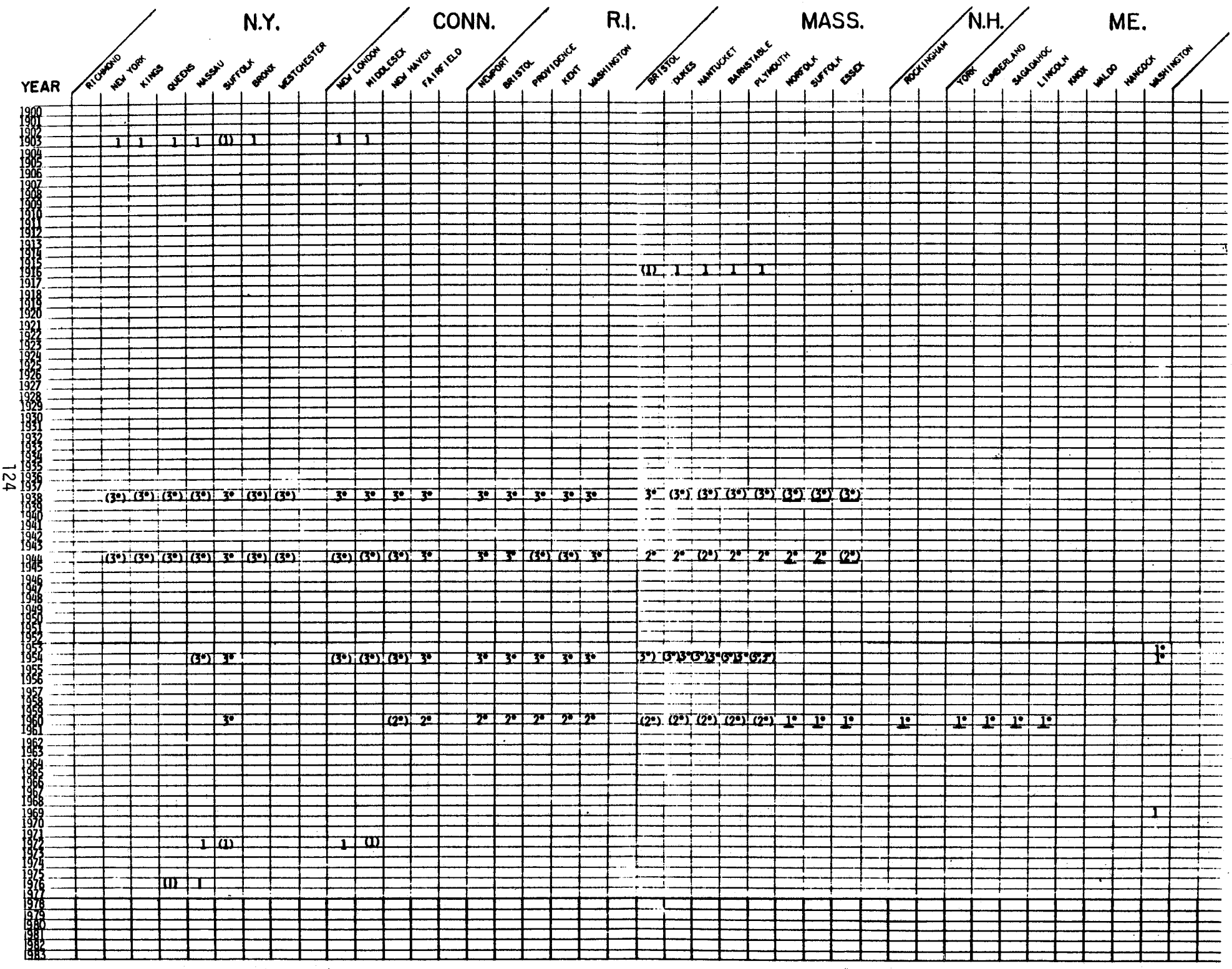

N.Y.
CONN.
R.I.
MASS.
N.H.
ME.
YEAR
RICHMOND
NEW YORK
KINGS
QUEENS
NASSAU
SUFFOLK
BRONX
WESTCHESTER
NEW LONDON
MIDDLESEX
NEW HAVEN
FAIRFIELD
NEWPORT
BRISTOL
PROVIDENCE
KENT
WASHINGTON
BRISTOL
DUKES
NANTUCKET
BARNSTABLE
PLYMOUTH
NORFOLK
SUFFOLK
ESSEX
ROCKINGHAM
YORK
CUMBERLAND
SAGADAHOC
LINCOLN
KNOX
WALDO
HANCOCK
WASHINGTON

TABLE 5

COASTAL COUNTY POPULATION BY STATES (1980)

STATE	COUNTY	POPULATION
TX		
	Cameron	209,680
	Willacy	17,495
	Kenedy	543
	Kleberg	33,358
	Nueces	268,215
	San Patrico	58,013
	Aransas	14,260
	Refugio	9,289
	Calhoun	19,547
	Jackson	13,352
	Matagorda	37,828
	Brazoria	169,587
	Galveston	195,940
	Harris	2,409,544
	Chambers	18,583
	Jefferson	250,938
	Orange	83,838
LA		
	Cameron	9,336
	Vermilion	48,458
	Iberia	63,752
	St.Mary	64,395
	Terrebonne	94,393
	Lafourche	82,483
	Jefferson	454,592
	Plaquemines	26,049
	St. Bernard	64,097
	Orleans	557,482
	St. Tammany	110,554
MS		
	Hancock	24,537
	Harrison	157,665
	Jackson	118,015
AL		
	Mobile	364,379
	Baldwin	78,440

STATE	COUNTY	POPULATION
FL		
	Escambia	233,794
	Santa Rosa	55,988
	Okaloosa	109,920
	Walton	21,300
	Bay	97,740
	Gulf	10,658
	Franklin	7,661
	Wakulla	10,887
	Jefferson	10,703
	Taylor	16,532
	Dixie	7,751
	Levy	19,870
	Citrus	54,703
	Hernando	44,469
	Pasco	194,123
	Pinellas	728,409
	Hillsborough	490,265
	Manatee	148,442
	Sarasota	202,251
	Charlotte	59,115
	Lee	205,266
	Collier	85,791
	Monroe	63,098
	Dade	1,625,979
	Broward	1,014,043
	Palm Beach	573,125
	Hendry	18,599
	Glades	5,992
	Okeechobee	20,264
	Martin	64,014
	St. Lucie	87,182
	Indian River	59,896
	Brevard	272,959
	Volusia	258,762
	Flagler	10,913
	St. Johns	51,303
	Duval	570,981
	Nassau	32,894

TABLE 5 (Cont'd)

COASTAL COUNTY POPULATION BY STATES (1980)

State	County	Population
GA		
	Camden	13,371
	Glynn	54,981
	McIntosh	8,046
	Liberty	37,583
	Bryan	10,175
	Chatham	202,226
SC		
	Beaufort	65,364
	Colleton	31,676
	Charleston	277,308
	Georgetown	42,461
	Horry	101,419
NC		
	Brunswick	33,767
	New Hanover	103,471
	Pender	22,215
	Onslow	112,784
	Carteret	41,092
	Pamlico	10,398
	Beaufort	40,266
	Hyde	5,873
	Dare	13,377
	Tyrrell	3,975
	Washington	14,801
	Bertie	21,024
	Chowan	12,558
	Perquimans	9,486
	Pasquotank	28,462
	Camden	5,829
	Currituck	11,089
VA		
	Princess Anne	262,199
	Chesapeake, Norfolk and Portsmouth	857,345
	Suffolk City	47,621
VA (Cont'd)		
	Isle of Wight	21,603
	Surry	6,046
	York	302,983
	James City	32,633
	Gloucester	20,107
	Mathews	7,995
	Middlesex	7,719
	Lancaster	10,129
	Northumberland	9,828
	Westmoreland	14,401
	Northampton	14,625
	Accomack	31,268
MD		
	Worcester	30,889
	Somerset	19,188
	St Marys	59,895
	Calvert	34,638
	Anne Arundel	370,775
	Baltimore	1,442,390
	Harford	145,930
	Cecil	60,430
	Kent	16,695
	Queen Annes	25,508
	Talbot	25,604
	Caroline	23,143
	Dorchester	30,623
	Wicomico	64,540
DE		
	Sussex	98,044
	Kent	98,219
	Newcastle	399,002
NJ		
	Salem	64,676
	Cumberland	132,866
	Cape May	82,266
	Atlantic	194,119

TABLE 5 (Cont'd)

Coastal County Population by States (1980)

State	County	Population
NJ		
	Burlington	362,542
	Ocean	346,038
	Monmouth	503,173
	Middlesex	595,893
	Hudson	556,972
	Bergen	845,385
NY		
	Richmond	352,121
	New York	1,427,533
	Kings	2,230,936
	Queens	1,891,325
	Nassau	1,321,582
	Suffolk	1,284,231
	Bronx	1,169,115
	Westchester	866,599
CT		
	New London	238,409
	Middlesex	129,017
	New Haven	761,337
	Fairfield	807,143
RI		
	Newport	81,383
	Bristol	469,942
	Providence	571,349
	Kent	154,163
	Washington	93,319
MA		
	Bristol	474,641
	Dukes	8,942
	Nantucket	5,087
	Barnstable	147,925
	Plymouth	405,437
	Norfolk	606,587
	Suffolk	65,142
	Essex	633,632
NH		
	Rockingham	190,345
ME		
	York	139,666
	Cumberland	215,789
	Sagadahoc	28,795
	Lincoln	25,691
	Knox	32,941
	Waldo	28,414
	Hancock	41,781
	Washington	34,963