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The populations of most island groups in Micronesia changed dramatically over the past 450 years. For the area comprising modem Pohnpei State these changes took the form of early depopulation, followed during most of the present century by a steady increase in total population and a growing concentration of people on Pohnpei Island. The present study examines regional demographic change in Pohnpei State. It begins with a brief summary of colonization efforts in the area. Attention then turns towards shifts in regional population, emphasizing data from censuses conducted between 1920 and 1985. Through examining fertility, mortality, and migration data, the article explores possible causes of population change in Pohnpei State. Spatial statistics indicate a high degree of local demographic consistency maintained at the expense of increased regional cohesion. The study closes by examining sociocultural, economic, and ecological repercussions of the regional population change experienced in this portion of the eastern Caroline Islands.

Introduction

Micronesian cultures experienced several major changes throughout the past 450 years, usually as a result of interaction with more technologically advanced societies from outside Oceania. Of the many consequences of this interaction, few have had more far-reaching effects than demographic change--generating modifications in economic, political,

social, and ecological aspects of native sociocultural systems. As was the case in many parts of the world, the demographic evolution of Micronesia typically encompassed two phases: an initial period of depopulation, usually due to diseases introduced by people from outside the area; and a subsequent period of population growth, most often attributable to improved medical technology and health care, which once again were introduced by other cultures (Taueber 1961). Though most of Micronesia experienced basic population change of the types noted, the precise nature of these changes varied between places. The islands and atolls of Pohnpei State[1] witnessed a dramatic decline in population during the mid-nineteenth century, followed throughout most of the present century by sustained, often rapid demographic growth.[2] Currently Pohnpei State contains nearly five times the population recorded for the area in 1920, with more than 90 percent of the total living on Pohnpei Island.

The present study of Pohnpei State represents one of a series that examines regional demographic development in the Federated States of Micronesia (FSM) (see Gorenflo and Levin 1991). It begins with a compressed review of interaction between Pohnpei State and non-Micronesian cultures, to help understand better the impact of other societies on population in the area. The study then summarizes data on Pohnpei State regional demography, focusing in particular upon ten censuses conducted between 1920 and 1985. By considering population change in light of data on fertility, mortality, migration, and population structure, the article explores possible causes of regional demographic change. It then employs selected spatial statistics to examine formal aspects of regional demographic change in Pohnpei State. Finally, the study considers ecological, economic, and sociocultural repercussions of population change in Pohnpei State--notably the challenge of incorporating growing numbers of people, many of them residing on Pohnpei Island, within a self-sustaining, regionally integrated component of the Federated States of Micronesia.

Colonization: The Impacts of Non-Micronesian Societies on Regional Demography

Pohnpei State lies between 1° and 7° north latitude, and 154° and 160° east longitude, in the eastern Caroline Islands (Bryan 1971). It comprises volcanic Pohnpei Island, and eight coralline atolls (seven of which usually are inhabited) located at varying distances from Pohnpei Island (Shinn 1984:325; Figure 1). Two of the atolls, Kapingamarangi

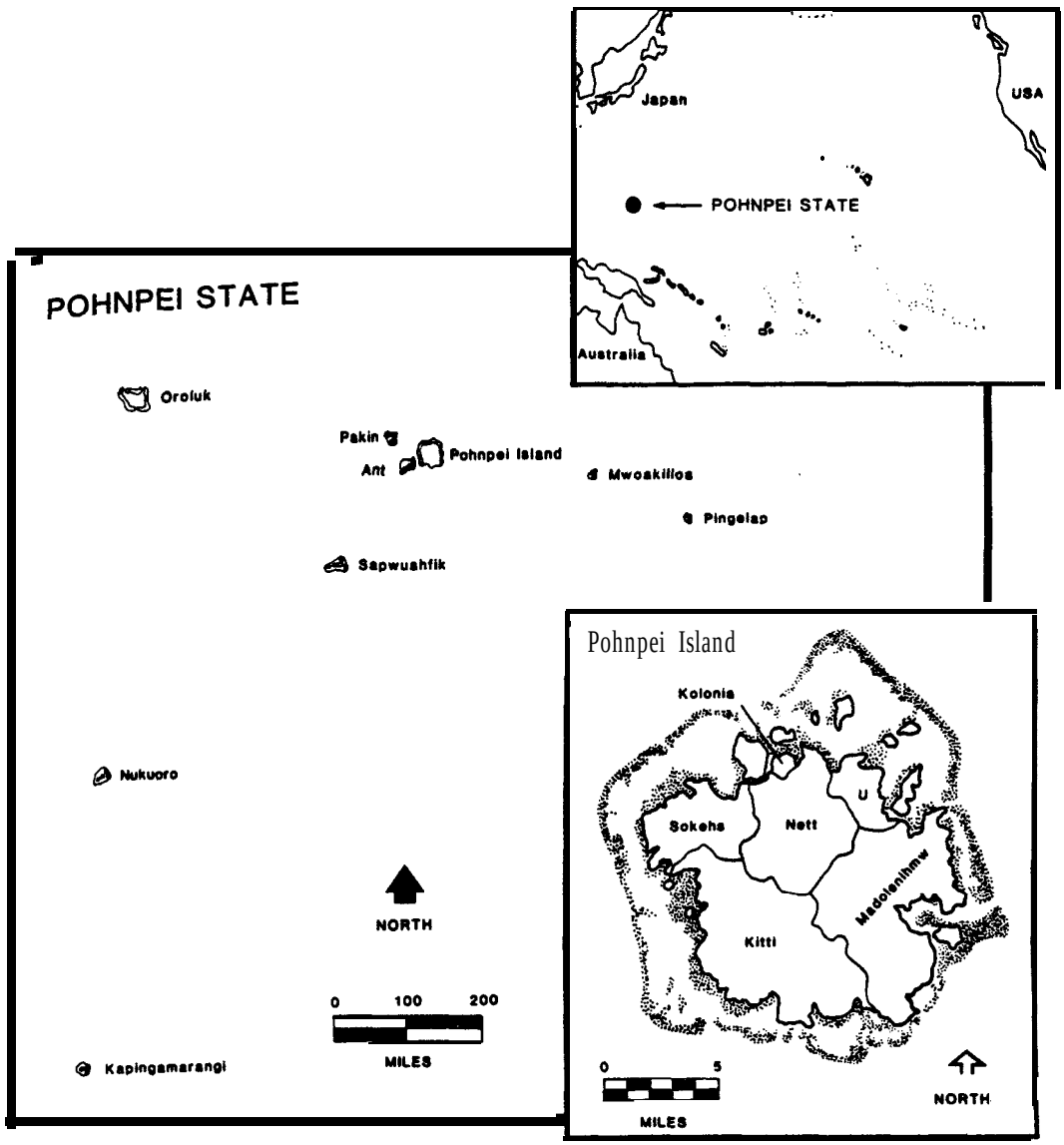


FIGURE 1. Pohnpei State.

and Nukuoro, are Polynesian outliers located far to the south of Pohnpei Island. Two other atolls, Pakin and Ant, are located so close to Pohnpei Island that their populations usually are recorded as part of Sokehs Municipality on the high island itself (as they are in this study).

Eastern Micronesia was settled by people from eastern Melanesia moving northward about 1000 B.C. (Hezel 1983:3; Kiste 1984:14). The state's prehistory is best documented on Pohnpei Island, where the earliest evidence for human occupation dates to roughly the time of Christ (Hanlon 1988:9). Initially inhabited by several autonomous sociopoliti-

cal groups, around A.D. 1000 Pohnpei Island came under the rule of a single polity called the Sandeleurs, their capital located off the southeast coast at the site of Nan Madol (Athens 1983). This unified rule continued until the early seventeenth century, after which organization of the island again split among several independent polities (Hanlon 1988: 18). Demographic data on the prehistoric and early historic periods presently are unavailable, though ongoing efforts to map and date all archaeological sites on Pohnpei Island (E. Esperiam, pers. com., 1990) may soon enable the estimation of prehistoric populations.

Although Spanish explorers possibly sighted Pohnpei Island between 1526 and 1528 (Riesenberg 1968:2), most researchers consider the Spaniard Quiros as the first Westerner to discover the island (in 1595; Hezel 1983:34). With the exception of Grijalvares's sighting of Kapingamarangi Atoll in 1536, and Quiros's sighting of Sapwuahfik Atoll in 1595, the remainder of Pohnpei State was discovered by Europeans either in the late eighteenth or early nineteenth centuries (Office of the Chief of Naval Operations 1944:17-18). Spain claimed this entire portion of the Pacific as part of its expanding empire. But Pohnpei State largely went ignored, and with the exception of Kapingamarangi Atoll was not even visited by Westerners before the early nineteenth century. The Russian Lütke finally attempted to explore part of the area systematically when he visited Pohnpei Island in 1828, though neither he nor any member of his crew actually landed (Lütke 1971, 2: 3-31; Hanlon 1988:31-36). Sporadic interaction with Westerners began following Lütke's visit, and continued until the mid-nineteenth century. Whalers occasionally stopped in the area during the 1830s to obtain water and supplies, notably at Mwoakilloa Atoll and Pohnpei Island (Hezel 1983: 122-124; Hanlon 1988:74-76). Trading vessels also visited the area, particularly following the efforts of the Englishman Cheyne in the early 1840s to develop trade with the natives (Shineberg 1971). Gradually interaction with Westerners grew: the roughly forty ships that visited Pohnpei Island between 1834 and 1840 (Hezel 1979:37-44) increased to nearly thirty ships per year in the early 1850s, and to more than a hundred annually in 1855 and 1856 (Hanlon 1988:74). As the frequency of visits by Westerners to the area increased, so too did the number of resident beachcombers--usually deserters or castaways (often convicts) from whaling and trading vessels (O'Connell 1972; see also Shineberg 1971:158; Hezel 1978). Numbering about forty in 1840, the beachcomber population on Pohnpei Island reached 150 by 1850 (Hezel 1983: 124). After a brief, unsuccessful attempt to establish a mission on Pohnpei Island during the late 1830s, missionaries began sustained work

on the island in 1852 (Hezel 1983:123-124, 142-158; Hanlon 1988: 87-112).

Although details on the demography of any portion of Pohnpei State are elusive for the early period of interaction with Westerners, particularly dramatic impacts on population are documented. Various Skirmishes between Micronesians and non-Micronesians led to deaths on both sides. The most notable of these conflicts was the attack on Pohnpei Island in 1836 by crews from the British ships *Falcon* and *Lambton,* which left an unknown number of natives dead; and the attack on Sapwuahfik Atoll in 1837 by the crew of the latter ship, in which all (fifty or sixty) adult native males were killed (Hezel 1983:118-121; Poyer 1985; Hanlon 1988:50-58). But the most significant demographic impacts during this period were caused by a series of introduced diseases that devastated the high-island population. Venereal disease, influenza, and smallpox epidemics occurred in the area during the early 1840s, killing untold numbers (Hezel 1983: 130). A more serious smallpox epidemic occurred in 1854 on Pohnpei Island, in roughly six months killing 2,000 to 3,000 persons (Yanaihara 1967:43; Hezel 1983:140; Hanlon 1988:109-111). As a result of diseases, the population of Pohnpei Island declined from more than 10,000 persons in the 1820s to as few as 2,000 in the late 1850s (see Riesenberg 1968:6; Fischer and Fischer 1957:29). Outbreaks of influenza in 1856, 1874, and 1879, and measles in 1861, continued depopulation during the mid-to-late nineteenth century (Hanlon 1988:204). Isolated instances of depopulation on outer islands in Pohnpei State also are documented for this period, such as the killing of several individuals on Kapingamarangi Atoll in 1870 by a group of Marshallese castaways (Emory 1965:66).

After roughly 300 years of ignoring Micronesia, Spain began to exercise its authority over the Carolines in the 1870s in an attempt to control trading in the area by other European nations (Office of the Chief of Naval Operations 1944:19; see Hanlon 1988:145-147). Striving to expand its own empire, Germany annexed Pohnpei State in October 1885, sending a warship to Pohnpei Island to take control from the resident Spanish militia. Arbitration by Pope Leo XIII reaffirmed Spain's sovereignty, though this decision also guaranteed Germany's trading and fishing rights (Hanlon 1988:145-146). The Spanish presence in the area was confined largely to Pohnpei Island, primarily in the form of a garrison in the newly established community of Santiago de la Ascención (present-day Kolonia). But overly zealous attempts to build Pohnpei Island into a Spanish colony, complicated by rivalries between native polities, quickly led to turmoil with the islanders--a condition

that characterized most of the short period of active Spanish administration (Fischer and Fischer 1957:37-38; Hempenstall 1977:212-213). Assorted conflicts led to deaths of a limited (unknown) number of Pohnpeians. And a measles epidemic in 1894 caused additional deaths (Hanlon 1988:205). Despite these losses, Pohnpei Island population began a sustained period of growth about 1890 (Bascom 1965:6, 140).

Following Spain's defeat in the Spanish-American war, Germany finally gained control of the Carolines when it purchased the area in 1899 (Office of the Chief of Naval Operations 1944:20; Brown 1977). Germany's goal was to develop the Carolines economically (see Ehrlich 1978). Pohnpei State played an important role in the German economic plans, with the colonial headquarters of the eastern Carolines located on Pohnpei Island. But problems quickly ensued, due largely to German efforts to reorganize the traditional social hierarchy and recruit forced labor for construction projects. A rebellion by inhabitants of Sokehs Municipality eventually occurred in 1910, and though brought under control six months later ill feelings between natives and their German administrators persisted (see Fischer and Fischer 1957:51-58). Germany's inability to exploit Pohnpei State's population in an efficient manner stifled its attempts to develop the area economically. Although net demographic impacts of the fifteen-year German administration are uncertain, particularly dramatic losses of population occurred during the early 1900s. In 1905 a severe typhoon struck Pohnpei Island, and Mwoakilloa and Pingelap atolls, killing an unknown number of people and causing a subsequent famine. In addition to seventeen persons executed at the end of the Sokehs rebellion, several natives were killed in battles with German forces; moreover, following the reestablishment of German control after the uprising nearly 450 persons were exiled by German administrators to Palau to prevent future rebellions (Office of the Chief of Naval Operations 1944:20). Although the exiles were allowed to return several years later, the land they originally owned was distributed to about 1,250 in-migrants from Mwoakilloa and Pingelap atolls (who relocated to Pohnpei Island after the 1905 typhoon), Sapwuahfik Atoll, and the Mortlocks (who relocated to Pohnpei Island after a typhoon in 1907; see Fischer and Fischer 1957:58).

At the onset of Germany's involvement in World War I in 1914, Japanese military forces occupied German-held Micronesian territories (Kiste 1984:43). In 1920 a Class C Mandate from the League of Nations officially awarded to Japan all German possessions in the Pacific north of the equator, including Pohnpei State (Clyde 1967). Administration during the Japanese period was much more intensive than any foreign

rule that had preceded--representing part of a focused effort to develop Pohnpei State economically and incorporate the island group as a functioning component of the Japanese Pacific empire (Falgout 1989:282-285). Japanese administrators of Pohnpei State quickly imposed their own order (Fischer and Fischer 1957:59-62). Authority was placed in the hands of Japanese bureaucrats and imposed locally through the Japanese police. Traditional chiefs, in turn, became minor functionaries who served as agents of the Japanese administrators (Peattie 1988:76, 98, 326). The Japanese promoted a range of agricultural, commercial fishing, and industrial enterprises, mostly on Pohnpei Island, in the process of developing the area's economic potential (Peattie 1988: 102, 122, 137, 140, 177; Falgout 1989:283).

Due both to its size and natural resources, Pohnpei Island eventually became home to the third largest number of Japanese in-migrants in the Mandated Territory (Peattie 1988: 176-180). Kolonia grew from a scattering of shacks to the population center of the island, and the number of Japanese in Pohnpei State grew from less than 150 in 1923 to more than 13,400 by 1945 (Bascom 1965:8). As discussed in greater detail below, the Pacific Islander population in Pohnpei State increased markedly during the Japanese administration--growing by more than 1,800 persons during the years (1920-1935) documented by Japanese censuses.[3] In addition to this overall increase in population, Pacific Islander inhabitants of Pohnpei State were increasingly mobile during the Japanese administration. Isolated relocations occurred, such as the migration of several people from Kapingamarangi Atoll to Pohnpei Island in 1918 to escape the ravages of a famine (Emory 1965:20). But more frequently people were relocated to supply labor on various Japanese projects. The incidence of labor-related relocations increased as the impending war neared. The specific effects of World War II on natives throughout the state is uncertain. Despite intensive bombardment of Pohnpei Island by American forces during 1944, apparently few inhabitants of the high island died as a result of war-related activities (Bascom 1965:6; Falgout 1989:281). Interaction between outer islanders and the Japanese was limited. With the exception of the recruitment and relocation of relatively few individuals to provide labor for the war effort, the outer islands generally avoided impacts of the war (Poyer 1989:104-114).

U.S. military forces bypassed Pohnpei State in 1944, and occupied the area following the Japanese surrender in 1945 (Peattie 1988:278-279). Japanese civilians and military personnel were repatriated by December 1945; Pacific Islanders with Japanese spouses were given the

opportunity to live in Japan or remain in Pohnpei State (most choosing the latter; Fischer and Fischer 1957:65). In 1947 the island units in Pohnpei State became part of the Trust Territory of the Pacific Islands (TTPI), a strategic area established by the United Nations and administered by the United States (Shinn 1984:303-305). During the first decade of its administration, the United States began returning business and government responsibilities to natives--its interest in the area being much more strategic than economic. Under successive administrations by the U.S. Navy (1945-1951) and the U.S. Department of the Interior (1952-1986), the population grew rapidly. Between the last Japanese census in 1935 and the first TTPI census in 1958, Pohnpei State population increased by more than 3,600 persons; by 1980, state population had grown by another 10,800.

Pohnpei State and three other Caroline districts of the TTPI (Chuuk, Kosrae, and Yap) approved a constitution on 10 May 1979, becoming the self-governing nation of the Federated States of Micronesia. The U.S. Congress ratified a Compact of Free Association in 1986, an agreement that defined future relations between the Federated States of Micronesia and the United States. The sustained population growth that characterized the years of U.S. administration apparently continued into the 1980s; during the first five years of independence, population in Pohnpei State grew to more than 20,000 persons.

Changing Regional Demography in Pohnpei State

The demography of Pohnpei State was poorly documented before the Japanese **Nan'yō-chō** (South Seas Bureau) conducted its first systematic census of the Mandated Territory in 1920. Although limited information on population is available beginning in the early nineteenth century for certain island units, this usually entails estimates made by explorers and missionaries, often after relatively brief encounters with inhabitants (see Hambruch 1932; Eilers 1934; Riesenberg 1968:6). Particularly evident in estimates for Pohnpei Island are demographic impacts of the diseases discussed above, with population declining from as many as 15,000 in 1840 to about 1,700 by 1891 (Table 1). German administrators conducted a partial census of the area (Yanaihara 1967:29). But no single set of demographic estimates or census data is available for all of Pohnpei State at one time before the Japanese administration.

Ten systematic censuses of Pohnpei State were conducted during the twentieth century: four by the Japanese South Seas Bureau (1920, 1925, 1930, and 1935), two by the TTPI administration (1958 and 1973), one

TABLE 1. **Early Population Estimates for Pohnpei State**

Area	1840	1844	1852	1877	1878	1880	1883	1890	1891	1894	1896	1900	1903	1904	1905	1910	1912	1914
Pohnpei Island[a]	15,000	7,500		5,000		2,000			1,705			3,165		3,279				4,401
Outer Atolls																		
Kapingamarangi							150	150									150	
Mwoakilloa			87										214					
Nukuoro					124					150							123	
Pingelap											1,000				870			
Sapwuahfik												240				250		

Sources: Hambruch 1932; Eilers 1934; Bascom 1965.

Notes: Most population figures and dates were recorded as approximations. Middle value is presented for population figures listed as ranges. Empty cells signify unavailable data.

[a]Early demographic data for Pohnpei Island ("Central Municipalities" on other tables) were not recorded for individual municipalities, and hence are presented for the island as a whole.

by the U.S. Peace Corps in conjunction with the University of Hawaii School of Public Health (1967), two by the U.S. Bureau of the Census (1970, 1980), and one by the FSM Office of Planning and Statistics (1985). The data collected indicate that Pohnpei State population grew throughout the twentieth century, the relatively modest increases preceding World War II contrasting with more rapid growth over the past forty-five years (Table 2; Figure 2).

Demographic change varied between individual island units in Pohnpei State (Table 3). In part, these differences corresponded to the major geographic division between the high island and Outer Atolls, pointing up the increased concentration of population on Pohnpei Island, particularly in the municipalities of Nett and Kolonia. Changes in population density over time document further the differences in demographic change experienced by different places in Pohnpei State, though densities on the limited land areas of the Outer Atolls continued to be much greater than any observed on the high island despite its more rapid population growth (Table 4).

We now briefly describe the demographic evolution of Pohnpei State in regional terms, organized in seven sections. The first discusses demo-

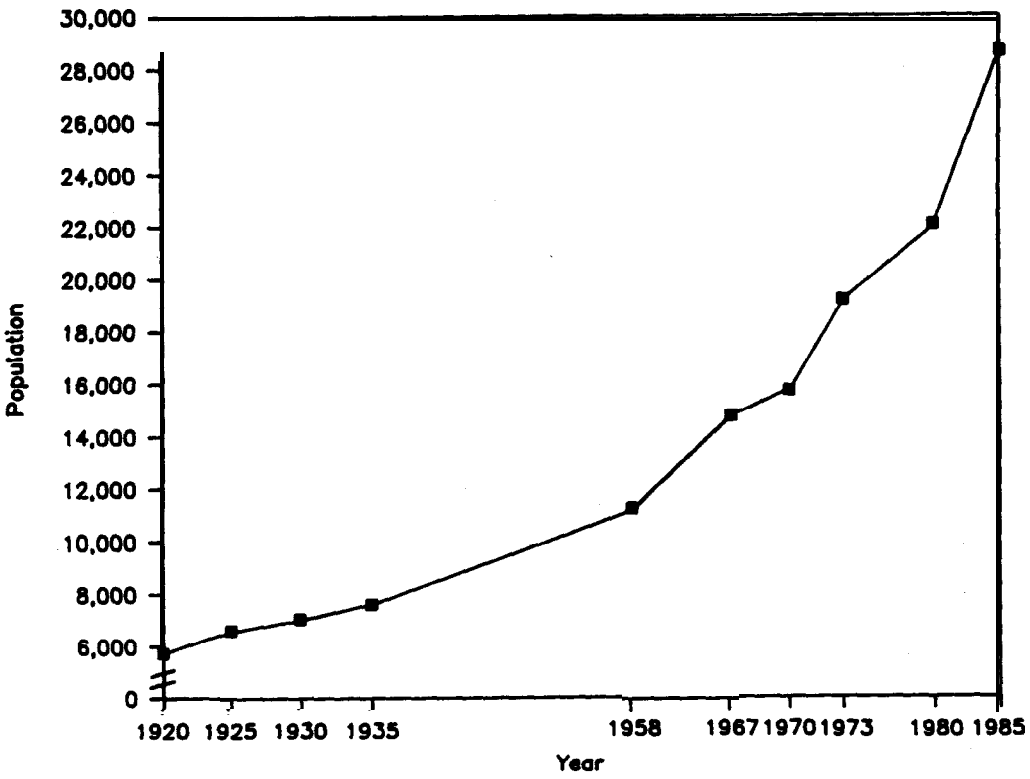


FIGURE 2. **Change in the total population of Pohnpei State over time.**

TABLE 2. **Population of Pohnpei State by Year, Showing Population Change between Census Years: Select Years**

Year	Population	Change from Previous Listed Census Yr.	Average Annual Change from Previous Listed Census Yr.	Source
1920	**5,748**	**...**	**...**	**Nan'yō-chō 1937**
1925	**6,597**	**849**	**2.8%**	**Nan'yō-chō 1927**
1930	**7,051**	**101**	**1.3%**	**Nan'yō-chō 1931**
1935	**7,596**	**545**	**1.5%**	**Nan'yō-chō 1937**
1949	8,023	...	...	U.S. Dept. of the Navy 1949
1950	8,159	...	...	U.S. Dept. of the Navy 1950
1951	8,445	...	...	U.S. Dept. of the Navy 1951
1952	9,145	...	...	U.S. Dept. of Interior 1952
1954	10,023	...	...	U.S. Dept. of State 1955
1956	10,338	...	...	U.S. Dept. of State 1957
1957	11,035	...	...	U.S. Dept. of State 1958
1958	**11,253**	**3,657**	**1.7%**	**Office of the High Commissioner 1959**
1959	12,050	...	...	U.S. Dept. of State 1960
1960	12,627	...	...	U.S. Dept. of State 1961
1961	13,462	...	...	U.S. Dept. of State 1962
1962	14,205	...	...	U.S. Dept. of State 1963
1963	14,647	...	...	U.S. Dept. of State 1964
1964	15,048	...	...	U.S. Dept. of State 1965
1965	15,607	...	...	U.S. Dept. of State 1966
1967	**15,044**	**3,791**	**3.3%**	**School of Public Health n.d.**
1968	15,335	...	...	U.S. Dept. of State 1969
1969	16,445	...	...	U.S. Dept. of State 1970
1970	**15,270**	**226**	**0.5%**	**U.S. Bureau of the Census 1972**
1971	17,569	...	...	U.S. Dept. of State 1972
1972	19,109	...	...	U.S. Dept. of State 1973
1973	**19,263**	**3,993**	**8.1%**	**Office of Census Coordinator 1975**
1975	20,030	...	...	U.S. Dept. of State 1978
1976	20,610	...	...	U.S. Dept. of State 1978
1977	21,190	...	...	U.S. Dept. of State 1978
1978	21,780	...	...	U.S. Dept. of State 1979
1979	22,420	...	...	U.S. Dept. of State 1980
1980	**22,081**	**2,818**	**2.0%**	**U.S. Bureau of the Census 1983a**
1984	26,922	...	...	U.S. Dept. of State 1985
1985	**28,671**	**6,590**	**5.4%**	**Office of Planning and Statistics 1988**

Notes: Census years in **boldface.** 1920-1935 data are for Pacific Islanders only. Intercensal estimates are de jure population; census data are de facto population. For alI tables, "-" denotes zero or a percentage that rounds to less than 0.1; "NA" = not available; "..." = not applicable.

TABLE 3. **Population by Area: Census Years**

Area	1920	1925	1930	1935	1958	1967	1970	1973	1980	1985
Pohnpei State	5,748	6,597	7,051	7,596	11,253	15,044	15,270	19,263	22,081	28,671
Central Municipalities	4,169	4,954	5,320	5,758	9,339	12,884	13,135	17,259	20,035	26,198
Kolonia[a]	...	...	(357)	...	1,720	2,991	2,649	4,795	5,549	6,169
Kitti	1,322	1,399	1,409	1,500	1,896	2,369	2,436	2,427	3,401	3,987
Madolenihmw	763	889	1,067	1,229	1,794	2,571	2,152	2,627	3,376	4,340
Nett	779	1,016	1,044	1,201	1,068	1,368	1,662	2,357	2,226	4,067
Sokehs	623	887	1,024	1,066	1,671	2,115	2,486	3,216	3,632	5,047
U	682	763	776	762	1,190	1,470	1,750	1,837	1,851	2,588
Outer Atolls	1,579	1,643	1,731	1,838	1,914	2,160	2,135	2,004	2,046	2,473
Kapingamarangi	300	341	378	396	404	428	369	389	508	511
Mwoakilloa	246	236	269	258	338	397	387	321	290	268
Nukuoro	159	184	168	191	247	287	267	245	307	393
Oroluk	–	–	–	4	–	–	–	–	6	–
Pingelap	601	601	638	694	627	647	661	641	375	737
Sapwuahfik	273	281	278	295	298	401	451	408	560	564

Sources: **Nan'yō-chō** 1927, 1931, 1937; Office of the High Commissioner 1959; School of Public Health n.d.; U.S. Bureau of the Census 1972, 1983a; Office of Census Coordinator 1975; Office of Planning and Statistics 1988.

Note: Data for 1920-1935 comprise de facto Pacific Islanders; remaining data are de facto population.

[a]Kolonia recorded as part of Nett in 1920, 1925, and 1935. Nett total for 1930 includes Kolonia population, shown parenthetically.

TABLE 4. **Population Density by Area: Census Years (Persons per Square Mile)**

Area	1920	1925	1930	1935	1958	1967	1970	1973	1980	1985
Pohnpei State	43	50	53	57	84	113	115	145	166	215
Central Municipalities	32	38	41	45	72	100	102	134	155	203
Kolonia	NA	NA	(277)	NA	1,333	2,319	2,054	3,717	4,302	4,782
Kitti	35	37	37	40	50	62	64	64	90	105
Madolenihmw	22	26	31	36	52	75	63	76	98	126
Nett	31	41	42	48	43	55	66	94	89	201
Sokehs	44	63	72	75	118	149	175	227	256	287
U	88	99	100	98	154	190	226	237	239	334
Outer Atolls	497	517	544	578	602	679	671	630	643	778
Kapingamarangi	577	656	727	762	777	823	710	748	977	983
Mwoakilloa	513	492	560	538	704	827	806	669	604	558
Nukuoro	248	288	263	298	386	448	417	383	480	614
Oroluk	–	–	21	–	–	–	–	–	32	–
Pingelap	884	884	938	1,021	922	952	972	943	552	1,084
Sapwuahfik	408	420	415	440	445	599	673	609	836	842

graphic data from the Japanese period, examining the four censuses between 1920 and 1935 when the population of Pohnpei State increased steadily. Each of the remaining six sections deals with one of the post-World War II censuses, in total encompassing a period when the population of Pohnpei State grew substantially and became more concentrated on Pohnpei Island. In the interest of brevity, we confine this discussion to a presentation of key data, drawing attention to possible causes of population change when possible.

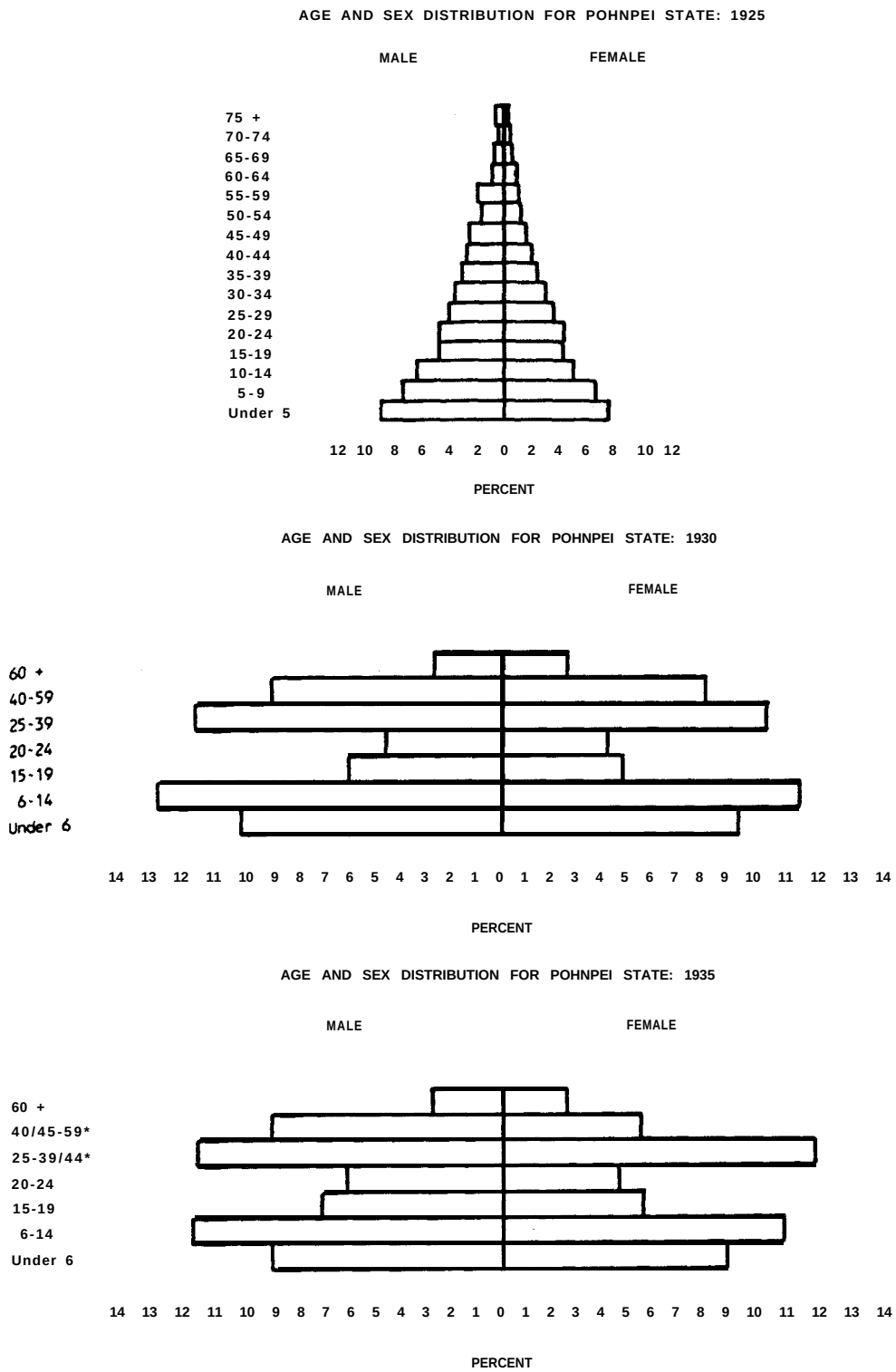
Regional Demography during the Japanese Period: 1920, 1925, 1930, and 1935

Beginning in 1920 the Japanese **Nan'yō-chō** conducted four censuses of the area currently comprising Pohnpei State, providing valuable data on the demographic evolution of this region during the Japanese administration. Population increased throughout this period, both on Pohnpei Island and on the Outer Atolls, with statewide growth ranging from an annual average rate of 1.3 to 2.8 percent (see Table 2).

The 1920 census recorded a total of 5,748 Pacific Islanders (**Nan'yō-chō** 1937). Population was counted on each Outer Atoll and in each municipality on the high island except Kolonia (which was combined with Nett; see Table 3). In 1920, slightly less than three times as many people resided on Pohnpei Island as in the Outer Atolls. Kitti Municipality dominated the high island demographically, containing nearly twice as many persons as any other municipality. Pingelap Atoll contained roughly twice as many persons as any other Outer Atoll.

The population of Pohnpei State grew rapidly between 1920 and 1925, with an average annual increase of 2.8 percent producing a total of 6,597 Pacific Islanders by mid-decade (**Nan'yō-chō** 1927). Most of this growth occurred on Pohnpei Island (see Table 3). The increase in high-island municipalities was dominated by growth in Nett, most likely evidence of a surge in Kolonia's demographic development (in 1925 the population of Kolonia still was recorded as part of Nett). Growth on the Outer Atolls was much less pronounced, though only Mwoakilloa had a decline in population during this period. Data on the age-sex structure of Pohnpei State was available for the first time in 1925 (see Figure 3).

Vital statistics are poorly documented for the entire Mandated Territory during the early 1920s, and data for Pohnpei State are no exception. The estimated general fertility rate for the Pacific Islanders in the Pohnpei District of the Mandated Territory was at 94.5 in 1923, increas-



*Different ages used for males (25-39, 40-59) and females (25-44, 45-59).

FIGURE 3. **Population pyramids (Pacific Islanders only): 1925, 1930, 1935.**

ing to 102.1 in 1924 (Yanaihara 1967:35).[4,5] These values indicate that fertility in Pohnpei State was similar to that estimated for Chuuk State and the Republic of Palau in the same years, and much greater than the fertility of Yap State (see Gorenflo and Levin 1991:111). Contrasting totals of deaths in the Pohnpei District are presented on adjacent pages of the Japanese government's annual report to the League of Nations (Japan 1927:94-95); crude death rate thus may be calculated as 25.4 or 36.3 for 1925. Although age-specific deaths were recorded for 1925, they were not recorded in age groups that corresponded to census age groups, making it impossible to calculate age-specific death rates.

The 1930 Japanese census of the Mandated Territory recorded 7,051 Pacific Islanders in Pohnpei State (Nan'yo-cho 1931). Relative growth in population over the final five years of the 1920s was slightly greater on Pohnpei Island, with all municipalities gaining people (see Table 3). The population of Kolonia Municipality, recorded separately for the first time in 1930, was 357. Population increased on all Outer Atolls except Sapwuahfik and Nukuoro, each of which experienced slight declines. The age-sex structure of Pohnpei State in 1930 was similar to that documented five years earlier (see Figure 3). Data on the age composition of individual municipalities, available for the first time in 1930, indicate substantial variability between places (Table 5). In general, compared to the Outer Atolls the municipalities on Pohnpei Island contained relatively more persons of working age (in age groups 15-24 and 25-59) and fewer persons younger than 15 years and older than 59 years.

The general fertility rate for Pacific Islanders in the Pohnpei District of the Mandated Territory was estimated at 112.7 in 1926 and 101.5 in 1929, and measured at 139.1 in 1930, indicating slightly higher fertility in this area than elsewhere in the Mandated Territory for the years considered (Yanaihara 1967:35). Because mortality data are available only for the first six months of 1930 (Japan 1931:136), we did not calculate any measures of mortality for 1930. Data reflecting lifetime mobility of native inhabitants of Pohnpei State, on the other hand, are available for 1930 (Table 6). Information on residence by place of registration indicates that the majority of Pohnpei State residents in 1930 lived in the same locality where they were registered--with most of the remainder born elsewhere in the Pohnpei District. Residents on Pohnpei Island tended to be much more mobile, with 17.3 percent having migrated to Pohnpei State from another district in the Mandated Territory; this inmigration was particularly high in Sokehs Municipality, owing to the German resettlement of outer islanders there following the rebellion in

TABLE 5. **Pacific Islander Population by Age and Area: 1930**

Area	Total Persons	Age Group (Percentage)			
		<15	15-24	25-59	60+
Pohnpei State	7,051	41.6	17.1	36.5	4.8
Central Municipalities[a]	5,320	40.5	17.6	37.4	4.5
Kitti	1,409	39.6	16.1	38.8	5.5
Madolenihmw	1,067	40.0	17.3	37.3	5.3
Nett	1,044	44.3	19.9	32.1	3.7
Sokehs	1,024	39.1	17.5	40.2	3.2
U	776	39.9	17.4	38.7	4.0
outer Atolls[b]	1,731	44.7	15.9	33.8	5.7
Kapingamarangi	378	48.7	19.6	29.4	2.4
Mwoakilloa	269	46.8	13.4	34.9	4.8
Nukuoro	168	47.6	11.3	32.1	8.9
Pingelap	638	42.0	14.4	36.4	7.2
Sapwuahfik	278	41.4	19.4	33.8	5.4

Source: **Nan'yō-chō** 1931.

Note: Percentages in this and following tables may not sum precisely to 100.0% due to rounding.

[a]Kolonia contained 357 persons in 1930; relative proportions in each age group, beginning with the youngest, were 46.8%, 26.1%, 26.6%, and 0.6%.

[b]Oroluk Atoll uninhabited in 1930.

1910 and the Japanese repatriation of Sokehs residents exiled by the Germans to Palau. Residents of the Outer Atolls, in contrast, were almost all registered on the atoll where they resided in 1930.

The population of Pohnpei State continued to grow during the early 1930s, reaching 7,596 Pacific Islanders by 1935 (**Nan'yō-chō** 1937). Population on both Pohnpei Island and the Outer Atolls grew over these five years, with the most rapid growth again experienced on the former (see Table 3). All municipalities on Pohnpei Island except U gained population between 1930 and 1935, with the greatest relative growth experienced in Madolenihmw and Nett. Similarly, all of the Outer Atolls except one (Mwoakilloa) gained people during the first half of the 1930s. Data on the age-sex structure of Pohnpei State population show relative decreases in persons aged less than 15 years, and females aged 40-59 years, between 1930 and 1935 (see Figure 3). Variability in the age structures of individual places continued, with the general tendency to find relatively more persons aged 15-24 and 25-59 years on Pohnpei Island than the Outer Atolls persisting (Table 7).

TABLE 6. **Pacific Islander Population by Area, According to Place of Registration: 1930**

Area	Total Persons	Percentage			
		Same Locality	Same District[a]	Other District[a]	Other Location[b]
Pohnpei State	7,051	68.1	18.2	13.1	0.5
Central Municipalities	5,320	58.5	23.6	17.3	0.6
Kitti	1,409	73.7	10.7	15.5	0.1
Madolenihmw	1,067	77.4	16.1	6.5	-
Nett	1,044	44.3	45.9	8.2	1.6
Sokehs	1,024	11.9	36.8	59.6	0.7
U	776	85.6	9.7	3.7	1.0
Outer Atolls[c]	1,731	97.7	1.8	0.3	0.1
Kapingamarangi	378	98.9	1.1	-	-
Mwoakilloa	269	97.0	2.2	0.7	-
Nukuoro	168	95.8	3.6	0.6	-
Pingelap	638	97.5	2.2	0.3	-
Sapwuahfik	278	98.6	0.7	0.4	0.4

Source: Nan'yo-cho 1931.

[a]Refers to major island districts within the Mandated Territory (e.g., Pohnpei District). Note that the Pohnpei District of the Mandated Territory included Kosrae State, and Enewetak and Ujelang atolls (presently contained within the Republic of the Marshall Islands); the above data will reflect this administrative geographical configuration.

[b]Refers to locations outside the Mandated Territory.

[c]Oroluk Atoll uninhabited in 1930.

Data on fertility of Pacific Islanders in the Pohnpei District of the Mandated Territory are available for 1937, the approximately 113.0 general fertility rate comparing to values recorded for the state during the 1920s. Crude death rate for the same year was 15.7, with tuberculosis and influenza identified as the most prevalent causes of death throughout the eastern Carolines (Office of the Chief of Naval Operations 1944:30). Data on mobility are unavailable for 1935.

Regional Demography in 1958

The 1958 TTPI census recorded 11,253 persons in Pohnpei State, indicating sustained population growth at an average annual rate of 1.7 percent over the preceding twenty-three years (Office of the High Commissioner 1959). The majority of this growth occurred on Pohnpei

TABLE 7. **Pacific Islander Population by Age and Area: 1935**

Area	Total Persons	Age Group (Percentage)			
		<15	15-24	25-59	60+
Pohnpei State	7,596	37.8	21.4	35.9	4.9
Central Municipalities	5,758	36.6	22.0	36.7	4.8
Kolonia	...	...	...	...	...
Kitti	1,500	39.8	18.8	35.2	6.2
Madolenihmw	1,229	30.0	25.1	39.5	5.3
Nett	1,201	40.5	23.9	32.3	3.3
Sokehs	1,066	37.2	20.5	38.8	3.5
U	762	33.7	22.0	38.7	5.5
Outer Atolls	1,838	41.8	19.5	33.6	5.1
Kapingamarangi	396	46.0	18.7	31.3	4.0
Mwoakilloa	258	42.6	20.2	32.2	5.0
Nukuoro	191	44.5	18.3	30.4	6.8
Oroluk	4	25.0	25.0	50.0	-
Pingelap	694	42.1	19.2	33.6	5.2
Sapwuahfik	295	33.2	21.7	40.0	5.1

Source: **Nan'yō-chō** 1937.

Island, where population increased by nearly 3,600 (see Table 3). Demographic growth occurred in all high-island municipalities during this period, but most rapidly in the combined Kolonia-Nett municipality. This localized surge in population corresponded to the emergence of Kolonia as the main population center on the island. Population growth on the Outer Atolls occurred at a much slower pace, gaining only 80 persons over the entire twenty-three-year period. The age-sex structure of Pohnpei State in 1958 indicates increased relative representation both among the young (particularly those aged less than 10 years) and the old (aged 60 years and older; Figure 4). Data on the age composition of individual places unfortunately are unavailable for 1958. Reliable vital statistics similarly are unavailable for 1958, though the increased representation of young persons implies increased fertility and possibly decreased infant mortality.

As a consequence of differences in the rates of population growth throughout Pohnpei State between 1935 and 1958, the relative concentration of population on the high island increased considerably. Throughout the period of Japanese administration, the relative distribution of population remained relatively constant: Pohnpei Island con-

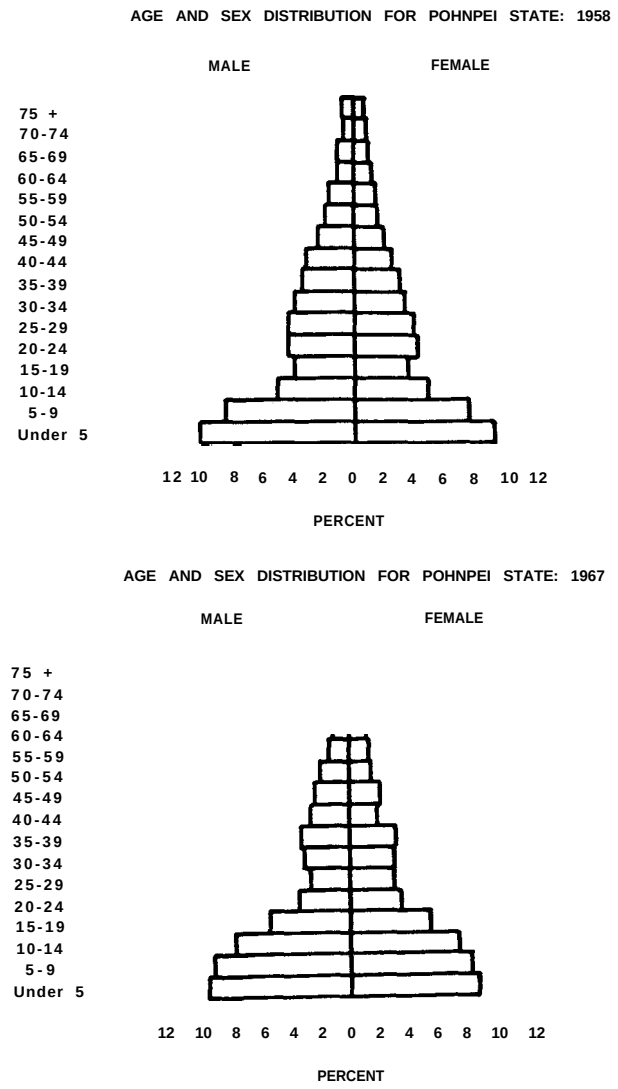


FIGURE 4. **Population pyramids: 1958 (including Kosrae), 1967.**

tained roughly 75 percent of the state population and the Outer Atolls the remainder. By 1958 the proportion residing on the high island had increased to 83.0 percent, corresponding to its growing importance in the region.

Regional Demography in 1967

The population of Pohnpei State was 15,044 by 1967, having grown at an average annual rate of 3.3 percent over the preceding nine years (School of Public Health n.d.). Once again, the majority of this increase

occurred on Pohnpei Island, where population grew by more than 3,500 persons (see Table 3). The population of all high-island municipalities increased, with Kolonia and Madolenihmw adding 1,271 and 777 persons, respectively. Population growth on the Outer Atolls was slower than that experienced on the high island, but similarly occurred on all places. As a result of this differential growth, the proportion of state population residing on Pohnpei Island increased to 85.6 percent. Minor shifts occurred among the persons in five-year age groups between 1958 and 1967 (see Figure 4). The age distributions at individual places also changed slightly from earlier years. The tendency that had persisted throughout the Japanese administration for proportionally more individuals younger than 15 years and 60 years or older to reside on the Outer Atolls than on the high island no longer was true in 1967 (Table 8). Age structure continued to vary between places.

Vital statistics for Pohnpei State in 1967 indicated much higher fertility than during the Japanese period (Table 9), helping to explain the rapid population growth for the nine years preceding the 1967 census.

TABLE 8. **Population by Age and Area: 1967**

Area	Total Persons	Age Group (Percentage)[a]			
		<15	15-24	25-59	60+
Pohnpei State	15,044	48.0	15.4	28.7	6.0
Central Municipalities	12,884	48.4	15.7	28.4	5.4
Kolonia	2,991	45.7	15.6	29.0	4.1
Kitti	2,369	50.8	16.6	26.7	5.3
Madolenihmw	2,571	47.6	15.1	29.6	6.9
Nett	1,368	51.5	12.7	29.1	5.3
Sokehs	2,115	47.8	16.9	28.5	5.8
U	1,470	49.8	16.4	27.3	4.8
Outer Atolls[b]	2,160	45.8	13.7	30.3	9.7
Kapingamarangi	428	42.8	13.1	34.3	8.9
Mwoakilloa	397	49.6	19.4	22.7	8.1
Nukuoro	287	42.2	19.9	29.6	8.0
Pingelap	647	50.2	9.0	30.9	9.4
Sapwuahfik	401	40.6	12.0	32.9	13.7

Source: School of Public Health n.d.

[a]Percentages may not sum to precisely 100.0%, due to exclusion of individuals whose ages were "not specified" and individuals who were "foreign born" (whose ages similarly were not specified).

[b]Oroluk Atoll uninhabited in 1967.

TABLE 9. **Measures of Fertility for Pohnpei State: Select Years**

Year	Total Persons	Total Births	Crude Birth Rate	General Fertility Rate	Total Fertility Rate
1967[a]	18,304	616[b]	34.0	176.3	6,246
1970[a]	18,536	673	41.7	205.2	7,205
1973[a]	23,252	817	35.1	176.0	5,952
1980	22,081	932[b]	42.2	203.0	6,028
1985[c]	28,671	879	30.7	144.7	4,131

Sources: School of Public Health n.d.; U.S. Bureau of the Census 1972, 1983a; U.S. Dept. of State 1981, 1983; Office of Budget, Planning, and Statistics 1987; Office of Planning and Statistics 1988.

[a]Measures for 1967, 1970, and 1973 incorporate population figures and births for Pohnpei and Kosrae states combined, as births for the latter were not recorded separately until 1976.

[b]Measures for 1967 and 1980 differ from those in Table 10 due to conflicting data. The data here are reported births in all of Pohnpei State for each year, and thus should be comparable across years. Unfortunately, these same data are not available for each municipality, forcing us to employ different sources for Table 10.

[C]Natality measures for 1985 calculated based upon data presented in Office of Budget, Planning, and Statistics 1987. These figures disagree with those presented in Office of Planning and Statistics 1988, where crude birth rate was reported as 40.1 and total fertility rate was reported as 5,150.

Natality varied between places, but generally was relatively high throughout the state (Table 10). Mortality data are available for Pohnpei State by five-year age groups (Table 11). The statewide crude death rate in 1967 was less than one-third that recorded during the Japanese period (Table 12), providing additional evidence for natural growth in Pohnpei State during the mid-to-late 1960s.

Regional Demography in 1970

The 1970 census recorded a total of 15,270 persons (U.S. Bureau of the Census 1972), a number that, if accurate, would indicate population growth in the area slowed considerably during the final three years of the 1960s. However, researchers generally consider that the 1970 census featured major undercounts for most portions of the TTPI (including Pohnpei State). We discuss the 1970 census data briefly for the sake of completeness, keeping the likelihood of an undercount clearly in mind.

TABLE 10. **Fertility Measures by Area: 1967 and 1980**

Area	1967 Total Persons	1967 Total Births[a]	1967 Crude Birth Rate	1967 General Fertility Rate	1967 Total Fertility Rate	1980 Total Persons	1980 Total Births	1980 Crude Birth Rate	1980 General Fertility Rate	1980 Total Fertility Rate
Pohnpei State	15,044	511	34.0	166.6	6,071	22,081	993	45.0	216.3	7,511
Central Municipalities	12,884	435	33.8	166.7	6,089	20,035	920	45.9	220.3	7,656
Kolonia	2,991	116	38.8	177.6	5,931	5,549	250	45.1	191.7	6,405
Kitti	2,369	67	28.3	149.3	5,619	3,401	148	43.5	237.9	8,731
Madolenihmw	2,571	95	37.0	179.5	6,825	3,376	170	50.4	266.5	9,311
Nett	1,368	45	32.9	176.0	6,248	2,226	130	58.4	287.6	10,378
Sokehs	2,115	59	27.9	132.7	5,233	3,632	153	42.1	194.2	7,102
U	1,470	53	36.1	189.4	6,948	1,851	69	37.3	185.0	5,533
Outer Atolls	2,160	76	35.2	166.3	6,037	2,046	73	35.7	176.8	6,026
Kapingamarangi	428	17	39.7	178.9	6,131	508	12	23.6	108.1	3,815
Mwoakilloa	397	10	25.2	133.3	4,786	290	6	20.7	107.1	3,333
Nukuoro	287	7	24.4	85.7	4,845	307	30	97.7	416.7	13,556
Oroluk						6	-	-	-	-
Pingelap	647	30	46.4	252.2	8,383	375	5	13.3	75.8	2,718
Sapwuahfik	401	12	29.9	128.2	4,089	560	20	35.7	185.2	6,349

Sources: School of Public Health n.d.; U.S. Bureau of the Census 1983b.

Note: Total births include infants born to mothers aged <15, >49, and of unknown age (used for crude fertility rate, but not for general or total fertility rates).

[a]1967 natality based upon infants 1 year old and younger, and thus excludes those who died during the first year of life.

TABLE 11. **Deaths in Pohnpei State, Percentages by Age Group: 1967, 1970, 1973, 1980, and 1985**

Age	1967	1970[a]	1973[a]	1980	1985
	Number				
Total Persons	15,044	18,536	23,252	22,081	28,671
	Percentage				
All Ages	100.0	100.0	100.0	100.0	100.0
<1	20.9	16.7	25.3	18.1	20.0
1-4	10.4	5.3	7.7	5.8	NA
5-9	-	2.6	2.2	1.4	NA
10-14	-	5.3	1.1	2.2	NA
15-19	1.5	2.6	-	3.6	NA
20-24	1.5	2.6	5.5	1.4	NA
25-29	-	2.6	1.1	3.6	NA
30-34	6.0	1.8	5.5	1.4	NA
35-39	1.5	2.6	3.3	2.9	NA
40-44	3.0	3.5	6.6	3.6	NA
45-49	3.0	5.3	8.8	5.8	NA
50-54	3.0	3.5	7.7	5.1	NA
55-59	4.5	5.3	5.5	3.6	NA
60-64	1.5	7.0	6.6	6.5	NA
65-69	1.5	7.9	-	12.3	NA
70-74	3.0	5.3	1.1	7.2	NA
75+	23.9	20.2	12.1	15.2	NA

Sources: 1967 calculations based upon data on deaths in the 11.5 months preceding the 1967 census, as presented in School of Public Health n.d.; 1970 and 1973 calculations based upon data on deaths for each calendar year in U.S. Dept. of State 1981; 1980 calculations based upon data on deaths in calendar year in U.S. Dept. of State 1982; 1985 calculations based upon data in Office of Budget, Planning, and Statistics 1987.

[a]Calculations for 1970 and 1973 combine Pohnpei and Kosrae states, as age-specific mortality data available for those years did not distinguish between the two areas.

The 1970 census indicated that minimal population growth occurred on Pohnpei Island after 1967, the substantial decreases recorded for Kolonia and Madolenihmw countered by growth in the remaining four high-island municipalities (see Table 3). The population on the Outer Atolls in total decreased during the same time period, with all except Pingelap and Sapwuahfik experiencing depopulation. As a consequence

TABLE 12. **Age-Specific Death Rates in Pohnpei State: 1967, 1970, 1973, 1980, and 1985**

Age Group	1967	1970[a]	1973[a]	1980	1985
Total	4.45	6.15	3.91	6.25	3.50
< 1	27.56	21.84	23.21	29.48	22.50
1-4	3.34	2.40	2.11	2.49	NA
5-9	-	1.02	0.55	0.57	NA
10-14	-	2.26	0.31	1.04	NA
15-19	0.68	1.48	-	2.13	NA
20-24	1.19	2.16	2.68	1.04	NA
25-29	-	3.27	0.83	3.15	NA
30-34	5.42	2.40	5.04	1.71	NA
35-39	1.31	3.50	3.01	5.17	NA
40-44	3.21	5.18	6.39	7.20	NA
45-49	3.23	7.99	9.96	11.40	NA
50-54	4.06	6.86	8.55	10.48	NA
55-59	7.67	13.95	8.64	8.99	NA
60-64	3.56	22.79	13.42	18.40	NA
65-69	4.52	31.69	-	60.07	NA
70-74	12.74	39.74	4.26	56.18	NA
75+	66.39	96.64	43.48	83.00	NA

Sources: See Table 11.

[a]Calculations for 1970 and 1973 combine Pohnpei and Kosrae states, as age-specific mortality data available for those years did not distinguish between the two areas.

of these differences in demographic change, the proportion of the state population residing on the high island increased once more. The age-sex structure of Pohnpei State changed little between 1967 and 1970 (Figure 5). Data on the age structure of individual places are unavailable for 1970.

A range of vital statistics are available for Pohnpei State (combined with Kosrae) in 1970. All three natality measures considered in this study increased during the early 1970s (see Table 9). Overall mortality also increased, though infant mortality declined between 1967 and 1970 (see Table 12). Data on mobility in 1970 are unavailable.

Regional Demography in 1973

Because of likely problems with data from the 1970 census, the TTPI administration conducted another census in 1973 (Office of Census Coordinator 1975). This census recorded 19,263 persons living in Pohn-

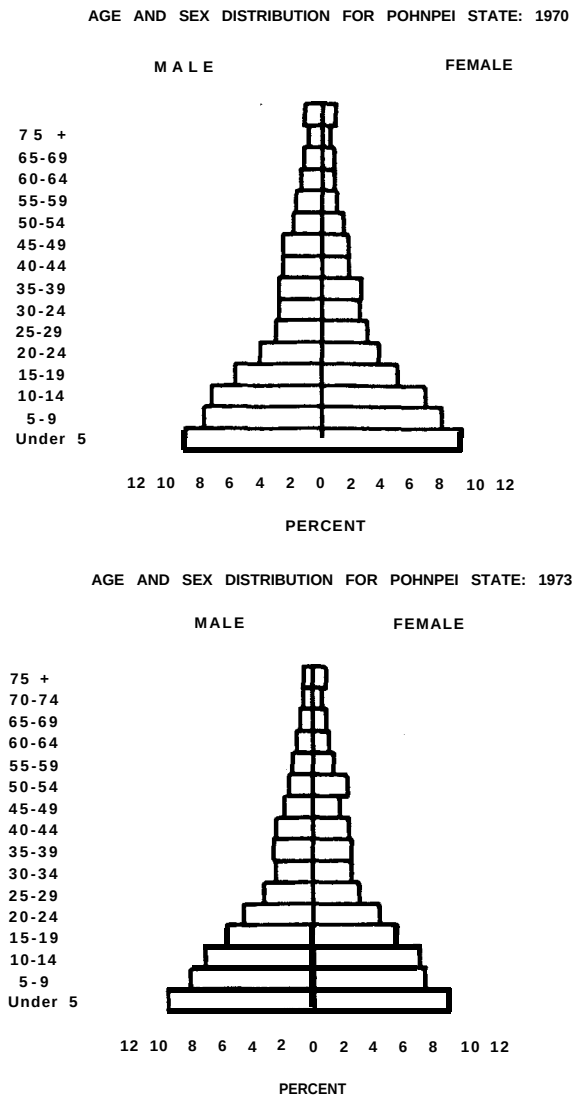


FIGURE 5. **Population pyramids: 1970 (including Kosrae), 1973.**

pei State and provided additional evidence that the 1970 census represented a substantial undercount. If both the 1973 and the 1970 census data were accurate, the increase during the early 1970s represented average annual growth of 8.1 percent, with 9.5 percent annual growth on Pohnpei Island--both of which are impossible in the absence of substantial in-migration (which, as discussed below, was not apparent). Although the accuracy of the 1970 census generally is challenged, the 1973 census capitalized on adequate funding and preparation to provide what generally are considered accurate data. Any discussion of demographic change throughout Pohnpei State during the early 1970s is

weakened greatly by the dubious quality of the 1970 data. To avoid this problem, we speak of change that occurred between 1967 and 1973.

Demographic growth in Pohnpei State between 1967 and 1973 occurred exclusively on Pohnpei Island, where all municipalities registered substantial relative increases in population (see Table 3). The most rapid growth on the high island occurred in Nett, Kolonia, and Sokehs municipalities. By contrast, all Outer Atolls except Sapwuahfik lost population during this period. As a consequence of these differences in demographic change, the proportion of total population residing on Pohnpei Island exceeded 89 percent in 1973. The age-sex structure of Pohnpei State population in 1973 was similar to that recorded in 1967 (see Figure 5). However, the age composition of individual places shifted slightly between these two years (Table 13). Variability between places persisted. But as was the case during the Japanese administration, in 1973 more young (aged less than 15 years) and old (aged 60 years and older) persons resided on the Outer Atolls than on the high island.

TABLE 13. **Population by Age and Area: 1973**

Area	Total Persons	Age Croup (Percentage)[a]			
		<15	15-24	25-59	60+
Pohnpei State	19,263	47.5	19.3	27.6	5.4
Central Municipalities	17,259	47.4	20.0	27.5	4.8
Kolonia	4,795	43.9	21.2	30.8	3.8
Kitti	2,427	52.6	17.3	24.8	5.2
Madolenihmw	2,627	47.6	19.8	25.7	6.8
Nett	2,357	45.7	24.1	26.3	3.6
Sokehs	3,216	49.1	17.9	27.2	5.7
U	1,837	49.2	18.7	27.3	4.6
Outer Atolls[b]	2,004	47.9	13.4	28.0	10.4
Kapingamarangi	389	41.4	14.7	30.8	12.9
Mwoakilloa	321	54.2	14.3	23.7	7.8
Nukuoro	245	44.1	15.1	33.5	7.3
Pingelap	641	50.5	12.2	27.0	10.1
Sapwuahfik	408	47.3	12.5	27.2	12.5

Source: Office of Census Coordinator 1975.

[a]Percentages may not sum to precisely 100.0 due to exclusion of 39 individuals whose ages were "not specified."

[b]Oroluk Atoll uninhabited in 1973.

TABLE 14. **TTPI-born Population by Area, According to Municipality of Usual Residence and Home District: 1973**

Area	Total Persons	Percentage			
		Same Municipality	Elsewhere in Pohnpei	Elsewhere in TTPI	Outside TTPI
Pohnpei State	18,935	73.7	24.4	1.6	0.2
Central Municipalities	16,942	71.2	26.8	1.8	0.2
Kolonia	4,633	25.9	70.2	3.1	0.8
Kitti	2,422	97.4	2.0	0.6	-
Madolenihmw	2,614	78.2	18.0	3.8	-
Nett	2,249	83.2	15.5	1.1	0.2
Sokehs	3,199	87.9	11.6	0.5	-
U	1,825	97.2	2.5	0.3	-
Outer Atolls[a]	1,993	95.1	4.7	0.1	0.1
Kapingamarangi	389	84.6	15.4	-	-
Mwoakilloa	317	93.7	6.0	-	0.3
Nukuoro	245	96.3	3.7	-	-
Pingelap	634	99.5	0.5	-	-
Sapwuahfik	408	98.8	0.7	0.5	-

Source: Office of Census Coordinator 1975.

Notes: Calculations do not include individuals whose residential affiliation was "not stated." The Pohnpei District of the TTPI included Kosrae in 1973; data reflects this administrative configuration ("Elsewhere in Pohnpei" thus includes present-day Pohnpei State as well as Kosrae State).

[a]Oroluk Atoll uninhabited in 1973.

Fertility in Pohnpei State (again combined with Kosrae) decreased between 1970 and 1973 for all three measures considered, to levels more comparable to those of 1967 (see Table 9). Statewide mortality similarly decreased from 1970, although infant mortality registered a slight increase (see Table 12). Data on mobility in 1973 indicate that the majority of TTPI-born persons in the Pohnpei District (which, in 1973, included Kosrae) resided in their home municipality and that virtually all state residents were Pohnpeian or Kosraen (Table 14). However, as was the case in 1930 internal migration apparently played an important role in the arrangement of state population. Although only 4.7 percent of the TTPI-born persons residing on Outer Atolls came from elsewhere in the Pohnpei District of the TTPI, 26.8 percent of the high-island residents moved from another municipality. In-migration was particularly important on Kapingamarangi Atoll, providing a major exception to

the trend for limited movement to Outer Atolls. Migration played an even more important role in the demography of Kolonia Municipality, for in 1973 70.2 percent of its population called some other portion of the Pohnpei District home.

Regional Demography in 1980

In 1980 the population of Pohnpei State was 22,081, indicating average annual growth of 2.0 percent over the preceding seven years (U.S. Bureau of the Census 1983a). Most of this growth once again occurred on Pohnpei Island, which contained 90.7 percent of the state population in 1980 (see Table 3). All municipalities on the high island except Nett gained population between 1973 and 1980, with Kitti growing the fastest in relative terms. The Outer Atolls population grew at a more modest rate during this period, largely due to *recorded* depopulation (due to an undercount, or temporary absence) on Pingelap Atoll, which according to the 1980 census lost nearly 300 persons. The age-sex composition of Pohnpei State remained generally similar to that of 1973 (Figure 6). But the age composition of the two main components of Pohnpei State shifted once again, with relatively fewer persons aged less than 25 years residing on Outer Atolls, and relatively fewer aged 25 years and older residing on Pohnpei Island (Table 15). For only the second census year examined in this study, a population was recorded on Oroluk Atoll.

Statewide natality increased between 1973 and 1980 for all three measures considered (see Table 9). Fertility was higher on Pohnpei Island than among the Outer Atolls, and particularly high in Nett and Madolenihmw municipalities (see Table 10). Both the overall crude death rate and infant mortality increased between 1973 and 1980 (see Table 12). As in 1930 and 1973, mobility was minimal on the Outer Atolls and more pronounced on the high island (Table 16). In-migration was greatest in Kitti and Kolonia municipalities, helping to explain the population growth recorded for the former. Although the data employed to examine mobility in 1980 do not allow strict comparisons with 1930 and 1973, the role of migration apparently decreased in 1980--particularly in the case of mobility within the state.

Regional Demography in 1985

The 1985 census of Pohnpei State recorded 28,671 persons, an increase of nearly 6,600 since 1980 (Office of Planning and Statistics 1988). The

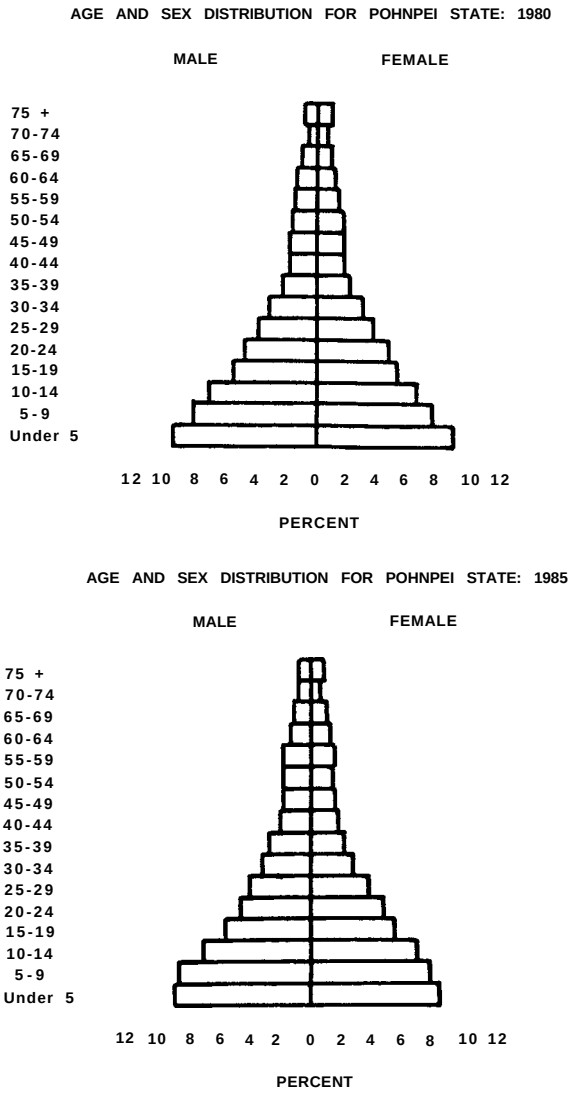


FIGURE 6. **Population pyramids: 1980, 1985.**

population of both Pohnpei Island and the Outer Atolls increased during this five-year period, though more so on the former (see Table 3). Demographic growth was particularly marked in Nett Municipality on the high island and on Pingelap Atoll, with population on the latter exceeding that recorded prior to the 1980 census undercount. The 1985 age-sex composition of Pohnpei State changed little from that of five years previously (see Figure 6). Data on the age composition of individual places in Pohnpei State indicate relatively fewer persons aged younger than 25 years, and relatively more persons aged 25 years and older, resided on the Outer Atolls than on the high island (Table 17).

Available vital statistics indicate a decrease in natality between 1980

TABLE 15. **Population by Age and Area: 1980**

Area	Total Persons	Age Group (Percentage)			
		<15	15-24	25-59	60+
Pohnpei State	22,081	47.4	19.3	27.9	5.4
Central Municipalities	20,035	47.6	19.7	27.9	4.9
Kolonia	5,549	46.5	19.7	30.1	3.8
Kitti	3,401	51.8	19.4	24.1	4.7
Madolenihmw	3,376	49.4	18.9	26.2	5.6
Nett	2,226	46.9	20.3	28.3	4.5
Sokehs	3,632	44.6	19.9	29.6	5.8
U	1,851	46.2	20.2	27.1	6.5
Outer Atolls	2,046	45.4	16.0	28.1	10.6
Kapingamarangi	508	41.3	16.1	32.3	10.2
Mwoakilloa	290	45.2	17.6	26.9	10.3
Nukuoro	307	49.5	16.0	28.0	6.5
Oroluk	6	-	-	100.0	-
Pingelap	375	47.7	13.3	26.4	12.5
Sapwuahfik	560	45.7	17.1	25.2	12.0

Source: U.S. Bureau of the Census 1983a.

and 1985 for all three measures calculated (see Table 9). Both crude death rate and infant mortality rate decreased over this same time period (see Table 12), though annual estimates for the early 1980s indicate slight fluctuations (Office of Budget, Planning, and Statistics 1987:159). An independent analysis of the 1985 census data indicated that during the year preceding that census 123 persons migrated to Pohnpei State from outside the Federated States of Micronesia, and 92 from elsewhere within the federation. Most migration within the state between 1984 and 1985 occurred between municipalities on the high island, with fewer migrating from the Outer Atolls to Pohnpei Island (Office of Planning and Statistics 1988:54-57).

Evolving Regional Demography in Pohnpei State: Causes, Results, and Repercussions

Causes Underlying Regional Demographic Change in Pohnpei State

Available evidence indicates that Pohnpei State population grew throughout the sixty-five years covered by the ten censuses examined above. In the process of describing demographic data and vital statistics

TABLE 16. **Population by Area, According to Place of Residence in 1975: 1980**

Area	Total Persons[a]	Percentage			
		Same Municipality	Elsewhere in Pohnpei	Elsewhere in TTPI	Outside TTPI
Pohnpei State	17,073	91.9	5.2	1.8	1.1
Central Municipalities	15,583	91.2	5.7	1.9	1.2
Kolonia	4,343	86.3	6.9	4.4	2.4
Kitti	2,589	89.8	9.7	0.3	0.2
Madolenihmw	2,543	96.0	3.5	0.3	0.1
Nett	1,757	91.4	3.6	1.4	3.6
Sokehs	2,914	91.8	5.3	2.3	0.7
U	1,437	98.3	1.7	-	-
Outer Atolls	1,490	99.1	0.5	0.3	0.1
Kapingamarangi	364	98.6	1.1	-	0.3
Mwoakilloa	239	100.0	-	-	-
Nukuoro	231	100.0	-	-	-
Oroluk	6	NA	NA	NA	NA
Pingelap	299	97.3	1.3	1.3	-
Sapwuahfik	357	100.0	-	-	-

Source: U.S. Bureau of the Census 1983b.

[a]Includes only those individuals more than 5 years old. Excludes 20 persons whose 1975 place of residence was not given.

in this region, we briefly noted possible reasons for population change. We now examine the mechanisms underlying the evolution of Pohnpei State regional demography more closely, considering *both* overall population change as well as shifts in geographical distribution.

Pohnpei State experienced demographic growth among Pacific Islanders throughout the Japanese administration. Insights on the specific processes underlying this growth are uncertain due to a lack of data. Natural increase probably played the most important role: relatively high fertility persisted for several years, exceeding mortality in those years when both types of data were available (see Yanaihara 1967: 32-35). The demographic importance of natural increase during the Japanese administration suggests that health problems that could affect both natality and mortality--such as respiratory ailments, infectious diseases (especially gonorrhea and yaws), and intestinal disorders (Office of the Chief of Naval Operations 1944:93-96)--were kept under control. Migration probably also played some role in the population

TABLE 17. **Population by Age and Area: 1985**

Area	Total Persons	Age Group (Percentage)[a]			
		<15	15-24	25-59	60+
Pohnpei State	28,671	46.2	19.3	28.8	5.6
Central Municipalities	26,198	46.0	19.9	28.7	5.1
Kolonia	6,169	42.5	20.5	31.9	4.7
Kitti	3,987	52.9	18.0	24.6	4.3
Madolenihmw	4,340	47.6	20.7	25.3	6.3
Nett	4,067	44.8	19.9	30.2	4.7
Sokehs	5,047	45.7	19.6	29.5	5.2
U	2,588	43.6	20.6	29.6	6.1
Outer Atolls[b]	2,473	48.0	13.0	29.2	9.9
Kapingamarangi	511	42.7	12.7	33.5	11.2
Mwoakilloa	268	49.3	10.8	29.5	10.4
Nukuoro	393	50.6	12.7	29.3	7.4
Pingelap	737	48.4	14.2	27.7	9.6
Sapwuahfik	564	49.6	12.8	27.1	10.5

Source: Office of Planning and Statistics 1988.

[a]Percentages may not sum to precisely 100.0 due to exclusion of individuals whose ages were "not specified."

[b]Oroluk Atoll uninhabited in 1985.

growth, with nearly 14 percent of the total native population in 1930 originally registered by the Japanese administration outside the Pohnpei District (see Table 6). Minimal shifts in the relative demographic importance of the geographic components of Pohnpei State occurred during the Japanese administration, with population becoming slightly more concentrated on the high island. This increased demographic concentration on Pohnpei Island probably resulted from migration--mostly persons who relocated from other portions of Micronesia, as well as individuals recruited from the Outer Atolls by the Japanese administration to provide labor on the high island.

As indicated by the data presented in the preceding section, Pohnpei State population grew rapidly following World War II; indications of slower demographic growth probably were products of census undercounts. Available evidence suggests that most of the postwar change in state population was due to natural increase, notably the result of the changing balance between natality and mortality. The general fertility rate, a reliable indicator of natality, was reasonably constant during

both the period of Japanese administration and during the period of U.S. administration. But general fertility rates during the latter period were substantially greater than those preceding the war (see Table 9). One can offer several possible explanations for this increase in fertility, including changes in cultural behavior that led to larger families, the eradication of imposed relocation (thus decreasing the disruption of family life), and the introduction of certain types of medicine that decreased the incidence of fertility-inhibiting diseases (such as gonorrhea and yaws; see Fischer and Fischer 1957:67). Recent data suggest a leveling off of fertility, with a slight decline in total fertility rate between 1973 and 1985 (Office of Planning and Statistics 1988:37; see also Levin and Retherford 1986:17, 46, 52).

Complementing the increase in fertility evident between pre- and post-World War II years was an apparent decrease in mortality between the same periods. The limited evidence available suggests that the postwar crude death rate was between 22 and 40 percent that of the prewar rate. The reasons for this reduction are uncertain, but they almost certainly included the introduction of improved medical technology, health care, and education on health-related matters. Although the Japanese administration introduced modern health care, at least on the high island, certain key improvements such as the introduction of antibiotics did not occur until the U.S. administration (Fischer and Fischer 1957:67). Recent data document the persistence of certain types of illness in Pohnpei State, such as venereal disease and influenza, but indicate that most are not fatal (Office of Budget, Planning, and Statistics 1987:163-164). Infant mortality also probably declined during the postwar years. Although the data are unavailable for Pohnpei State alone, infant mortality for the Mandated Territory ranged between 108.8 and 272.4 between 1926 and 1931 (Yanaihara 1967:35); infant mortality in Pohnpei State for the 1967-1985 census years, in turn, ranged between 21.8 and 29.5 (see Table 12).[6]

In-migration to Pohnpei State played a more important role in demographic growth during the Japanese period than during the postwar years. In contrast to 1930 when nearly 14 percent of the state's Pacific Islander population was born elsewhere, by 1973 less than 2 percent of the TTPI-born population of Pohnpei State migrated from beyond the bounds of the state (see Tables 6 and 14). Data on mobility in 1980 suggest that this general trend continued--with the slight increases in migration from other districts in the TTPI and from outside the territory possibly linked to the emergence of the Federated States of Micronesia, with its capital at the time located in Kolonia. Migration

from other portions of Pohnpei State continued to play an important role in the regional distribution of population in 1973, particularly for municipalities on the high island. As documented in the 1985 census, much of this relocation probably occurred between municipalities on Pohnpei Island itself, due to the ease of movement. This would have been supplemented by migration from the Outer Atolls to the high island (e.g., see Carroll 1975:381-390), particularly in cases where Outer Atoll populations have established places of permanent residence on Pohnpei Island (such as the Kapingamarangi neighborhood of Porakiet on the edge of Kolonia). Internal migration had declined substantially by 1980 (see Table 16), and further still by 1985 (Office of Planning and Statistics 1988:56).

Changes in the Regional Organization of Population in Pohnpei State: Statistical Insights

Having discussed demographic evolution in Pohnpei State and potential causes of this evolution, we now explore the nature of change in regional organization. This inquiry employs three different spatial statistics. Two of the measures, *point-to-point temporal association* and *spatiotemporal association*, provide complementary means of assessing regional change over time. The third, *spatial autocorrelation*, evaluates the nature of a spatial configuration at some particular point in time. For the sake of brevity, we present only brief discussions of the measures themselves. Additional technical details may be found elsewhere: Gale and Gorenflo (1990) discuss point-to-point temporal and spatiotemporal association; and Cliff and Ord (1973, 1981) examine the foundations of spatial autocorrelation. Less technical introductions of the measures employed below may be found in other examples of their application to regional demographic data (e.g., Gorenflo 1990; Gorenflo and Levin 1991).

Point-to-point temporal association assesses total local change in regional demographic organization, namely the degree to which the number of persons living in particular places at some time *t'* corresponded to the number of persons living in those same places at an earlier time *t*. Here we employ two statistical measures of correlation, defined originally in a nonspatial context, to assess point-to-point temporal association: Pearson's product moment correlation coefficient and Spearman's rank order correlation coefficient. Coefficient values range from 1.0 (perfect positive correlation) to -1.0 (perfect negative correlation). Measures of point-to-point temporal association for patterns of

minimal and nonsignificant statistically ($p > .10$) (see Table 18).[7] Through considering the population of places *and* the distance separating them, this statistic measures the degree to which the population of a place at some time *t'* corresponded to the population of proximal places at an earlier time *t*. Values again can range from 1.0 to -1.0--the former indicating that places at time *t'* were located close to places with similar numbers of people and far from places with dissimilar numbers of people at time *t* (and the latter measure indicating the opposite situation). Comparisons of Pohnpei State demographic data between successive census years yielded nonsignificant ($p > .10$) spatiotemporal association values close to 0.0. These results indicate neither similarities nor differences in the shifting arrangement of regional population when distance is considered explicitly. The only statistically significant measure of spatiotemporal association for regional demographic organization resulted from comparing the arrangement of population in 1920 and 1985. The result indicates a marginally significant ($.05 < p < .10$) tendency for places in 1985 to be near places with *dissimilar* populations and far from places with similar populations in 1920. As in the point-to-point case, results of the spatiotemporal association statistics indicate noteworthy change in regional demography over the sixty-five years separating the first and most recent censuses.

We calculated spatial autocorrelation values for population distributions in each census year, to augment the statistics that explore questions of change over time. Spatial autocorrelation measures the interdependence of a variable over space: in the present research setting, strong positive spatial autocorrelation signifies a situation where *in a particular year* places with similar numbers of people were proximal and places with dissimilar numbers of people were distant. As was the case with the spatiotemporal association calculations, spatial autocorrelation values indicate virtually no statistically measurable tendencies in the regional organization of Pohnpei State population (Table 19). Only in 1970, when data quality is open to question (as noted above), was spatial autocorrelation even marginally significant.

Repercussions of Changing Regional Demography in Pohnpei State

The population of Pohnpei State increased steadily throughout the present century, with the total number of inhabitants recorded in the most recent census roughly five times that recorded in 1920. Accompanying this growth was an increased concentration of population on Pohnpei Island. Historically, the high island always has contained most

TABLE 19. **Spatial Autocorrelation Calculations for Pohnpei State Regional Population: Census Years**

Year	Spatial Autocorrelation	Significance
1920	.038	>.10
1925	.054	>.10
1930	.085	>.10
1935	.051	>.10
1958	.110	>.10
1967	.026	>.10
1970	.147	.10
1973	-.002	>.10
1980	-.049	>.10
1985	.039	>.10

of the region's population (see Tables 1 and 3). But the proportion grew from roughly 75 percent during the 1920s and 1930s to 91.4 percent in 1985, and is expected to remain high in the foreseeable future. In the face of the dramatic demographic growth experienced in Pohnpei State, the overall regional *organization* of state population remained relatively constant over the past seventy years--the result of generally small incremental changes between census years. These contrasts in regional evolution have important implications for the development of Pohnpei State as an integrated component of the Federated States of Micronesia.

Before European contact, the islands and atolls comprising contemporary Pohnpei State were politically and economically autonomous. As noted earlier, prior to Western intervention the high island was consolidated under the administration of a single ruling entity for only part of its history, fragmenting into several separate polities in the early seventeenth century (Hanlon 1988: 18). During both the period of centralized rule and the ensuing period of political fragmentation, societies that anthropologists would describe as ranked or chiefdoms inhabited Pohnpei Island (see Fried 1967; Service 1971). High-island chiefdoms are well known for their exceedingly complex social structures. Each Pohnpei chiefdom featured two parallel lines of authority, comprising twelve chiefs each. The head of one of these lines, the Nahnmwarki, was the paramount chief. The head of the second line, the Nahnken, technically was subordinate to the Nahnmwarki but was responsible for much of the daily leadership of the chiefdom. Socially and politi-

TABLE 18. **Statistical Comparisons for Pohnpei State Regional Population: Between Census Years**

	Point-to-Point Temporal		Spatiotemporal
Years Compared	Pearson	Spearman	Quadratic Assignment
1920 & 1925	.981	.991	.016[a]
1925 & 1930	.992	.991	.059[a]
1930 & 1935	.996	1.000	.058[a]
1935 & 1958	.917	.964	-.013[a]
1958 & 1967	.976	.965	-.016[a]
1967 & 1970	.974	.951	.090[a]
1970 & 1973	.947	.979	.040[a]
1973 & 1980	.987	.965	-.045[a]
1980 & 1985	.944	.916	-.044[a]
1920 & 1985	.605[b]	.909	-.538

Note: Levels of significance, unless otherwise noted, are $p < .01$.

[a] $p > .10$.

[b] $.01 < p < .05$.

regional demographic arrangement in Pohnpei State indicate strong, statistically significant ($p < .01$) positive correspondence between successive census years (Table 18). High correlation values persisted even when comparing 1935 and 1958--census years separated by twenty-three years that included World War II--when values of the two measures employed exceeded .91.

In all, the results of our statistical assessment of point-to-point temporal association indicate limited local change in the arrangement of Pohnpei State population between census years. Despite constant demographic growth and an increasing concentration of people on Pohnpei Island, the spatial configuration of people in one census year largely corresponded to the spatial configuration in the following census year. It is only when one considers longer time periods that evidence for local change in the arrangement of population emerges. The comparison between 1920 and 1985 indicates such change, with the value of Pearson's coefficient decreasing to .605. Ultimately, the results of assessing point-to-point temporal association indicate that slight incremental changes in regional organization accumulated over time.

Spatiotemporal association measures of Pohnpei State regional demographic change between successive years, on the other hand, tend to be

cally subordinate to the above two individuals were a series of lesser chiefs scattered throughout the chiefdom. Ultimately, the Nahnmwarki owned all land in his chiefdom and decided who could use it (Office of the Chief of Naval Operations 1944: 146-147). Tribute in the form of labor and tangible goods (particularly food) flowed up the social hierarchy, from commoners ultimately to the Nahnmwarki himself.

Corresponding to the hierarchical social organization of Pohnpei Island chiefdoms was a hierarchical spatial organization (see Bascom 1965:21-27; Oliver 1989:983). The smallest spatial unit was the farmstead, each on average covering eight to ten acres and inhabited by an extended family. The next largest unit was the section, an area that usually stretched from the coast to the island's center, composed of fifteen to thirty-eight farmsteads. Each section was an administrative unit in its own right, ruled by a lesser chief. The largest spatial unit in the traditional organization of Pohnpei Island was the district. Each district contained fifteen to thirty-eight sections and represented an autonomous chiefdom that was ruled by a Nahnmwarki-Nahnken pair. Conflict and competition, both between and within districts, were common among the high-island chiefdoms. This conflict frequently caused fragmentation and reorganization of the polities, a trend that has persisted into recent times (Petersen 1982; see Bascom 1950). The number of districts on Pohnpei Island varied over the past two hundred years, with three emerging after the downfall of the Sandeleurs in the early seventeenth century (Hanlon 1988:21-22), then subsequently splitting and recombining to form the five-district political order encountered by the Spanish in the late nineteenth century. The municipalities of recent times on Pohnpei Island--Kitti, Madolenihmw, Nett, Sokehs, and U--correspond to traditional districts.

The sociopolitical organization of the Outer Atolls is not as well known as that on Pohnpei Island. The groups living on atolls within Pohnpei State apparently also were organized as chiefdoms. On each of the two Polynesian outlier atolls, Kapingamarangi and Nukuoro, authority was split between a hereditary chief and an elected leader (Emory 1965:92-95). On Mwoakilloa, Sapwuahfik, and Pingelap, authority was divided between two hereditary leaders, one secular and one sacred (Fischer and Fischer 1957:179-180). Tribute also flowed up the sociopolitical hierarchies of the Outer Atolls. But the amount of authority accompanying higher statuses on these island units, and hence the amount of tribute that could be demanded of commoners, was more limited than among the chiefdoms on the high island (Fischer and Fischer 1957:159-160).

The traditional economies of island units within Pohnpei State can best be understood in terms of the social order and environmental characteristics of the region. During traditional times, most exchange on the high island occurred within districts, oriented along lines of kinship and authority. Trade, embodied in the exchange of one tangible good for another, apparently was an unknown concept; tribute was given in exchange for food, land rights, titles, and so on as an expression of social rank, and within the social framework of the chiefdom (Hanlon 1988: 71-72). Additional impetus for exchange, particularly between chiefdoms, was absent. Pohnpei Island and its surrounding waters are rich in natural resources and environmentally quite diverse, containing a wide range of plants and animals (see Office of the Chief of Naval Operations 1944:127-130; Bascom 1965:86-136; Oliver 1989:982). But because most sections and all districts crosscut this diversity, generally each chiefdom had access to the same things--providing little motivation to exchange items between autonomous districts. Exchange on the Outer Atolls similarly was guided by kinship and authority. Without exception, these atolls were much less productive than the high island. As the microenvironment of sections bordering a lagoon differed from those bordering the ocean, fundamental diversity was present (see Wiens 1962). Because each of the inhabited Outer Atolls contained a single chiefdom in traditional times, exchange between sociopolitical entities is not an issue. The relatively limited resources present were exploited by the human inhabitants of each Outer Atoll, in some cases exchanged along kin lines at feasts, with some ultimately flowing up the social hierarchy to the paramount chief.

If exchange within island units in Pohnpei State was limited, exchange between units was even less prevalent (Office of the Chief of Naval Operations 1944:22). The economic impetus for regional trade existed in the form of differential access to various resources, particularly when comparing Pohnpei Island to the Outer Atolls. Throughout the eastern Carolines researchers noted some tendency for exchange between high islands and surrounding low islands, with various types of food provided by the more fertile high islands traded for certain handicrafts (e.g., woven mats, twine) and prepared foods (e.g., dried fish; see Fischer and Fisher 1957: 166-167). But interisland trade was infrequent in Pohnpei State (Bascom 1965:140). In contrast to places with broad regional exchange systems, such as the Yap Empire (see Oliver 1989:580-584), social obligations did not exist between the high island and any of the Outer Atolls comprising present Pohnpei State. In addition to the absence of any underlying sociocultural framework to regu-

enced was due primarily to improvements in health care; the relatively high fertility found during the Japanese administration increased even further during the forty-five years following World War II, while relatively low mortality decreased. The growing concentration of people on Pohnpei Island, in turn, was due primarily to migration--both from places outside Pohnpei State and from the Outer Atolls. In an effort to understand the demographic evolution of Pohnpei State, we examined the changing arrangements of population through the application of selected spatial statistics. The results of our statistical analyses indicated that despite the increased concentration of people on the high island, the overall regional arrangement of people in Pohnpei State changed relatively little during the twentieth century, with a strong statistical correspondence between the populations of individual places in different census years. As additional evidence of spatial consistency, our statistical analyses also indicated a persisting lack of regional integration in Pohnpei State--both within particular census years and as the area evolved over time.

The demographic changes experienced in Pohnpei State over the past seventy years are largely similar to those experienced elsewhere in Micronesia during the same period. But the challenges that these changes present to the state's future are different. Growing population and increasing concentrations of people generally characterized the Marshall Islands throughout the twentieth century (Gorenflo and Levin 1990; see also Gorenflo and Levin 1989). However, the changes experienced in the Marshalls represented a fundamental break from the traditional sociocultural system and regional organization found in that area, in addition creating a range of environmental problems by concentrating large numbers of people on ecologically fragile coralline atolls. Although population grew more slowly and became less concentrated in Yap State than in Pohnpei State over the past seven decades, the absence of change in the regional organization of each was similar (Gorenflo and Levin 1991). But Yap State was much more integrated during traditional times than was Pohnpei State and with its widely dispersed population faces greater impetus to develop a more-integrated regional system.

The growing concentration of people on Pohnpei Island in general is consistent with past regional demography in the Pohnpei State region, as well as with the island's capacity to sustain a large population. The persisting lack of regional cohesion similarly is consistent with the past; political integration rarely was achieved on the high island, let alone in

late exchange, the distance between island units also would have inhibited frequent exchange. The inhabitants of Pohnpei Island were not a seafaring people, focusing upon the exploitation of their island and its coastal waters instead. The barrier of distance was particularly severe in the cases of Kapingamarangi and Nukuoro; both atolls are located far from any other inhabited island unit, and the inhabitants of each lost their navigation skills sometime before European contact (Fischer and Fischer 1957: 165; Carroll 1975:359).

The spatial statistical analyses of regional demography in Pohnpei State failed to provide any evidence of regional cohesion, We found no statistically significant (at $p < .05$) autocorrelation in any of the census years examined. Two types of autocorrelation might indicate a region well arranged for regional interaction: strong positive autocorrelation, suggesting that similar numbers of producers and consumers were spatially proximal, thereby reducing distribution costs; and strong negative autocorrelation, indicating spatially interspersed small and large populations, as might be found in a regional system of centers surrounded by hinterlands comprising smaller settlements. Point-to-point temporal correlation statistics indicated a strong correspondence in the demographic evolution of *individual places* over time. But changes in the distribution of population throughout the twentieth century indicated no tendency for increased potential interaction, either in the form of significant positive or negative spatiotemporal association. In general one might expect such statistical results in a system that is not well integrated regionally, as was the case in Pohnpei State during traditional times. But in becoming an operating political entity for seventy years--a district both in the Japanese Mandated Territory and the TTPI, and more recently a state in the Federated States of Micronesia--one might expect evidence of greater regional integration in the arrangement of population.

Concluding Remarks

In the preceding pages we examined regional demographic evolution in Pohnpei State, Federated States of Micronesia. We provided a foundation for the study by describing population change for the ten census years between 1920 and 1985, and attempted to explain these changes in terms of fundamental demographic processes. The demographic history of Pohnpei State during the twentieth century is one of constant population growth, with increasing proportions of the total state population residing on Pohnpei Island. The demographic growth experi-

the remainder of the area, and remains elusive despite the introduction of Western political concepts (Hughes 1974). Ultimately, the vast differences in available land area and resources always will determine to a large extent the types of regional organization feasible in Pohnpei State. Although a more interactive state might be desirable, possibly as evidence of greater political and economic health, major changes in the regional organization of Pohnpei State in many ways are impractical. Development almost certainly will continue to concentrate on the high island, possibly spawning the emergence of secondary centers to complement Kolonia. The Outer Atolls, in turn, probably will remain tangential to the regional organization of the state, as they have been throughout the history of the area.

NOTES

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1. In the interest of clarity and consistency, we follow modem convention when referring to the island units that form the present state of Pohnpei. We use the term *Pohnpei State* to denote the geographic area of the present state of Pohnpei within the Federated States of Micronesia--even when discussing the region prior to 1979, before the "state" as such officially existed. We refer to the six separate administrative portions of Pohnpei Island as the *Central Municipalities* and to the remaining inhabited island units as the *Outer Atolls.* For the period of Japanese administration, certain vital statistics are available for the *Pohnpei District of the Mandated Territory,* which included the area presently comprising Pohnpei State, Kosrae State, and Enewetak and Ujelang atolls (the latter two atolls currently part of the Republic of the Marshall Islands).

2. Whenever possible, we base this study upon census data and calculations made with census data. Many of the population figures available over the past seventy years for the area comprising modern Pohnpei State are de jure estimates whose accuracy can be challenged. Thus, although declines in population are indicated between 1965 and 1967, 1969 and 1970, and 1979 and 1980 (see Table 2), these *apparent* decreases probably are the result of mixing de jure intercensal estimates with de facto census data (the problem exacerbated by possible census undercounts, such as occurred in 1970). Ultimately we treat Pohnpei State as if it experienced uninterrupted population growth since 1920, and Pohnpei Island as if it experienced uninterrupted growth since the late nineteenth century.

3. Because this study seeks to examine demographic change within a functioning sociocultural system, we exclusively examine demographic data on Pacific Islanders inhabiting the Pohnpei District during the Japanese period. The number of Japanese residing within the Mandated Territory varied over the three decades of Japanese control. As noted in the text, Pohnpei Island eventually contained more than 13,000 Japanese civilian and military personnel. Because these fluctuating numbers of essentially *imposed* inmigrants would cloud our understanding of several key aspects of regional demographic

change within Pohnpei State, we consider only Pacific Islanders for the Japanese period of administration.

4. Vital statistics measures used in this article are defined as follows. Crude birth rate is the number of births in a year per 1,000 total population. General fertility rate is the number of births in a year per 1,000 women of childbearing age (ages 15-49 inclusive). Total fertility rate is the sum of age-specific fertility rates for women of childbearing age. Crude death rate is the number of deaths in a year per 1,000 total population. Finally, age-specific death rate is the number of deaths in a year per 1,000 persons in a particular age group.

With regard to vital statistics, we add a brief cautionary note concerning their accuracy. Fertility and mortality are fundamental components of demographic change and must be considered in a study such as this. However, vital statistics in Micronesia traditionally are inaccurate, particularly mortality statistics (often underreported). The vital statistics examined here probably provide accurate insights on general trends, namely increasing fertility and decreasing mortality over time. But in absolute terms these data probably should not be taken at face value.

5. Kosrae, presently a separate FSM state, was considered a portion of the Pohnpei districts of both the Japanese Mandated Territory and the TTPI. Many data from Kosrae, including vital statistics, were aggregated with data from the remainder of Pohnpei State --explaining our inclusion of information from Kosrae State in certain calculations and figures for the state of Pohnpei. Strictly speaking, comparisons are not entirely valid between these years (pre-1977) and years for which Pohnpei State data may be separated from that of Kosrae State, though Kosrae State always was a relatively small proportion (11.8 to 17.8 percent for the years considered) of the Pohnpei-Kosrae population total.

6. Research on the demography of Nukuoro Atoll indicates a slight deviation from the general scenario proposed here for the demographic evolution of Pohnpei State as a whole. According to Carroll (1975), demographic homeostasis, resulting from low fertility coupled with low mortality, apparently characterized this population prior to intensive contact with outsiders. Ensuing increases in mortality, if they occurred, were less abrupt than the dramatic changes that tended to accompany the introduction of outside diseases. Although fertility increased with Western contact, this increase was delayed due to the concurrent introduction of gonorrhea. Isolation during World War II reduced both fertility and mortality on Nukuoro Atoll. Mortality increased immediately following the war, eventually compensated for by modem medical technology (which ultimately contributed to the population growth experienced over the past four decades).

7. For the sake of consistency and comparability, we calculated spatiotemporal association and spatial autocorrelation measures via a method of matrix comparison called *quadratic assignment* (Hubert and Schultz 1976; see also Hubert, Golledge, and Constanzo 1981; Gale and Gorenflo 1999). We conducted three tests of statistical significance for the quadratic assignment calculations: comparison to an approximation of a Normal distribution; comparison to a Pearson Type III Gamma distribution; and comparison to a Monte Carlo reference distribution for each pair of matrices examined (see Cliff and Ord 1981: 63-65). Significance levels noted in this article invariably refer to the latter test. Such an approach to assessing statistical significance removes the need to make a key (and possibly incorrect) parametric assumption about the distribution underlying the statistics calculated.

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