# REGIONAL DEMOGRAPHIC CHANGE IN YAP STATE, FEDERATED STATES OF MICRONESIA

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Most island groups in Micronesia experienced major demographic changes throughout the past 450 years, usually as a consequence of interaction with other, more technologically advanced societies. The contemporary state of Yap provides a particularly extreme example of such changes-its population declining by as much as 90 percent to fewer than 5,000 persons by 1950, and then gradually rebounding to roughly 10,000 persons by 1987. The present study examines the regional demographic evolution of Yap State. Following a brief historical introduction, it summarizes data on population change, focusing in particular upon data from censuses conducted between 1920 and 1987. Then, through examining complementary information on fertility, mortality, and migration, the article explores possible causes of demographic evolution throughout the region. A spatial statistical analysis reveals how little regional organization has changed over the past seventy years, preserving a heterogeneous population distribution which will complicate attempts at regional integration.

## Introduction

Of the many changes in traditional Micronesian cultures that resulted from interaction with more technologically advanced sociocultural systems, few have had the broad impacts of demographic change. Typi-

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cally, population change in Micronesia encompassed two phases: an initial period of depopulation, usually due to diseases introduced by explorers, whalers, missionaries, and other early visitors from outside Micronesia; and subsequent population growth, most often the result of improved health care, and frequently leading to modern populations larger than any known in the past (see Taueber 1961; Gorenflo and Levin 1990, 1992). The impacts of such demographic changes often are wide-ranging, for social, political, economic, and other cultural developments frequently accompany dramatic shifts in population. But, though most of Micronesia experienced basic demographic changes of the type noted, the precise nature of these changes often varied. In the state of Yap population decline was more prolonged, and subsequent demographic recovery much slower, than elsewhere in Micronesia.[1]

The present study examines the demography of Yap State during the twentieth century. It begins with a compressed review of colonization efforts, emphasizing their effects on population levels and distributions. Demographic data then are examined in some detail, focusing in particular upon eleven censuses conducted between 1920 and 1987. Through analyzing data on fertility, mortality, and migration, the article attempts to explain the population changes documented. The application of spatial statistics explores formal aspects of demographic change in Yap State in regional terms-that is, changing population ***and*** its distribution throughout the islands, atolls, and municipalities that comprise Yap State. Finally, the study considers ecological, economic, and sociocultural repercussions of population change in an effort to characterize past and present regional challenges faced in this portion of the Federated States of Micronesia (FSM).

## Non-Micronesian Societies and Their Impacts on Demography in Yap State

Yap State lies between 6°41' and 10°05' north latitude, and 137°20' and 147°03' east longitude, in the western Caroline Islands (Bryan 1971). It comprises four closely grouped limestone high islands, along with nine coralline atolls and six islands (four of which usually are uninhabited) at varying distances from the high islands (Shinn 1984:325; Figure 1). The demography changed greatly over the past several hundred years, often as a result of contact with non-Micronesian cultures. Before examining demographic data from the state of Yap, we summarize briefly the history of this interaction and its effects on population.

Yap State was unknown to the West until Portuguese and Spanish

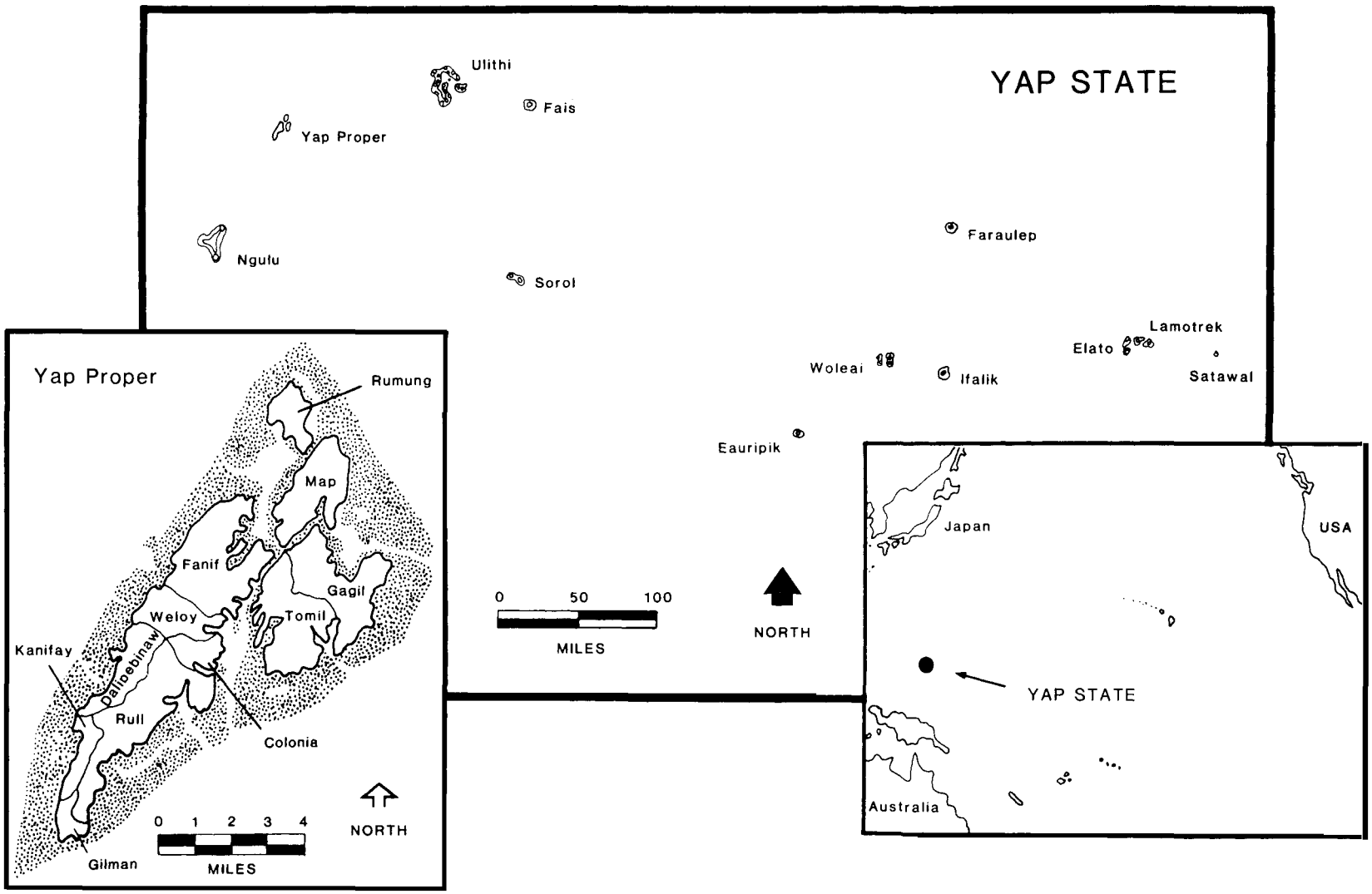



FIGURE 1. **Yap State.**

explorers sighted islands in the western Carolines during the 1520s (Müller 1917:l; Office of the Chief of Naval Operations 1944:21; Lessa 1966:5; Hezel 1983: 14-19). Although Spain claimed Yap State as part of its growing global empire, few Westerners visited the region until the nineteenth century. Western interest in Yap State revived with visits by British ships to the area between 1786 and 1802, and grew with a resurgence of Spanish desires for further economic growth and with the general expansion of trading and whaling throughout Micronesia (Lingenfelter 1975:183; Hezel 1983:82-83). In 1827 a Russian expedition led by Frederic Lütke explored portions of the Caroline Islands east of Yap Proper (Lütke 1971). Interaction with Westerners following the Lütke expedition was intermittent; traders and whalers began frequent visits after 1840 in the eastern Carolines, although the western Carolines largely remained unknown to outsiders (Office of the Chief of Naval Operations 1944:23). A German trading company finally established a European presence on the High Islands in 1869 (see Shineberg 1971; Hezel 1983: 181-182, 264-265).

Unfortunately, demographic data for the long period of early contact between components of the present Yap State and Western nations are limited. Available evidence suggests that despite the sporadic, infrequent contact with outsiders major periods of depopulation were well underway in the nineteenth century. This was due largely to the introduction of influenza, tuberculosis, smallpox, and venereal disease (see Labby 1976:2; Peattie 1988:86-87). Although details are unknown, by the latter half of the nineteenth century depopulation had nearly crippled traditional hereditary mechanisms guiding the transfer of ritual information and status (Müller 1917).

Yap State's commercial position in the Pacific grew during the 1870s and 1880s through the activity of German companies. By 1880 Yap Proper had become the commercial center for all the Caroline Islands, emerging as an important source of both copra and trepang (bêche-de-mer) (Hezel 1983:281). Germany officially challenged Spain's sovereignty in 1885, annexing the High Islands-an action overturned by Pope Leo XIII's arbitration shortly thereafter (Hezel 1983:308-312; Shinn 1984:326). Germany finally acquired Yap State when it purchased the Carolines and Northern Marianas from Spain in 1899 following the Spanish-American War. German efforts to develop the area economically focused primarily upon the production of and trade in copra, in the process introducing technological innovations such as new roads, a canal, and a cable station (Office of the Chief of Naval Operations 1944:25). Although the Germans administered the Yapese primarily

through native chiefs, acts such as the reorganization of administrative districts and the abolition of warfare greatly affected the sociopolitical dynamics of the society (Lingenfelter 1975: 183-184; Labby 1976:3-4). These cultural changes coincided with continued depopulation on Yap Proper, and probably to a lesser degree on several of the Outer Islands. Between 1899 and 1911, population on the High Islands decreased from approximately 7,800 to slightly less than 6,200 (Hunt et al. 1954:23).

Capitalizing upon Germany's involvement in World War I, in 1914 Japan occupied the Carolines militarily. Japan had begun commercial efforts in the area as early as 1890, and by 1912 had succeeded in establishing itself as a major trading power (Labby 1976:4). In 1920 the League of Nations awarded Japan a Class C Mandate over Yap State and other German islands in the Pacific north of the equator (Peattie 1988:56-59). As with Germany, Japan's presence had both commercial and political motives. However, Yap State's physical composition and location limited its immediate value to the Japanese. Although a naval contingent arrived in 1915, adding Yap Proper as the sixth Japanese Naval District in Micronesia, its military value was minimal (Peattie 1988:64, 231-232). Moreover, the predominantly hilly High Islands and small, generally infertile Outer Islands had restricted agricultural potential (Peattie 1988: 181-182; see also Clyde 1967:47-48).

Yap State quickly proved to be a source of frustration for the Japanese, in large part due to population dynamics. One concern was the frequent need to relocate people forcibly, usually from Yap Proper to the Outer Islands and other areas in Micronesia, in pursuit of military and commercial goals (Lingenfelter 1975: 186). But the main demographic problem faced by the Japanese was continued depopulation. The immediate reasons for this decline appeared to be a high death rate, linked to tuberculosis and infant diarrhea, and a low birth rate due to gonorrhea (Office of the Chief of Naval Operations 1944:32-38; Clyde 1967:151). In addition to carrying out economic, cultural, and social changes in establishing its authority and improving commerce in the area (see Shuster 1978), Japan introduced better health care and related training in 1915 to help stem depopulation. But these efforts were unsuccessful; by 1937 the population of the High Islands had declined to roughly 3,400 Pacific Islanders (Hunt et al. 1954:23).

U.S. military forces either captured or bypassed islands in Yap State late in World War II (Peattie 1988:297-307). Following the Japanese surrender in August 1945, the United States began to administer island groups throughout Micronesia. In 1947 the islands in Yap State became part of the Trust Territory of the Pacific Islands (TTPI), a strategic area

established by the United Nations with the United States as "administering authority" (Shinn 1984:303-305). For the first decade of its administration, the United States generally tried to avoid involvement in Yapese affairs-restricting visits and trade from outside and enabling the Yapese to elect district leaders or "chiefs" (Lingenfelter 1975:l88-189). After 1956 increased trade from outside Yap State, coupled with growing opportunities for wage labor, led to greater changes. Under successive administrations by the U.S. Navy (1945-1951) and the U.S. Department of the Interior (1951-1986) depopulation ceased followed by a gradual resurgence in population growth. In the 1970s total population finally reached the highest levels documented earlier this century.

On 10 May 1979, Yap and three other Caroline districts of the TTPI (Chuuk, Kosrae, and Pohnpei) approved a constitution and became the self-governing nation of the FSM. The U.S. Congress ratified a Compact of Free Association in 1986, establishing future relations between the FSM and the United States. Under the compact, the United States provides grant funds and program assistance for fifteen years, as the states of the FSM strive for economic and political development (Shinn 1984:308-311). During the first seven years of independence, population growth in Yap State occurred on an order previously undocumented, reaching an average annual rate of 3.3 percent.

## Changing Demography in Yap State

The demography of Yap State is poorly documented before 1920, when the Japanese South Seas Bureau (Nan'yō-chō) conducted the first systematic census of the entire region. Population data are available from the late eighteenth century for certain portions of Yap Proper, initially collected by explorers and missionaries, and later by German administrators (see Müller 1917; Kramer 1937; Damm 1938). But demographic data preceding 1920 often represent estimates prepared at irregular dates, with no single set covering all islands in Yap State at one time (Table 1). This paucity of detailed evidence is particularly unfortunate in the present setting, for researchers generally believe that the early population was much greater even than that found currently-possibly between 25,000 and 50,000 on the High Islands during the late eighteenth century (Labby 1976:2; see also Office of the Chief of Naval Operations 1944:32-33; Mahoney 1958; Hunter-Anderson 1983).

Various agencies and organizations conducted a total of eleven systematic censuses of Yap State during the twentieth century: four by the Japanese South Seas Bureau (1920, 1925, 1930, and 1935), two by the

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

| Area | 1791 | 1797 | 1819 | 1828 | 1843 | 1844 | 1852 | 1862 | 1870 | 1873 | 1896 | 1899 | 1900 | 1903 | 1909 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Yap Proper[a] | | | | | | | | | | | 12,000 | 7,808 | | 7,156 | |
| Outer Islands" | | | | | | | | | | | | | | | |
| Eauripik | 50 | | | 30 | | 150 | | | | | | | 50 | 48 | |
| Elato | | | 1,200 | | | | | | | | | | | | |
| Faraulep | | | | 60 | | | | | | | | | | 121 | 155 |
| Ifalik | | 200 | | 150 | | | 140 | | | | | | | 281 | 208 |
| Lamotrek | | | 2,000 | | | | | | | | | | | | |
| Ngulu | | | | | 35 | | | | 100 | | | | | | 50 |
| Satawal | | | 900 | | | | | | | | | | | | 190 |
| Sorol | | | | | | | | 20 | | | | | 20 | 72 | 156 |
| Ulithi | | | | | | | | | | 700 | | | | 797 | 797 |
| Woleai | | | | | | | | 600 | | | | | | | 700 |

Sources: Müller 1917; Kramer 1937; Damm 1938.

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

[a] Yap Proper was not broken into individual municipalities, and hence data are presented for the High Islands together.

[b] No population estimates were presented for Fais prior to the Nan'yō-chō censuses.

Office of the High Commissioner of the TTPI (1958 and 1973), one through a joint effort by the U.S. Peace Corps and the University of Hawaii School of Public Health (1967), two by the U.S. Bureau of the Census (1970, 1980), one by the TTPI Office of Planning and Statistics (1977), and one by the Yap Office of Planning and Budget (1987). Table 2 presents the total population of Yap State recorded by these eleven censuses, supplemented with intercensal population estimates prepared by various offices of the U.S. government. These census data indicate two trends in the evolution of the total population of Yap State: a generally steady decline until 1958 (until 1952, if one considers the population estimates presented in Table 2), followed by generally sustained growth through 1987 (Figure 2).[2]

The regional distribution of population in Yap State suggests that individual islands experienced trends similar to those found in the entire region--that is to say, initial demographic decline followed by a resur-

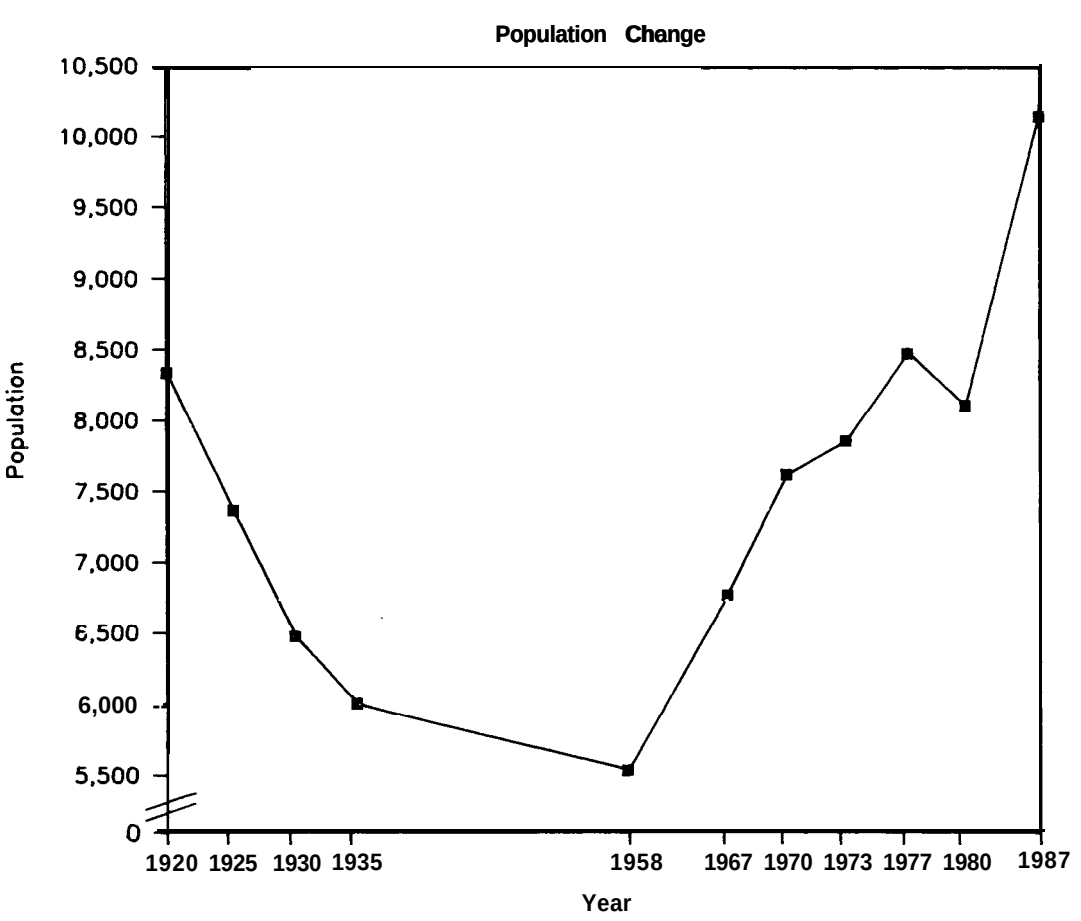



**FIGURE 2. Change in the total population of Yap State over time.**

**TABLE 2. Population of Yap 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 | 8,338 | ... | ... | **Nan'yō-chō** 1937 |
| 1925 | 7,366 | -972 | -2.4% | **Nan'yō-chō** 1927 |
| 1930 | 6,486 | -880 | -2.5% | **Nan'yō-chō** 1931 |
| 1935 | 6,006 | -480 | -1.5% | **Nan'yō-chō** 1937 |
| 1949 | 5,284 | ... | ... | U.S. Dept. of the Navy 1949 |
| 1950 | 4,717 | ... | ... | U.S. Dept. of the Navy 1950 |
| 1951 | 4,884 | ... | ... | U.S. Dept. of the Navy 1951 |
| 1952 | 4,866 | ... | ... | U.S. Dept. of Interior 1952 |
| 1954 | 5,071 | ... | ... | U.S. Dept. of State 1955 |
| 1955 | 5,102 | ... | ... | U.S. Dept. of State 1956 |
| 1956 | 5,251 | ... | ... | U.S. Dept. of State 1957 |
| 1957 | 5,355 | ... | ... | U.S. Dept. of State 1958 |
| 1958 | 5,540 | -466 | -0.4% | Office of the High Commissioner 1959 |
| 1959 | 5,622 | ... | ... | U.S. Dept. of State 1960 |
| 1960 | 5,686 | ... | ... | U.S. Dept. of State 1961 |
| 1961 | 5,797 | ... | ... | U.S. Dept. of State 1962 |
| 1962 | 5,931 | ... | ... | U.S. Dept. of State 1963 |
| 1963 | 6,021 | ... | ... | U.S. Dept. of State 1964 |
| 1964 | 6,293 | ... | ... | U.S. Dept. of State 1965 |
| 1965 | 6,438 | ... | ... | U.S. Dept. of State 1966 |
| 1966 | 6,606 | ... | ... | U.S. Dept. of State 1967 |
| 1967 | 6,761 | 1,221 | 2.2% | School of Public Health n.d. |
| 1968 | 6,870 | ... | ... | U.S. Dept. of State 1969 |
| 1969 | 7,017 | ... | ... | U.S. Dept. of State 1970 |
| 1970 | 7,625 | 864 | 4.1% | U.S. Bureau of the Census 1972 |
| 1971 | 7,369 | ... | ... | U.S. Dept. of State 1972 |
| 1972 | 7,536 | ... | ... | U.S. Dept. of State 1973 |
| 1973 | 7,870 | 245 | 1.1% | Office of Census Coordinator 1975 |
| 1975 | 8,348 | ... | ... | U.S. Dept. of State 1977 |
| 1977 | 8,480 | 610 | 1.9% | Office of Planning and Statistics 1982 |
| 1978 | 8,750 | ... | ... | U.S. Dept. of State 1979 |
| 1979 | 9,020 | ... | ... | U.S. Dept. of State 1980 |
| 1980 | 8,100 | -380 | -1.5% | U.S. Bureau of the Census 1983a |
| 1984 | 10,595 | ... | ... | U.S. Dept. of State 1985 |
| 1985 | 10,948 | ... | ... | U.S. Dept. of State 1986 |
| 1987 | 10,139 | 2,039 | 3.3% | Yap Office of Planning and Budget 1988a |

Notes: Census years in boldface. 1920-1935 data are for Pacific Islanders only. Intercensal estimates and 1977 census are de jure population; remaining census data are de facto. For all tables, "-" denotes zero or a percentage that rounds to less than 0.1; "NA" = not available; ". . ." = not applicable.

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

| Area | 1920[a] | 1925 | 1930 | 1935 | 1958 | 1967 | 1973 | 1977 | 1980 | 1987 |
|---|---|---|---|---|---|---|---|---|---|---|
| Yap State | 8,338 | 7,366 | 6,486 | 6,006 | 5,540 | 6,761 | 7,870 | 8,480 | 8,100 | 10,139 |
| Yap Proper | 5,382 | 4,655 | 4,019 | 3,694 | 3,243 | 4,024 | 5,140 | 5,474 | 5,196 | 6,650 |
| Dalipebinaw | 309 | 280 | 229 | 200 | 202 | 153 | 169 | 212 | 211 | 262 |
| Fanif | NA | 433 | 376 | 386 | 356 | 394 | 367 | 376 | 392 | 460 |
| Gagil | 846 | 622 | 579 | 501 | 400 | 352 | 537 | 601 | 616 | 711 |
| Gilman | 307 | 257 | 223 | 186 | 143 | 175 | 217 | 233 | 228 | 180 |
| Kanifay | 333 | 290 | 239 | 213 | 181 | 202 | 235 | 239 | 225 | 276 |
| Map | 666 | 559 | 466 | 390 | 300 | 303 | 337 | 322 | 319 | 520 |
| Rull[b] | 883 | 749 | 660 | 603 | 524 | 941 | 1,463 | 1,696 | 1,436 | 1,852 |
| Rumung | 252 | 210 | 168 | 141 | 120 | 160 | 129 | 131 | 130 | 102 |
| Tomil | 724 | 653 | 523 | 472 | 503 | 544 | 666 | 643 | 713 | 843 |
| Weloy[b] | 1,062 | 602 | 556 | 602 | 514 | 800 | 1,020 | 1,021 | 926 | 1,444 |
| Outer Islands | 2,956 | 2,711 | 2,467 | 2,312 | 2,297 | 2,737 | 2,728 | 3,006 | 2,904 | 3,489 |
| Eauripik | NA | 102 | 113 | 105 | 141 | 146 | 127 | 116 | 121 | 99 |
| Elato | 250 | 92 | 72 | 72 | 40 | 48 | 32 | 54 | 51 | 70 |
| Fais | 1,014 | 472 | 367 | 310 | 234 | 213 | 212 | 195 | 207 | 253 |
| Faraulep | 141 | 157 | 145 | 141 | 118 | 149 | 122 | 147 | 132 | 182 |
| Ifalik | NA | 296 | 305 | 250 | 301 | 325 | 314 | 359 | 389 | 475 |
| Lamotrek | 93 | 204 | 164 | 176 | 172 | 243 | 233 | 204 | 242 | 278 |
| Ngulu | 71 | 79 | 64 | 58 | 45 | 18 | 8 | 16 | 21 | 26 |
| Satawal | 293 | 254 | 250 | 264 | 285 | 389 | 354 | 382 | 386 | 465 |
| Sorol | NA | 6 | - | 8 | 13 | 13 | 8 | 6 | 7 | - |
| Ulithi | 448 | 505 | 449 | 407 | 460 | 549 | 710 | 859 | 710 | 847 |
| Woleai | 646 | 544 | 538 | 521 | 488 | 644 | 608 | 668 | 638 | 794 |

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

Notes: Population data for 1920-1935 are for Pacific Islanders only. Remaining population data, except 1977 (de jure), represent de facto population. Because the 1970 census erred in assigning the population of Yap State to area of residence, the 1970 census data are not presented in this table.

[a] In 1920, population data for Fanif and Weloy were grouped together (listed above under the latter); similarly, data for Eauripik, Ifalik, and Sorol were grouped with Fais (and again listed above under the latter).

[b] The community of Colonia, presently the capital of Yap State, is part of Rull and Weloy municipalities. Colonia's population is recorded within these municipalities.

gence of growth beginning during the 1950s (Table 3). Despite the changes in total population, the regional distribution of population generally remained quite constant. However, as absolute numbers of people shifted so, too, did their densities (Table 4), presenting a wide array of challenges in terms of cultural ecology and sociocultural integration.

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

| Area | 1920 | 1925 | 1930 | 1935 | 1958 | 1967 | 1973 | 1977 | 1980 | 1987 |
|---|---|---|---|---|---|---|---|---|---|---|
| Yap State | 171 | 151 | 133 | 123 | 113 | 138 | 161 | 174 | 166 | 208 |
| Yap Proper | 128 | 111 | 96 | 88 | 77 | 96 | 122 | 130 | 124 | 158 |
| Dalipebinaw | 144 | 130 | 107 | 93 | 94 | 71 | 79 | 99 | 98 | 122 |
| Fanif | NA | 66 | 57 | 59 | 54 | 60 | 56 | 57 | 59 | 70 |
| Gagil | 125 | 92 | 86 | 74 | 59 | 52 | 80 | 89 | 91 | 105 |
| Gilman | 159 | 133 | 115 | 96 | 74 | 90 | 112 | 120 | 118 | 93 |
| Kanifay | 318 | 277 | 228 | 203 | 173 | 193 | 224 | 228 | 215 | 263 |
| Map | 167 | 140 | 117 | 98 | 75 | 76 | 84 | 81 | 80 | 130 |
| Rull | 124 | 105 | 92 | 84 | 73 | 132 | 205 | 238 | 201 | 259 |
| Rumung | 157 | 130 | 104 | 88 | 75 | 99 | 80 | 81 | 81 | 63 |
| Tomil | 113 | 102 | 82 | 74 | 79 | 85 | 104 | 101 | 112 | 132 |
| Weloy | NA | 137 | 127 | 137 | 117 | 182 | 233 | 233 | 211 | 329 |
| Outer Islands | 430 | 394 | 359 | 336 | 334 | 398 | 397 | 437 | 422 | 507 |
| Eauripik | NA | 1,121 | 1,242 | 1,154 | 1,549 | 1,604 | 1,396 | 1,275 | 1,330 | 1,088 |
| Elato | 1,232 | 453 | 355 | 355 | 197 | 236 | 158 | 266 | 251 | 345 |
| Fais | NA | 436 | 339 | 286 | 216 | 197 | 196 | 180 | 191 | 234 |
| Faraulep | 865 | 963 | 890 | 865 | 724 | 914 | 748 | 902 | 810 | 1,117 |
| Ifalik | NA | 802 | 827 | 678 | 816 | 881 | 851 | 973 | 1,054 | 1,287 |
| Lamotrek | 245 | 538 | 433 | 464 | 454 | 641 | 615 | 538 | 639 | 734 |
| Ngulu | 430 | 479 | 388 | 352 | 273 | 109 | 48 | 97 | 127 | 158 |
| Satawal | 580 | 503 | 495 | 523 | 564 | 770 | 701 | 756 | 764 | 921 |
| Sorol | NA | 17 | - | 22 | 36 | 36 | 22 | 17 | 19 | - |
| Ulithi | 249 | 281 | 250 | 226 | 256 | 305 | 395 | 477 | 395 | 471 |
| Woleai | 367 | 309 | 306 | 296 | 277 | 366 | 346 | 380 | 363 | 451 |

We now briefly examine Yap State's changing regional demography in eight sections: one on the Japanese period, spanning the four censuses between 1920 and 1935 when the population declined slowly; and one section for each of the remaining seven censuses (1958, 1967, 1970, 1973, 1977, 1980, and 1987), when the population ceased to decline, and then began to increase once more. We confine our presentation to essential data, in particular drawing attention to possible causes of population change.

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

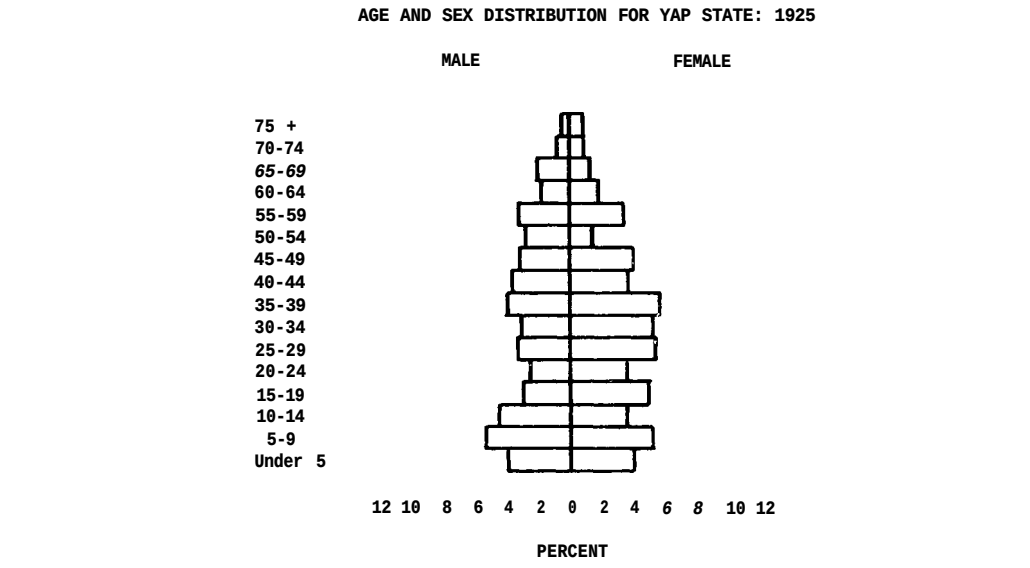
In 1920, the Japanese South Seas Bureau conducted the first detailed census of Yap State (the Yap District of the Mandated Territory; see

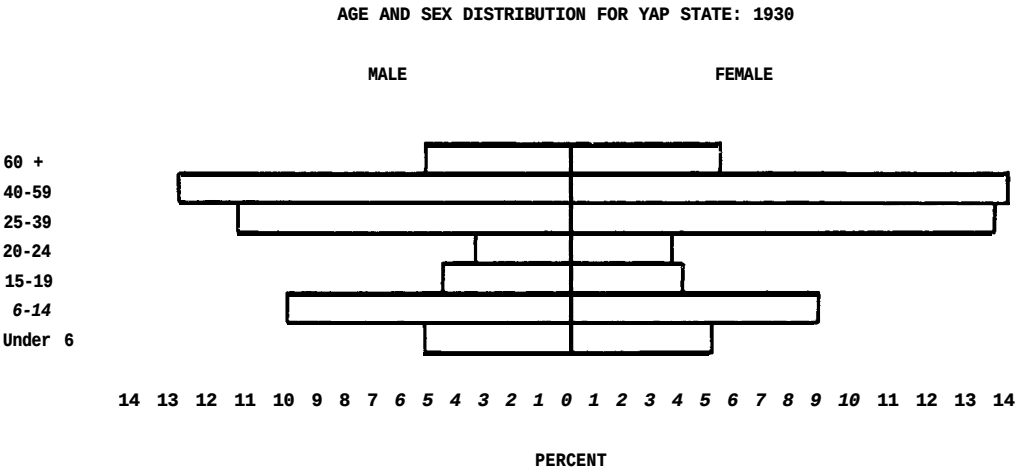
Nan'yō-chō 1937). The South Seas Bureau conducted similar censuses in 1925, 1930, and 1935, providing an extremely detailed data base for the period of Japanese administration. The demographic picture emerging from these data is one of steadily declining population, on both the High Islands and Outer Islands, with the average annual decrease in total population between censuses ranging from 1.5 to 2.5 percent (see Table 2). We discuss these censuses briefly below, focusing upon Pacific Islanders and for the most part excluding any examination of resident Japanese. [3]

Nearly 8,350 Pacific Islanders resided in Yap State in 1920 (Nan'yō-chō 1937; see Table 3). This number probably represents a decrease from earlier in the century, although the magnitude and rate of decrease are unknown. Total population was recorded for each municipality in Yap State, excluding Fanif (recorded with Weloy) and Eauripik, Ifalik, and Sorol atolls (all combined with Fais Island; see Table 3). In 1920 nearly twice as many persons resided on Yap Proper (64.5 percent of the total) as on the Outer Islands. The major populations on Yap Proper were in Gagil and Rull municipalities; the population of Weloy Municipality, important in later years, is uncertain because it was combined with Fanif. Woleai Atoll had the largest population of the Outer Island units recorded separately in 1920.

The population of Yap State declined by roughly 1,000 between 1920 and 1925 (see Table 3), an average of roughly 2.4 percent annually (Nan'yō-chō 1927). Yap Proper experienced the greatest decline; all municipalities had losses averaging in excess of 2.0 percent annually, with Gagil's annual losses reaching 6.0 percent. The loss of population on the Outer Islands was much less; cases of substantial loss (such as Elato Atoll) were compensated for by marked gains in other places (such as Lamotrek Atoll), suggesting a role for interisland migration during this five-year period (or, possibly, visitors from Elato to Lamotrek at census time). In terms of relative proportions of total Yap State population, with the exception of Elato and Lamotrek atolls the distribution remained about the same in 1925 as in 1920. Figure 3 presents data on the age-sex structure of Yap State, available for the first time in 1925. Note the high male ratio in the youngest age group, a trend seen throughout the twentieth century (particularly in births on the High Islands; see Hunt 1965; Hunt et al. 1965).

The population of Yap State decreased at an annual average of 2.5 percent between 1925 and 1930, a decline of nearly 900 individuals (see Table 3; Nan'yō-chō 1931). Once again, most of the decrease occurred on Yap Proper, where all municipalities had some reduction. Depopulation



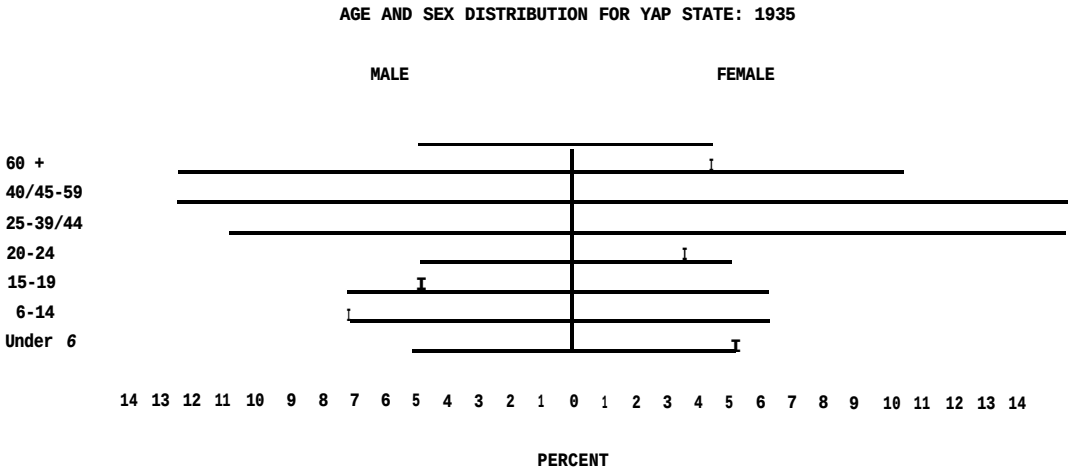




**FIGURE 3. Population pyramids (Pacific Islanders only): 1925, 1930, 1935.**

on the Outer Islands was less severe but nevertheless substantial; all but two municipalities experienced decreases. Although the proportion of total population residing on Yap Proper decreased for the second time (to 61.9 percent), in general the regional distribution remained constant. The age-sex structure for Yap State was similar in 1930 to that documented in 1925 (Figure 3). In addition to data on age and sex at the regional level, such data also are available for residents of individual municipalities in 1930 (Table 5). The evidence presented indicates general variability in the age-sex composition of municipalities. Note in particular Weloy Municipality and the large proportion of individuals aged less than 24 years compared to the rest of the population. This probably is

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

| Area | Total Persons | Age Group (Percentage) | | | |
|---|---|---|---|---|---|
| | | <15 | 15-24 | 25-59 | 60+ |
| Yap State | 6,486 | 26.1 | 13.7 | 50.4 | 9.8 |
| Yap Proper | 4,019 | 26.9 | 14.2 | 50.1 | 8.8 |
| Dalipebinaw | 229 | 24.9 | 14.4 | 50.7 | 10.0 |
| Fanif | 376 | 31.1 | 10.1 | 54.3 | 4.5 |
| Gagil | 579 | 23.3 | 18.7 | 48.9 | 9.2 |
| Gilman | 223 | 23.8 | 13.0 | 57.0 | 6.3 |
| Kanifay | 239 | 25.1 | 12.6 | 51.9 | 10.5 |
| Map | 466 | 21.9 | 10.5 | 54.1 | 13.5 |
| Rull | 660 | 24.2 | 13.2 | 53.8 | 8.8 |
| Rumung | 168 | 22.6 | 17.3 | 51.8 | 8.3 |
| Tomil | 523 | 25.6 | 13.0 | 52.4 | 9.0 |
| Weloy | 556 | 40.5 | 18.0 | 34.5 | 7.0 |
| Outer Islands[a] | 2,467 | 24.8 | 12.8 | 50.9 | 11.5 |
| Eauripik | 113 | 37.2 | 15.0 | 44.2 | 3.5 |
| Elato | 72 | 16.7 | 9.7 | 58.3 | 15.3 |
| Fais | 367 | 13.9 | 14.2 | 48.8 | 23.2 |
| Faraulep | 145 | 33.1 | 12.4 | 49.7 | 4.8 |
| Ifalik | 305 | 22.3 | 13.1 | 51.8 | 12.8 |
| Lamotrek | 164 | 27.4 | 17.7 | 51.2 | 3.7 |
| Ngulu | 64 | 26.6 | 15.6 | 50.0 | 7.8 |
| Satawal | 250 | 43.6 | 11.6 | 36.4 | 8.4 |
| Ulithi | 449 | 18.3 | 9.4 | 57.0 | 15.4 |
| Woleai | 538 | 25.8 | 13.2 | 54.1 | 6.9 |

*Source:* Nan'yo-cho 1931.

Note: In this and following tables, percentages may not sum precisely to 100.0% due to rounding. Other reasons for not summing to 100.0% are noted for each case.

[a] Sorol Atoll unpopulated in 1930.

due to the presence of a community of Chamorros from the Northern Marianas in Weloy from 1911 to the mid-1940s (Yanaihara 1967:41), a community with much higher fertility at that time than the Yapese.

Although vital statistics and migration data for Yap State during the Japanese period are limited, some information on fertility, mortality, and migration is available. Between 1925 and 1929 the crude birth rate for Yap State was 14.4 (Yanaihara 1967:46).[4] This is low fertility for Micronesia, substantially less than the 24.4 recorded for the remainder of the western Carolines (Palau) during the same period and less than one-third that recorded for Japanese living in Yap State between 1925 and 1929 (Office of the Chief of Naval Operations 1944:36). Crude death rate, on the other hand, averaged 44.1 for the period 1925-1929 (Yanaihara 1967:46). This figure is more than twice that recorded for Palau and nearly eight times that recorded for Japanese residents over the same six years. Data on mobility indicate that in 1930 the vast majority in Yap State lived in the municipality where they were registered; most of the remainder also were born in Yap State (Table 6). The only major exception to this trend was Weloy Municipality, where a substantial portion of the resident population (mostly the Chamorros noted above) in 1930 was registered outside Yap State.

The population in Yap State continued to decline between 1930 and 1935 (see Table 3), the loss of nearly 500 persons representing an average annual decrease of 1.5 percent (Nan'yō-chō 1937). As during the previous two five-year intervals, Yap Proper experienced the greatest absolute and relative losses in population, with decreases in all but two places. Depopulation on the Outer Islands was less severe, four actually gaining residents during these five years. The relative proportion of total Yap State population residing in various municipalities remained roughly the same as in 1930. Weloy, one of the two High Island areas that grew between 1930 and 1935, registered the greatest relative change. Slight changes in the age-sex structure of population occurred in Yap State during this period (Figure 3), notably the relative increase in individuals aged 15-24 at the expense of other age groups. Data on the age composition of individual municipalities indicate that these changes generally occurred both on Yap Proper and the Outer Islands (Table 7).

Yap State's crude birth rate decreased from the 1925-1929 average of 14.4 to 12.0 in 1935 (Yanaihara 1967:46). Once again, this value compares poorly with fertility measures for other populations in the area, being about one-half the Palauan crude birth rate and about one-third the crude birth rate for Japanese residing in Yap State. The crude death rate for the district decreased to 28.0 in 1935 (Yanaihara 1967:46).

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

| Area | Total Persons | Percentage | | | |
|---|---|---|---|---|---|
| | | Same Locality | Same District" | Outside District" | Other Location[b] |
| Yap State | 6,486 | 83.9 | 13.1 | 0.8 | 2.3 |
| Yap Proper | 4,019 | 79.4 | 16.6 | 0.3 | 3.6 |
| Dalipebinaw | 229 | 77.3 | 22.7 | - | |
| Fanif | 376 | 90.7 | 9.0 | 0.3 | - |
| Gagil | 579 | 72.7 | 26.9 | | 0.3 |
| Gilman | 223 | 80.7 | 19.3 | - | - |
| Kanifay | 239 | 89.1 | 10.0 | | 0.8 |
| Map | 466 | 88.8 | 10.3 | - | 0.9 |
| Rull | 660 | 85.8 | 10.5 | 0.3 | 3.5 |
| Rumung | 168 | 87.5 | 12.5 | - | - |
| Tomil | 523 | 91.2 | 8.8 | - | - |
| Weloy | 556 | 46.2 | 31.3 | 2.0 | 20.5 |
| Outer Islands[c] | 2,467 | 91.0 | 7.5 | 1.4 | – |
| Eauripik | 113 | 85.0 | 15.0 | - | |
| Elato | 72 | 97.2 | 2.8 | | – |
| Fais | 367 | 95.9 | 4.1 | | – |
| Faraulep | 145 | 89.0 | 11.0 | - | |
| Ifalik | 305 | 96.7 | 3.0 | 0.3 | – |
| Lamotrek | 164 | 91.5 | 7.9 | 0.6 | – |
| Ngulu | 64 | 82.8 | 17.2 | | – |
| Satawal | 250 | 98.0 | 1.6 | 0.4 | |
| Ulithi | 449 | 89.3 | 10.7 | | - |
| Woleai | 538 | 84.6 | 9.3 | 5.9 | 0.2 |

Source: Nan'yo-cho 1931.

[a] Refers to major island districts within the Mandated Territory (e.g., Yap State).

[b] Refers to locations outside the Mandated Territory.

[c] Sorol Atoll unpopulated in 1930.

Despite this drop, mortality still was roughly twice that in Palau, although only slightly greater than the mortality of resident Japanese (Office of the Chief of Naval Operations 1944:36).

*Regional Demography in 1958*

In 1958, the Office of the TTPI High Commissioner conducted the first systematic census of Yap State since the end of Japanese administration (Office of the High Commissioner 1959). Resulting data indicate that

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

| Area | Total Persons | Age Group (Percentage) | | | |
|---|---|---|---|---|---|
| | | <15 | 15-24 | 25-59 | 60+ |
| Yap State | 6,006 | 24.1 | 16.9 | 49.8 | 9.3 |
| Yap Proper | 3,694 | 25.7 | 16.7 | 49.3 | 8.3 |
| Dalipebinaw | 200 | 27.5 | 13.5 | 53.0 | 6.6 |
| Fanif | 386 | 28.5 | 17.4 | 49.5 | 4.7 |
| Gagil | 501 | 23.0 | 16.2 | 51.7 | 9.2 |
| Gilman | 186 | 21.5 | 15.6 | 53.8 | 9.1 |
| Kanifay | 213 | 20.7 | 19.2 | 47.9 | 12.2 |
| Map | 390 | 23.1 | 13.1 | 52.3 | 11.5 |
| Rull | 603 | 24.5 | 14.8 | 51.6 | 9.1 |
| Rumung | 141 | 23.4 | 12.8 | 55.3 | 8.5 |
| Tomil | 472 | 24.6 | 17.4 | 50.2 | 7.8 |
| Weloy | 602 | 32.9 | 22.1 | 38.9 | 6.1 |
| Outer Islands | 2,312 | 21.5 | 17.1 | 50.5 | 10.9 |
| Eauripik | 105 | 30.5 | 20.0 | 45.7 | 3.8 |
| Elato | 72 | 11.1 | 19.4 | 56.9 | 12.5 |
| Fais | 310 | 10.0 | 16.8 | 52.3 | 21.0 |
| Faraulep | 141 | 25.5 | 16.3 | 54.6 | 3.5 |
| Ifalik | 250 | 22.4 | 13.6 | 51.2 | 12.8 |
| Lamotrek | 176 | 22.7 | 21.0 | 54.5 | 1.7 |
| Ngulu | 58 | 20.7 | 19.0 | 51.7 | 8.6 |
| Satawal | 264 | 35.2 | 21.2 | 39.8 | 3.8 |
| Sorol | 8 | 25.0 | 12.5 | 62.5 | - |
| Ulithi | 407 | 16.7 | 12.3 | 53.8 | 17.2 |
| Woleai | 521 | 22.8 | 18.6 | 49.1 | 9.4 |

Source: Nan'yo-cho 1937.

the population continued to decrease during the first thirteen years of U.S. administration (see Table 3), although demographic estimates suggest that this decline ended by the early 1950s (see Table 2). The 1958 census recorded 466 fewer persons living in Yap State than in 1935, an average annual decrease of 0.4 percent. As before, the greatest decrease occurred on Yap Proper, which for the first time recorded less than 60 percent of the total population. All but two of the municipalities on Yap Proper, and all but five of the Outer Islands, lost population between 1935 and 1958. Shifts in the relative proportions of individuals residing in various municipalities were minimal during this twenty-three-year period. Similarly, the overall age-sex composition in 1958 indicates only relatively minor changes from that recorded in 1935 (Figure 4). Data on the age composition of individual municipalities, and sufficiently reliable vital statistics, are unavailable for 1958.

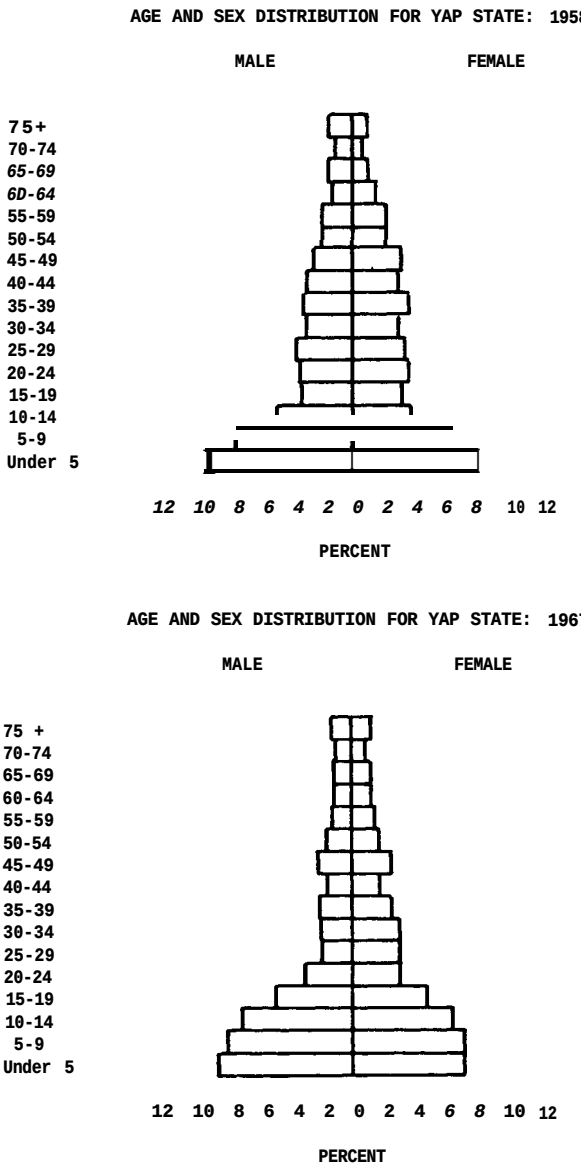



**FIGURE 4. Population pyramids: 1958, 1967.**

*Regional Demography in 1967*

The 1967 census indicates that population grew by more than 1,200 over the decade following the 1958 census, an average annual growth rate of 2.2 percent (School of Public Health n.d.). This marks the first population increase between censuses in forty-seven years (see Table 3). Population grew more rapidly on Yap Proper (to 59.5 percent of the total) than on the Outer Islands. Two High Island municipalities lost population, but increases in other municipalities on Yap Proper more

than compensated-notably Rull and Weloy, where population grew at average annual rates of 6.7 and 5.0 percent, respectively. Two Outer Islands lost population, once again compensated for by growth on the remaining Outer Islands. Shifts in the distribution of Yap State population reflect the population changes just discussed, with Rull and Weloy municipalities together containing 25.7 percent of the total.

The relative number of young persons, notably those aged O-14 and 15-24, increased substantially between 1958 and 1967 (Figure 4). These increases were not uniform, however, as the age composition of individual municipalities suggests substantial variability between places (Table

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

| Area | Total Persons | Age Group (Percentage)[a] | | | |
|---|---|---|---|---|---|
| | | <15 | 15-24 | 25-59 | 60+ |
| Yap State | 6,761 | 42.5 | 14.7 | 30.7 | 9.5 |
| Yap Proper | 4,024 | 43.5 | 13.7 | 30.3 | 9.3 |
| Dalipebinaw | 153 | 44.4 | 9.8 | 32.7 | 13.1 |
| Fanif | 394 | 47.2 | 14.2 | 29.9 | 6.9 |
| Gagil | 352 | 48.6 | 10.5 | 28.4 | 11.6 |
| Gilman | 175 | 41.7 | 10.3 | 36.0 | 8.6 |
| Kanifay | 202 | 41.6 | 12.4 | 28.7 | 14.4 |
| Map | 303 | 43.9 | 15.8 | 30.7 | 8.9 |
| Rull | 941 | 43.4 | 14.0 | 29.6 | 7.9 |
| Rumung | 160 | 45.6 | 8.1 | 32.5 | 12.5 |
| Tomil | 544 | 43.2 | 14.9 | 29.6 | 10.8 |
| Weloy | 800 | 40.0 | 15.6 | 30.8 | 8.0 |
| Outer Islands | 2,737 | 40.9 | 16.2 | 31.2 | 9.8 |
| Eauripik | 146 | 42.5 | 21.9 | 29.5 | 6.2 |
| Elato | 48 | 35.4 | 14.6 | 35.4 | 12.5 |
| Fais | 213 | 29.1 | 13.6 | 32.4 | 24.4 |
| Faraulep | 149 | 37.6 | 26.8 | 30.2 | 5.4 |
| Ifalik | 325 | 43.7 | 18.5 | 28.3 | 9.5 |
| Lamotrek | 243 | 47.7 | 11.1 | 35.4 | 4.5 |
| Ngulu | 18 | 27.8 | 11.1 | 50.0 | 5.6 |
| Satawal | 389 | 46.5 | 14.7 | 28.3 | 4.1 |
| Sorol | 13 | 7.7 | - | 53.8 | 38.5 |
| Ulithi | 549 | 37.7 | 14.8 | 29.0 | 16.0 |
| Woleai | 644 | 42.1 | 16.8 | 33.9 | 6.4 |

Source: School of Public Health n . d .

[a] Percentages may not sum to precisely 100.0%) due to exclusion of 34 individuals whose ages were “not specified’ or who were “foreign born” (whose ages similarly were not specified) .

8). In general terms, relatively more individuals aged less than 15 years lived on Yap Proper, and relatively more aged 15-24 lived on the Outer Islands. For Rull and Weloy, the two municipalities that experienced the greatest population growth between 1958 and 1967, young (less than 10 years old) and early middle-aged (25-39 years) persons were particularly well represented.

Vital statistics for Yap State in 1967 indicate a substantial increase in natality since 1935 (Table 9). This dramatic jump in fertility helps to account for the demographic growth during the decade preceding 1967. Natality by municipality also is available for 1967 (Table 10). Values vary, often greatly, between places, particularly where populations are small. In 1967 excessive fertility did not characterize Rull and Weloy municipalities, suggesting other causes of demographic growth in these two areas. Data on mortality in 1967 are available by five-year age group for Yap State (Table 11). Overall mortality, in terms of crude death rate, was slightly more than one-third of that recorded in 1935, with infant mortality in particular quite low (Table 12).

*Regional Demography in 1970*

In 1970 the U.S. Bureau of the Census conducted a census of each district in the TTPI (U.S. Bureau of the Census 1972). Unfortunately, geographic designations for Yap State were incorrect. Thus, although the total for the district may be accurate, data disaggregated to individual

**TABLE g. Measures of Fertility for Yap State: Select Years**

| Year | Total Persons | Total Births | Crude Birth Rate | General Fertility Rate | Total Fertility Rate |
|---|---|---|---|---|---|
| 1967[a] | 6,761 | 232 | 34.3 | 181.3 | 6.3 |
| 1970 | 7,625 | 251 | 32.9 | 159.9 | 5.6 |
| 1973 | 7,870 | 265 | 33.7 | 161.0 | 5.6 |
| 1980[a] | 8,100 | 290 | 35.8 | 163.6 | 4.9 |
| 1987 | 10,139 | 226 | 22.3 | 99.6 | NA[b] |

Sources: School of Public Health n.d.; U.S. Bureau of the Census 1972, 1983a; U.S. Dept. of State 1981, 1982; Yap Office of Planning and Budget 1988b.

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

[b] Insufficient data available to calculate total fertility rate for 1987.

## 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 |
|---|---|---|---|---|---|---|---|---|---|---|
| Yap State | 6,761 | 208 | 30.8 | 140.6 | 5,019 | 8,100 | 239 | **29.5** | 134.6 | 4,560 |
| Yap Proper | 4,024 | 128 | 31.8 | 157.0 | 5,529 | 5,196 | 147 | 28.3 | 136.5 | 4,564 |
| Dalipebinaw | 153 | **1** | 6.5 | 38.5 | 2,500 | 211 | 12 | 56.9 | 250.0 | 7,423 |
| Fanif | 394 | **10** | 25.4 | 138.9 | 6,095 | 392 | 10 | 25.5 | 117.6 | 3,455 |
| Gagil | 352 | **10** | 28.4 | 137.9 | 5,750 | 616 | 8 | 13.0 | 64.0 | 1,848 |
| Gilman | 175 | 4 | 22.9 | 133.3 | 5,333 | 228 | 8 | 35.1 | 186.0 | 7,197 |
| Kanifay | 202 | 6 | 29.7 | 166.7 | 5,722 | 225 | 3 | 13.3 | 75.0 | 2,677 |
| Map | 303 | 14 | 46.2 | 196.4 | 8,862 | 319 | 10 | 31.3 | 156.3 | 5,097 |
| Rull | 941 | 28 | 29.8 | 142.9 | 4,641 | 1,436 | 37 | 25.8 | 123.7 | 4,160 |
| Rumung | 160 | 5 | 31.3 | 200.0 | 10,167 | 130 | 3 | 23.1 | 130.4 | 6,339 |
| Tomil | 544 | 18 | 33.1 | 183.7 | 6,932 | 713 | 30 | 42.1 | 215.8 | 7,283 |
| Weloy | 800 | 32 | 40.0 | 174.2 | 5,827 | 926 | 26 | 28.1 | 123.2 | 4,478 |
| Outer Islands | 2,737 | 80 | 29.2 | 118.3 | 4,317 | 2,904 | 92 | 31.7 | 131.6 | 4,553 |
| Eauripik | 146 | 7 | 47.9 | 62.5 | 1,458 | 121 | **1** | 8.3 | 27.8 | 625 |
| Elato | 48 | - | - | - | - | 51 | **1** | **19.6** | 71.4 | 625 |
| Fais | 213 | 6 | 28.2 | 69.8 | 3,333 | 207 | **10** | 48.3 | 232.6 | 8,909 |
| Faraulep | 149 | 3 | 20.1 | 68.2 | 2,548 | 132 | **12** | 90.9 | 333.3 | 9,929 |
| Ifalik | 325 | 9 | 27.7 | 140.6 | 4,881 | 389 | 2 | 5.1 | 19.8 | 526 |
| Lamotrek | 243 | 10 | 41.2 | 183.7 | 6,542 | 242 | 3 | 12.4 | 49.2 | 1,165 |
| Ngulu | 18 | - | - | - | - | 21 | 1 | 47.6 | 200.0 | 2,500 |
| Satawal | 389 | 9 | 23.1 | 121.2 | 3,491 | 386 | 19 | 49.2 | 228.9 | 7,827 |
| Sorol | 13 | - | - | - | - | 7 | - | - | - | - |
| Ulithi | 549 | 16 | 29.1 | 142.9 | 5,339 | 710 | 24 | 33.8 | **161.1** | 5,770 |
| Woleai | 644 | 20 | 31.1 | 123.1 | 4,139 | 638 | **19** | 29.8 | **111.1** | 3,459 |

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 general or total fertility rates).

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

**TABLE 11. Deaths in Yap State, Percentages by Age Group: 1967, 1970, 1973, 198O**

| Age Group | 1967 | 1970 | 1973 | 1980 |
|---|---|---|---|---|
| | Number | | | |
| Total Persons | 6,761 | 7,625 | 7,870 | 8,100 |
| | Percentage | | | |
| All Ages | 100.0[a] | 100.0 | 100.0 | 100.0 |
| < l | 5.8 | 15.8 | 11.6 | 15.9 |
| l-4 | 2.9 | 3.9 | 5.8 | 10.1 |
| 5-9 | - | 2.6 | - | - |
| 10-14 | 1.4 | - | | - |
| 15-19 | 1.4 | - | 1.2 | 2.9 |
| 20-24 | | 2.6 | - | 2.9 |
| 25-29 | - | 1.3 | 3.5 | - |
| 30-34 | - | - | 2.3 | - |
| 35-39 | 7.2 | 3.9 | 3.5 | 1.4 |
| 40-44 | 2.9 | - | 1.2 | 1.4 |
| 45-49 | - | 1.3 | 4.7 | 8.7 |
| 50-54 | 5.8 | 3.9 | 5.8 | 4.3 |
| 55-59 | 8.7 | - | 7.0 | 8.7 |
| 60-64 | 10.1 | 14.5 | 5.8 | 4.3 |
| 65-69 | 7.2 | 13.2 | 11.6 | 11.6 |
| 70-74 | 13.0 | 5.3 | 14.0 | 10.1 |
| 75+ | 30.4 | 31.6 | 22.1 | 17.4 |

*Sources:* 1967 calculations based upon data on deaths between 10 April 1966 and 26 March 1967, as presented in School of Public Health n.d. (which differ slightly from the data presented in U.S. Dept. of State 1981); 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.

[a] Percentages for 1967 do not sum to precisely 100.0 due to two individuals whose age at death was "not specified."

municipalities are not. Over the preceding three years the population of Yap State grew by more than 850 persons, an average annual rate of 4.1 percent (see Table 2 above). Age and sex data for the region indicate minimal changes from 1967, except for a slight increase in the proportion of males (Figure 5).

Vital statistics for Yap State reveal a decrease in fertility between 1967 and 1970 (see Table 9). But mortality also decreased slightly. This shifting balance between births and deaths is a possible explanation for some of the population growth experienced between 1967 and 1970.

**TABLE 12. Age-Specific Death Rates in Yap State: 1967, 1970, 1973, 198O**

| Age Group | 1967 | 1970 | 1973 | 1980 |
|---|---|---|---|---|
| Total | 10.21 | 9.97 | 10.93 | 8.52 |
| < l | 18.87 | 45.28 | 37.17 | 43.14 |
| l-4 | 2.50 | 3.54 | 5.35 | 7.03 |
| 5-9 | - | 1.88 | - | - |
| 10-14 | 1.15 | - | - | - |
| 15-19 | 1.65 | - | 1.17 | 2.60 |
| 20-24 | - | 3.71 | - | 2.72 |
| 25-29 | | 2.65 | 6.82 | - |
| 30-34 | - | - | 5.70 | - |
| 35-39 | 14.49 | 7.77 | 7.89 | 3.04 |
| 40-44 | 8.06 | - | 2.79 | 3.25 |
| 45-49 | | 2.81 | 13.75 | 19.29 |
| 50-54 | 15.50 | 10.17 | 15.43 | 13.95 |
| 55-59 | 30.77 | - | 24.19 | 24.19 |
| 60-64 | 43.48 | 67.48 | 24.88 | 13.64 |
| 65-69 | 30.67 | 54.35 | 71.94 | 52.63 |
| 70-74 | 68.70 | 38.10 | 96.77 | 75.27 |
| 75+ | 111.11 | 150.94 | 117.28 | 61.22 |

Sources: See Table 11.

*Regional Demography in 1973*

The 1973 Trust Territory census indicated that population growth in Yap State continued, at an average annual rate of slightly more than 1.0 percent since 1970 (see Table 3; Office of Census Coordinator 1975). Moreover, the proportion of total population living in Yap Proper increased markedly, with 65.3 percent of the total residing on the High Islands. Population grew in all but two municipalities in Yap Proper over the six years preceding 1973, with the greatest relative and absolute increases in Rull, Gagil, and Weloy. The Outer Islands in total experienced a slight decline; all but one municipality lost population between 1967 and 1973. These demographic changes corresponded to shifts in regional distribution. In addition to Yap Proper, containing nearly two-thirds of the total population, Rull and Weloy municipalities together accounted for nearly one-third of the total. Relative decreases in population occurred throughout the Outer Islands. The exception is Ulithi Atoll, which for the first time on record contained the largest number of persons outside Yap Proper-possibly due to the opening of a high school there in the early 1970s.

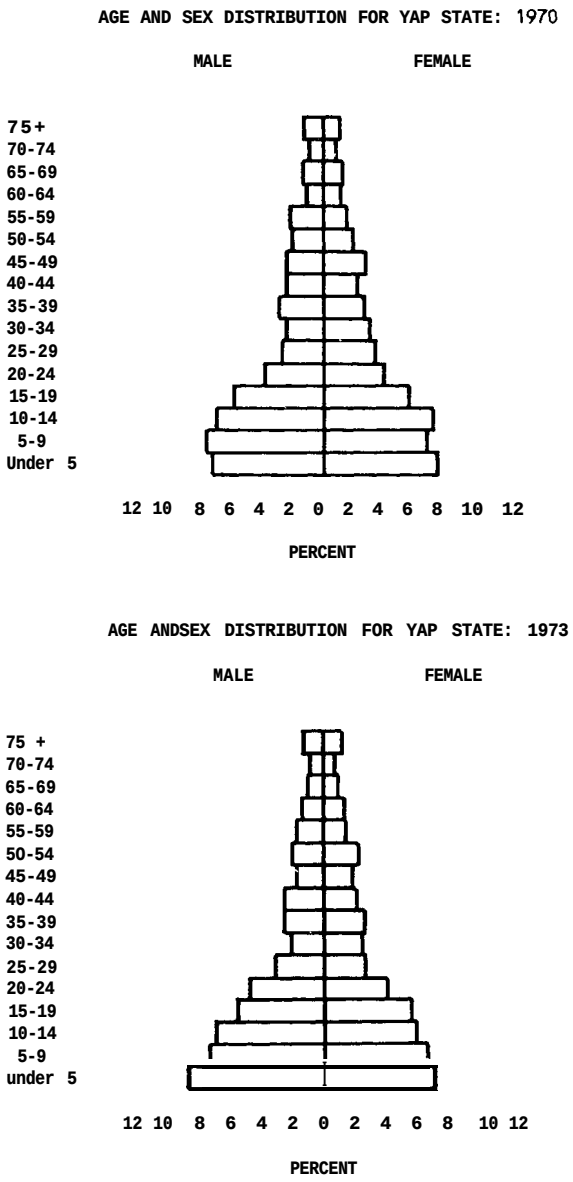



**FIGURE 5. Population pyramids: 1970, 1973.**

The age-sex structure of Yap State in 1973 indicates at most minor changes from 1970 (Figure 5). The age composition of individual municipalities was broadly similar to that found in 1967 (Table 13). Basic similarities hold when comparing municipalities and island units as well, with the age structure for Yap Proper and the Outer Islands essentially the same as for the entire region.

Yap State experienced slight increases between 1970 and 1973 in crude birth rate and general fertility rate, and an essentially constant total fertility rate (see Table 9). The crude death rate increased slightly

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

| Area | Total Persons | Age Group (Percentage)[a] | | | |
|---|---|---|---|---|---|
| | | <15 | 15-24 | 25-59 | 60+ |
| Yap State | 7,870 | 41.9 | 18.7 | 30.4 | 8.0 |
| Yap Proper | 5,140 | 42.0 | 18.8 | 30.8 | 7.7 |
| Dalipebinaw | 169 | 49.1 | 14.8 | 27.2 | 8.9 |
| Fanif | 367 | 42.2 | 16.3 | 31.9 | 7.4 |
| Gagil | 537 | 46.6 | 17.9 | 28.7 | 6.3 |
| Gilman | 217 | 36.9 | 21.2 | 29.0 | 12.4 |
| Kanifay | 235 | 42.6 | 19.1 | 28.9 | 8.9 |
| Map | 337 | 42.4 | 18.4 | 28.8 | 10.1 |
| Rull | 1,463 | 40.2 | 18.1 | 35.6 | 5.6 |
| Rumung | 129 | 50.4 | 7.8 | 27.1 | 14.7 |
| Tomil | 666 | 39.9 | 23.3 | 27.0 | 9.6 |
| Weloy | 1,020 | 42.2 | 19.9 | 29.7 | 7.0 |
| Outer Islands | 2,728 | 41.6 | 18.6 | 29.7 | 8.5 |
| Eauripik | 127 | 50.4 | 13.4 | 30.7 | 5.5 |
| Elato | 32 | 25.0 | 28.1 | 37.5 | 6.3 |
| Fais | 212 | 36.3 | 11.3 | 36.3 | 16.0 |
| Faraulep | 122 | 41.0 | 18.0 | 28.7 | 6.6 |
| Ifalik | 314 | 42.0 | 16.2 | 32.8 | 6.1 |
| Lamotrek | 233 | 49.4 | 12.9 | 32.6 | 4.7 |
| Ngulu | 8 | 25.0 | 0.0 | 62.5 | 0.0 |
| Satawal | 354 | 49.2 | 12.4 | 28.2 | 9.0 |
| Sorol | 8 | 12.5 | - | 87.5 | - |
| Ulithi | 710 | 33.5 | 29.9 | 24.2 | 9.9 |
| Woleai | 608 | 45.1 | 16.3 | 30.1 | 8.1 |

Source: Office of Census Coordinator 1975.

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

over the same period, although infant mortality decreased (see Table 12). Data on mobility in general suggest a continued limited role for migration in the demography of this region: in 1973 most TTPI-born persons in Yap State normally resided in the same municipality where they were born, with a lesser proportion having moved from elsewhere in the state (Table 14). The exception to this trend was Rull, nearly 16.0 percent of whose population came from other parts of the Trust Territory. Apparently municipalities that experienced substantial population growth during the early 1970s-notably Weloy, Rull, and Gilman municipalities, and Ulithi Atoll-also received relatively large numbers of in-migrants from elsewhere in the region. More than 27.0 percent of

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 Yap | Elsewhere in TTPI | Outside of TTPI |
| Yap State | 7,611 | 73.7 | 22.2 | 4.0 | 0.1 |
| Yap Proper | 4,903 | 66.4 | 27.5 | 5.9 | 0.1 |
| Dalipebinaw | 168 | 85.1 | 14.9 | - | – |
| Fanif | 364 | 90.4 | 9.6 | - | |
| Gagil | 536 | 96.8 | 3.2 | - | – |
| Gilman | 216 | 70.4 | 26.9 | 2.8 | – |
| Kanifay | 235 | 88.9 | 11.1 | - | – |
| Map | 337 | 87.5 | 12.5 | - | – |
| Rull | 1,314 | 47.4 | 36.3 | 15.8 | 0.5 |
| Rumung | 128 | 81.3 | 18.8 | - | – |
| Tomil | 623 | 88.1 | 11.7 | 0.2 | – |
| Weloy | 982 | 33.9 | 58.2 | 7.7 | 0.1 |
| Outer Islands | 2,708 | 86.9 | 12.6 | 0.5 | 0.1 |
| Eauripik | 127 | 92.9 | 7.1 | - | – |
| Elato | 32 | 96.9 | 3.1 | – | – |
| Fais | 212 | 92.9 | 7.1 | – | – |
| Faraulep | 122 | 99.2 | 0.8 | – | |
| Ifalik | 311 | 97.7 | 2.3 | – | – |
| Lamotrek | 233 | 90.1 | 9.9 | - | – |
| Ngulu | 8 | 87.5 | 12.5 | - | – |
| Satawal | 353 | 90.9 | 7.4 | 1.7 | – |
| Sorol | 8 | 100.0 | - | - | - |
| Ulithi | 697 | 67.6 | 31.4 | 0.7 | 0.3 |
| Woleai | 605 | 93.2 | 6.3 | 0.5 | - |

Source: Office of Census Coordinator 1975.

the 1973 population of Yap Proper had migrated from elsewhere in Yap State.

*Regional Demography in 1977*

The TTPI Office of Planning and Statistics conducted a census of Yap State in 1977 (Office of Planning and Statistics 1982). Unlike all other censuses discussed in this study, this effort focused upon de jure rather than de facto population and was designed primarily to document the distribution of skills throughout the state. Because this was not a com-

plete census, detailed data are unavailable on population characteristics such as age-sex composition. Moreover, because the data collected were de jure, strictly speaking they are not fully comparable with the de facto data collected in other census years. Nevertheless, information exists on the distribution of population throughout the region, and it probably provides a reasonable indication of the de facto arrangement of people (see Table 3). Note in particular the continued dominance of Yap Proper, which contained nearly 65 percent of the total population-once again dominated by Rull and Weloy municipalities. Similarly, note the continued dominance of Ulithi and Woleai atolls in the Outer Islands, which together accounted for more than half of the population outside Yap Proper.

*Regional Demography in 1980*

The U.S. Bureau of the Census conducted a second detailed census of the Trust Territory in 1980 (U.S. Bureau of the Census 1983a), making demographic data available for the entire state of Yap as well as for individual municipalities. Unfortunately, careful examination of the data suggests undercounts of certain ethnic groups (Yap Office of Planning and Budget 1988a:4). These undercounts, coupled with results of the de jure census of 1977 and likely heavy out-migration to the United States during the late 1970s (to take advantage of the recently established Education Opportunity Grants), give the impression that population decreased between 1977 and 1980-the first decrease between census years since 1958. Although out-migration is a legitimate demographic cause of depopulation, the former two reasons are functions of data accuracy and comparability and should be considered as such.

Because the 1977 census was de jure, we are reluctant to compare it with the 1980 de facto census. Indications are, however, that the relative population distribution on Yap Proper and in the Outer Islands in 1980 continued in the general proportions recorded in both 1973 and 1977. The earlier importance of certain municipalities began to diminish, with the relative contributions of Rull and Weloy on Yap Proper and Ulithi Atoll in the Outer Islands decreasing slightly.

Data on the age-sex composition of Yap State in 1980 show little change from 1973 (Figure 6). The same generally can be said for data on the age structure for individual municipalities (Table 15). Once more there is little regional difference in the age composition of Yap Proper versus the Outer Islands, or among individual municipalities.

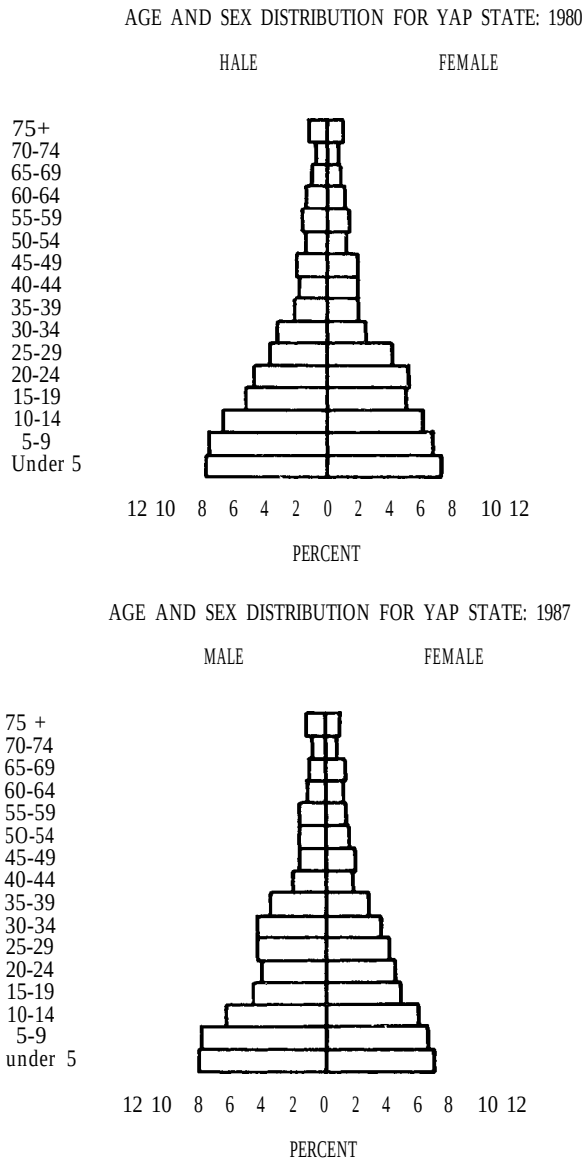



FIGURE 6. Population pyramids: 1980, 1987.

Vital statistics indicate slight increases in two of the three fertility measures considered (see Table 9). The most sensitive measures of fertility considered here, namely the general and total fertility rates, were slightly higher on Yap Proper than on the Outer Islands (see Table 10). Compared to 1967, the only other year for which we have such detailed data, fertility on Yap Proper apparently declined in 1980 while fertility on the Outer Islands increased. Mortality data for Yap State indicate a decrease in crude death rate and a slight increase in infant mortality when compared to 1973 (see Table 12).

Data on mobility in 1980 suggest a continuing limited role for migra-

TABLE 15. Population by Age and Area: 1980

| Area | Total Persons | Age Group (Percentage) | | | |
|---|---|---|---|---|---|
| | | <15 | 15-24 | 25-59 | 60+ |
| Yap State | 8,100 | 42.4 | 18.6 | 30.8 | 8.2 |
| Yap Proper | 5,196 | 42.0 | 19.0 | 31.2 | 7.9 |
| Dalipebinaw | 211 | 46.9 | 20.4 | 27.0 | 5.7 |
| Fanif | 392 | 41.3 | 17.1 | 33.2 | 8.4 |
| Gagil | 616 | 44.5 | 19.2 | 27.8 | 8.6 |
| Gilman | 228 | 37.7 | 23.7 | 25.9 | 12.7 |
| Kanifay | 225 | 41.3 | 19.6 | 29.3 | 9.8 |
| Map | 319 | 38.9 | 20.1 | 27.3 | 13.8 |
| Rull | 1,436 | 40.8 | 17.8 | 35.0 | 6.4 |
| Rumung | 130 | 46.2 | 16.9 | 25.4 | 11.5 |
| Tomil | 713 | 42.1 | 22.7 | 27.8 | 7.4 |
| Weloy | 926 | 42.8 | 16.8 | 34.2 | 6.2 |
| Outer Islands | 2,904 | 43.1 | 17.9 | 30.2 | 8.6 |
| Eauripik | 121 | 43.8 | 17.4 | 30.6 | 8.3 |
| Elato | 51 | 45.1 | 17.6 | 25.5 | 11.8 |
| Fais | 207 | 46.4 | 13.5 | 24.2 | 15.9 |
| Faraulep | 132 | 40.2 | 15.2 | 36.4 | 8.3 |
| Ifalik | 389 | 45.5 | 14.4 | 33.2 | 6.9 |
| Lamotrek | 242 | 46.3 | 17.4 | 27.7 | 8.7 |
| Ngulu | 21 | 14.3 | 14.3 | 57.1 | 14.3 |
| Satawal | 386 | 44.8 | 15.5 | 28.2 | 11.4 |
| Sorol[a] | 7 | NA | NA | NA | NA |
| Ulithi | 710 | 39.2 | 24.6 | 28.7 | 7.5 |
| Woleai | 638 | 44.4 | 16.5 | 32.4 | 6.7 |

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

[a] Age breakdown not provided.

tion which, if anything, declined in importance (see Table 16). Most Yap State residents in 1980 resided in the same municipality as in 1975. Slightly higher mobility occurred in Rull and Weloy municipalities on Yap Proper (now joined by Gilman), and on Ulithi Atoll in the Outer Islands.

### *Regional Demography in 1987*

In 1987 the Yap Office of Planning and Budget conducted the most recent detailed census of Yap State (Yap Office of Planning and Budget 1988a). Results indicate that the demographic structure--age-sex composition-for the state remained virtually unchanged from 1980 (Figure

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

| Area | Total Persons[a] | Percentage | | | |
|---|---|---|---|---|---|
| | | Same Municipality | Elsewhere in Yap | Elsewhere in TTPI | Outside of TTPI |
| Yap State | 6,376 | 90.3 | 6.7 | 1.3 | 1.6 |
| Yap Proper | 4,141 | 91.2 | 5.2 | 1.4 | 2.2 |
| Dalipebinaw | 175 | 93.1 | 6.3 | - | 0.6 |
| Fanif | 320 | 98.8 | 0.9 | 0.3 | - |
| Gagil | 507 | 98.0 | 0.8 | 0.4 | 0.8 |
| Gilman | 182 | 86.8 | 9.3 | 3.3 | 0.5 |
| Kanifay | 189 | 100.0 | - | - | - |
| Map | 227 | 98.2 | 1.3 | - | 0.4 |
| Rull | 1,111 | 83.2 | 9.5 | 2.4 | 5.0 |
| Rumung | 103 | 97.1 | 2.9 | - | - |
| Tomil | 568 | 94.5 | 3.9 | 0.7 | 0.9 |
| Weloy | 759 | 88.1 | 6.2 | 2.6 | 3.0 |
| Outer Islands | 2,235 | 88.7 | 9.5 | 1.1 | 0.6 |
| Eauripik | 104 | 98.1 | - | 1.9 | - |
| Elato | 41 | 95.1 | 4.9 | | - |
| Fais | 166 | 98.8 | 0.6 | - | 0.6 |
| Faraulep | 114 | 97.4 | 1.8 | 0.9 | - |
| Ifalik | 302 | 100.0 | - | - | |
| Lamotrek | 193 | 99.0 | - | 1.0 | |
| Ngulu | 9 | 100.0 | - | | - |
| Satawal | 326 | 91.5 | 3.5 | 4.1 | 0.9 |
| Sorol | NA | NA | NA | NA | NA |
| Ulithi | 478 | 64.6 | 33.1 | 0.8 | 1.5 |
| Woleai | 512 | 91.2 | 7.6 | 0.6 | 0.6 |

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

[a] Includes only those individuals more than 5 years old. Excludes 12 individuals whose 1975 place of residence was not given.

6). But overall population change is a different matter, for the total number of inhabitants grew by more than 2,000 during the first seven years of the 198Os, an average annual increase of 3.3 percent (see Table 3). The proportion residing on Yap Proper grew slightly between 1980 and 1987; the populations of all but two municipalities there increased and the demographic dominance of Rull and Weloy continued to grow. Though the proportion of Yap State population residing on Outer Islands declined during this period, the absolute population of all but

two Outer Island municipalities grew. Ulithi and Woleai atolls remained the largest population centers in the Outer Islands.

Vital statistics presented in Table 9 indicate substantial drops in natality between 1980 and 1987 for the crude birth and total fertility rates. However, decreases in mortality more than compensated for these drops. The crude death rate exceeded 10.0 only once between 1980 and 1987, and infant mortality exceeded 40.5 only three times during the same period (Yap Office of Planning and Budget 1988b:68). This low mortality resulted in substantial population increases. Data on migration to supplement the vital statistics presently are unavailable.

## Population Dynamics in Yap State: Causes, Results, and Repercussions

### Underlying Causes of Population Dynamics

The population of Yap State declined from at least the mid-nineteenth century until the 195Os, when it began to grow again. In describing population change in this region, we briefly noted possible reasons underlying it. We now examine the mechanisms of population change in Yap State more carefully, considering the demographic causes of both depopulation and regional population growth over the past three decades.

The population of Yap State had begun to decline by the time Germany acquired it in 1899. Despite the absence of detailed data, it is likely that high mortality played an important role in this depopulation. Although estimates of infant mortality as high as 80.0 percent during the Spanish period (Price 1936) probably are excessive, diseases that clearly were introduced before 1900 continued into the early twentieth century. German administrators also documented two epidemics for the Yap region during their tenure-influenza in 1903 and typhoid between 1910 and 1911 (Hunt et al. 1954:22-23).

Yap State's population decline continued throughout the three decades of Japanese rule, and attempts to curb depopulation began as early as 1915. The Japanese commissioned a special study of depopulation during the late 1920s and early 193Os, in response to growing concern from the League of Nations (see Fujii 1934a, 1934b). The immediate causes were identified as low fertility and high mortality. Measures of both compared poorly to other parts of the western Carolines as well as to the Japanese in Yap State itself. The Japanese study focused in particular upon health and its effects on fertility and mortality, and identified excessive mortality as the principal cause of population decline.

The high death rate was attributed to disease-in particular, widespread tuberculosis, chronic bronchial catarrh, and acute infantile intestinal inflammation (Office of the Chief of Naval Operations 1944: 37). In addition, at least three major epidemics were documented for the region: influenza about 1924, diphtheria in 1925, and amoebic dysentery in 1936 (Hunt et al. 1954:27).

The Japanese research concluded that low fertility significantly contributed to depopulation as well, and cited the high incidence of gonorrhea as the main cause (Office of the Chief of Naval Operations 1944: 37). In an attempt to curtail the depopulation, the Japanese improved the quality of drinking water, native housing, and waste disposal facilities, provided increased medical attention, and increased education and training on health-related issues (Office of the Chief of Naval Operations 1944:37-38). Population in the area continued to decrease, though, possibly due to Yapese reluctance to accept imposed cultural changes and possibly because of the incomplete distribution of improvements (see Yanaihara 1967: 192-194; Peattie 1988:87-90).

Throughout the period of Japanese rule, migration apparently played a limited role in the demography of Yap State (see Table 6). The relocation of men from Yap Proper to the Outer Islands and beyond (e.g., Angaur in Palau, to work phosphate mines) for commercial reasons represented the most prevalent cause of movement.

By 1946, soon after the United States took over administration of the region, the population of Yap Proper had declined to 2,582-a decrease of roughly 800 during the preceding decade (Hunt et al. 1949:36). Between 1947 and 1948, researchers from Harvard University studied depopulation on Yap Proper as part of the Coordinated Investigation of Micronesian Anthropology (Hunt et al. 1949, 1954; see also Murdock 1948). The study concluded that high mortality indeed was a major problem, naming widespread yaws, pulmonary tuberculosis, and epidemics such as those noted above as the main causes (Hunt et al. 1954: 27-29). The Harvard study also concluded that low fertility played a key role in depopulating Yap Proper, probably resulting from a combination of venereal and other diseases (such as amoebic dysentery) known to reduce fertility, and cultural practices that served to limit conception or terminate pregnancies when raising a family would have been difficult (Hunt et al. 1954:31-45). Some argued that self-induced abortion was the main cause of this low fertility (Schneider 1955); other researchers countered that genitourinary infections were the main contributors on Yap Proper prior to World War II (Underwood 1973; see also Hagaman 1974). A study of reproductive events among women on

the High Islands revealed no trends differing markedly from other populations examined (Hunt and Newcomer 1984). On Ulithi Atoll, an examination of depopulation led to the rejection of many prevalent theories of population decline (e.g., abortions, infanticide, male absenteeism) in favor of genitourinary disorders (Lessa 1955: 182).

Modern medicine eventually became available in Yap State, reducing mortality and helping to control diseases that reduced fertility. Noticeable improvements were evident shortly after the onset of U.S. administration (Hunt et al. 1954:45-47), and population began to grow on the High Islands almost immediately. An analysis of the demographic structure on Yap Proper between 1946 and 1966 indicated that resident populations were in the early phases of a period of rapid growth (Underwood 1969: 16). This growth in large measure was a direct product of the change in balance between crude birth rate and crude death rate, with the former exceeding the latter by 1947 (Figure 7). A

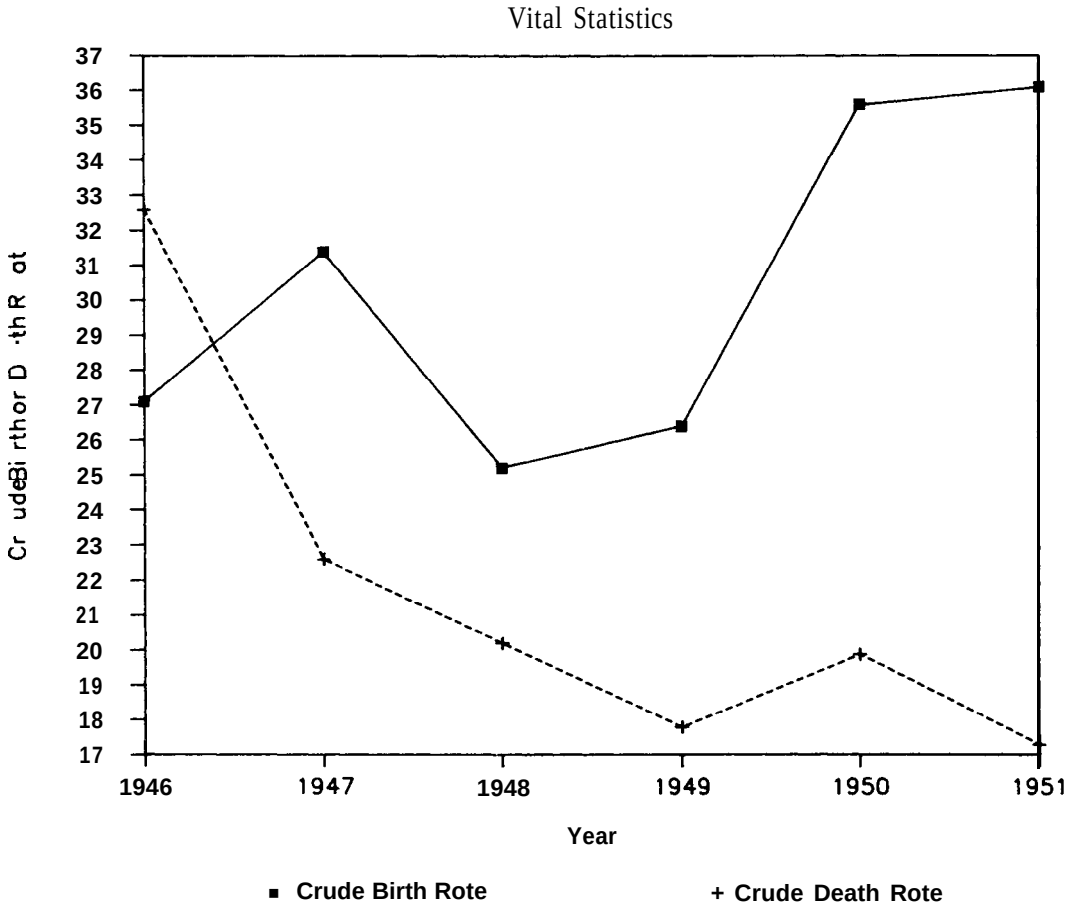



FIGURE 7. Change in fertility and mortality on the High Islands: 1946-1951.

generally constant relationship between fertility and mortality eventually emerged (see Tables 9 and 12) and persisted into the late 1980s.

With a few restricted exceptions, post-World War II population growth occurred through means other than migration. Detailed data beginning with the early 1970s support this claim. For example, although 15.8 percent of the residents in Rull Municipality in 1973 had come from outside Yap State, only 4.0 percent of the total state population migrated from beyond state boundaries (see Table 14). Internal migration apparently was more prevalent, particularly affecting Yap Proper; in 1973, of all persons residing there 27.5 percent claimed other parts of Yap State as home, helping to explain the surge in relative demographic importance of Yap Proper following the 1967 census. However, migration even within Yap State declined by 1980. More than 90.0 percent resided in the same municipality as in 1975 (see Table 16). One possibly important consideration, particularly on the Outer Islands, is the nonpermanent, short-term circulation of population, as documented elsewhere in the Pacific (see Chapman and Prothero 1985). Due to a lack of pertinent data, population circulation was not examined in this study.

## Changes in the Regional Organization of Population: Statistical Insights

Having discussed the demographic history of Yap State and possible reasons for changes in population, we now examine more formally shifts in the regional arrangement of people. This inquiry employs selected spatial statistics and focuses in particular upon changes in the geographic distribution of population during the twentieth century.

To evaluate the changing regional arrangement of people in Yap State, we apply two complementary statistical concepts: measures of *point-to-point temporal association* and *spatiotemporal association* (see Gale and Gorenflo 1990). These measures represent a slight modification of methods devised by Hubert et al. (1985) to examine spatial configurations in a single period. In the synchronic case, point-to-point association concerns the relation between the values of different variables measured at the same locations and at the same time; typically one can employ any of several familiar measures of correlation defined in a nonspatial context (e.g., Kendall's *tau)* to assess point-to-point association (Hubert et al. 1985:36). In the present research context, we apply this basic concept to evaluate the degree of correspondence between a single variable measured at the same location at different times, specifi-

cally, the degree to which the population distributed among various places at time *t* corresponded to the population of the same places at a later time *t'*. As in the synchronic case, point-to-point temporal association is not inherently spatial and employs statistical measures of correlation defined originally in a nonspatial setting. Here we use Pearson's product-moment coefficient and Spearman's rank-order coefficient. In point-to-point temporal association, high positive values for periods *t* and *t'* indicate a strong correspondence between the same places in those two periods. Values range from 1.0 (perfect positive correspondence) to -1.0 (perfect negative correspondence),

As originally defined (Hubert et al. 1985), spatial association concerns the correspondence between the values of two variables *and* their spatial distribution at a particular moment in time-thus explicitly incorporating location into the analysis. In this context, high positive spatial association indicates a situation where like values occur in proximal locations and contrasting values occur at locations further apart (see Tjostheim 1978; Hubert and Golledge 1982; Gorenflo and Gale 1986). Spatiotemporal association, on the other hand, examines the correlation of a single variable at two points in time and its spatial distribution in each time period (Gale and Gorenflo 1990). In the present setting, we employ the approach developed by Hubert et al. (1985) to assess spatial association, based upon a quadratic assignment method of comparing two matrices statistically (see Hubert and Schultz 1976). Here we focus upon the following matrices: D, a 21 x 21 matrix of Euclidian distances, where each entry $d_{ij}$ represents the distance separating place *i* (High Island municipality or Outer Island) from place *j* in Yap State; and C, a 21 x 21 matrix containing information on the population of places in Yap State recorded in two census years. For matrix C, letting $p_{i,t}$ and $p_{i,t'}$ denote the populations of place *i* at times *t* and *t'*, one may define each entry $c_{ij}$ via the following function:

$$c_{ij} = [|p_{i,t} - p_{j,t'}| + |p_{j,t} - p_{i,t'}|] / 2. \quad (1)$$

As with point-to-point temporal association, values of spatiotemporal association range from 1.0 to -1.0. Additional mathematical details of spatiotemporal association may be found in Gale and Gorenflo (1990) and in Gorenflo (1990).

Calculating point-to-point temporal and spatiotemporal association measures provides complementary means of assessing the changing structure of regional organization in Yap State. The former measures local change-that is, the degree to which the population living at par-

ticular places at time *t'* corresponded to the population at those same places at time *t.* In a traditional Micronesian setting with limited mobility, values of this measure should be fairly high, particularly over short periods and in the absence of disproportional changes in population such as might be caused by localized diseases or natural disasters. Spatiotemporal association assesses broader spatial change, the degree to which the populations of places at time *t'* were similar to the populations of proximal places at time *t.* High positive spatiotemporal association would indicate regional evolution toward a homogeneous spatial distribution of population, whereas high negative spatiotemporal association would indicate regional evolution toward more marked differences in the spatial distribution of population.

Measures of point-to-point temporal association for Yap State indicate very high and statistically significant *(p* < .0l) correspondence between successive census years, with all measures .937 or above (Table 17).[5] These results suggest that, despite the traditional distinction between the High Islands and Outer Islands, demographically these two subregions behaved similarly-through instances of depopulation as well as instances of population increase. Even between 1935

TABLE 17. Statistical Comparisons for Yap State Regional Population: Between Select Census **Years**

| | Point-to-Point Temporal | | Spatiotemporal |
|---|---|---|---|
| Years Compared | Pearson | Spearman | Quadratic Assignment |
| 1925 & 1930 | .990 | .981 | -.014[a] |
| 1930 & 1935 | .987 | .991 | -.036[a] |
| 1935 & 1958 | .968 | .974 | -.055[a] |
| 1958 & 1967 | .937 | .961 | -.111[b] |
| 1967 & 1973 | .969 | .981 | -.120[b] |
| 1973 & 1977 | .994 | .985 | -.112[a] |
| 1977 & 1980 | .992 | .983 | -.llO[a] |
| 1980 & 1987 | .988 | .974 | -.113[b] |
| 1925 & 1987 | .849 | .904 | -.120[a] |

Note: Levels of significance, unless otherwise noted, are $p < .0l$.

[a] $p > .lO$.

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

and 1958, a period of twenty-three years that included a major war, point-to-point temporal association was quite high. Over the sixty-two years between 1925 and 1987, point-to-point temporal association was nearly .850, indicating a noteworthy persistence of local similarities in the regional arrangement of population throughout Yap State even between distant points in time. These results contrast with similar measures calculated for the Marshall Islands, for instance, where a substantial decrease in point-to-point temporal association occurred during the war, and minimal correspondence was evident between the earliest and most recent censuses (Gorenflo 1990).

Spatiotemporal association between consecutive years in Yap State, on the other hand, tends to be minimal and negative. Only three of the eight comparisons were even marginally significant statistically ($.05 < p < .l0$) (see Table 17).[6] The three comparisons that are significant-for 1958 and 1967, 1967 and 1973, and 1980 and 1987-indicate very slight tendencies for the populations of places in one year to be near places with dissimilar populations and far from places with similar populations. No correspondence, either positive or negative, is apparent in the other comparisons between consecutive census years, or between 1925 and 1987.

To augment the statistics that explore questions of change over time, we also calculated spatial autocorrelation values for population distributions in each census year. Spatial autocorrelation concerns the interdependence of a variable over space (Cliff and Ord 1973, 1981); it represents a means of assessing what Tobler referred to as the first law of geography, namely that "everything is related to everything else, but near things are more related than distant things" (Tobler 1970:234). Strong positive spatial autocorrelation in the present research setting would signify a situation where places with similar population sizes were proximal and places with dissimilar population sizes were distant from one another. Comparing autocorrelation values for different years provides yet another means of assessing changes in regional demography over time. In the interest of consistency, we calculated spatial autocorrelation for census years 1925 through 1987 via a quadratic assignment approach for comparing two matrices (Hubert et al. 1981). The matrices examined included matrix D, defined as above; and matrix X, containing measures of population differences between all pairs of places at a single point in time (defined in a manner equivalent to the measure used above in equation [1]):

$$x_{ij} = |p_{i,t} - p_{j,t}|, \quad \textbf{(2)}$$

where $p_{i,t}$ and $p_{j,t}$ denote populations for places *i* and *j* at time *t.*

Results of our spatial autocorrelation calculations indicate two phases of interdependence between the population of separate places (Table 18). The first phase, comprising the census years 1925 through 1958, has very low and statistically nonsignificant (p > .lO) autocorrelation. The second phase, from 1967 through 1987, has slight (-.llO to -.119), marginally significant negative autocorrelation, indicating a limited tendency for places with dissimilar populations to be proximal and places with similar populations to be distant from one another.

*Repercussions of Yap's Population Dynamics*

Regional population change in Yap State presents an interesting example of demographic evolution. Absolute numbers of people decreased throughout the region from roughly the mid-nineteenth century until after World War II. In the past forty years this trend has reversed, often increasing at rates previously undocumented for the area. Reasons for population change, at the regional level as well as in individual places, often differed between years. Despite these many potential sources of variability, the regional arrangement of population remained remarkably consistent. Although physical constraints-size and location of potential areas of habitation-could explain some of this consistency, studies of other areas demonstrate the degree to which such constraints can be overcome in modern Micronesia (e.g., Gorenflo and Levin

TABLE 18. **Spatial Autocorrelation Calculations for Yap State Regional Population: Select Census Years**

| Year | Spatial Autocorrelation | Significance |
|---|---|---|
| 1925 | .003 | > .lO |
| 1930 | -.023 | > .lO |
| 1935 | -.043 | > .lO |
| 1958 | -.065 | > .lO |
| 1967 | -.118 | .05 |
| 1973 | -.113 | .lO |
| 1977 | -.llO | .lO |
| 1980 | -.llO | .lO |
| 1987 | -.119 | .05 |

1990). We now examine briefly previous and anticipated impacts of population dynamics in the area.

Traditionally, the people in Yap State comprised a series of individual, interrelated ranked societies-variations of the chiefdoms prevalent throughout the Pacific before European contact (Sahlins 1958:249). Populations on the High Islands were larger than those on the Outer Islands. Chiefdoms on the High Islands also were larger and class was of greater importance than on the Outer Islands. In all, Yap Proper contained 150 to 200 class-stratified communities (Oliver 1989a:32). Each High Island community contained three chiefs, the individuals possessing the highest status and greatest authority (Lingenfelter 1975:99-103). Villages also were ranked, and the chiefs of the three most highly ranked villages served as paramount chiefs for the High Islands (Lingenfelter 1975: 122-126). Despite certain key dissimilarities with their High Island counterparts-including smaller populations and differences in social and political structure-the Outer Islands were similar to Yap Proper in containing ranked societies ruled ultimately by paramount chiefs (see Bates and Abbott 1958:53-57; Alkire 1965:32-38; Lessa 1966:32-38).

Kinship defined most formal patterns of social, economic, and political interaction within island units in Yap State. Interaction between units followed traditional patterns of duties and obligations established by a widespread system of ranked clans and lineages, ritualistic behavior, and mutual economic interests. Such interaction apparently occurred often between certain proximal places. For instance, Alkire writes of the fundamental interdependence of Elato and Lamotrek atolls with Satawal Island, marked by frequent visits and exchanges among these three island units (1965:135-169); and Lingenfelter describes the complex network of communication and exchange between ranked communities on the High Islands (1975:131-147). On a much larger scale, during traditional times long-range interaction also occurred between Yap Proper and islands beyond the present eastern limits of Yap State, together comprising the "Yap Empire" (see Oliver 1989b:580-584).

The Yap Empire consisted of three basic units: landlords residing in the Gilman and Gagil districts of the High Islands, to whom certain other portions of Yap State owed tribute and allegiance; Ulithi Atoll (and semiautonomous Fais Island, which dealt only with Ulithi); and "Woleai," which included the atoll of that name and all islands eastward to Namonuito and Pulap atolls (the latter two places presently part of Chuuk State) (Lessa 1950; Oliver 1989b:582).[7] Every two or

three years, a canoe fleet formed at the easternmost components of the empire and moved in a prescribed pattern westward gathering representatives from the other subject islands with their tribute. Three types of tribute were brought to the High Islands: religious tribute, canoe tribute, and tribute of the land. The first two were collected by the ultimate leader of the fleet, and passed directly to the paramount chief of Gacpar in the Gagil District; the third was passed from each Outer Island representative to the High Island lineage head who claimed ownership of a particular island's lands. Representatives from the Outer Islands in turn received gifts of food and turmeric (Alkire 1977:51). As with most transactions between the traditional components of Yap State, the pattern of exchange within the Yap Empire was prescribed according to ranking between places (Figure 8) as well as between individuals.

The role of interisland exchange during traditional times in Yap State probably was only superficially economic, serving the more important function of establishing valuable socioeconomic ties through which the Outer Islands could receive assistance in times of environmental fluctuation (Alkire 1965: 135-174). This is not to say that economic exchange would not have been desirable. Fundamental environmental differences existed, notably between the rich and generally more productive High Islands and the limited natural resources characteristic of the coralline outer islands and atolls (see Office of the Chief of Naval Operations 1944:8-20; Wiens 1962; Alkire 1965:12-22; Connell 1983:l). As a result, some locations had direct access to particular resources that others did not, generating the potential for exchange. However, distance apparently limited the frequency of trade except between proximal locations. Thus, exchange occurred fairly frequently among Elato, Lamotrek, and Satawal (Alkire 1965), possibly between certain dominant-subservient proximal Outer Atolls (see Figure 8), and even annually between Ulithi Atoll and the Gagil District on the High Islands (Oliver 1989b:581)-but only every two or three years throughout the Yap Empire. Neither sociocultural nor technical mechanisms evolved to

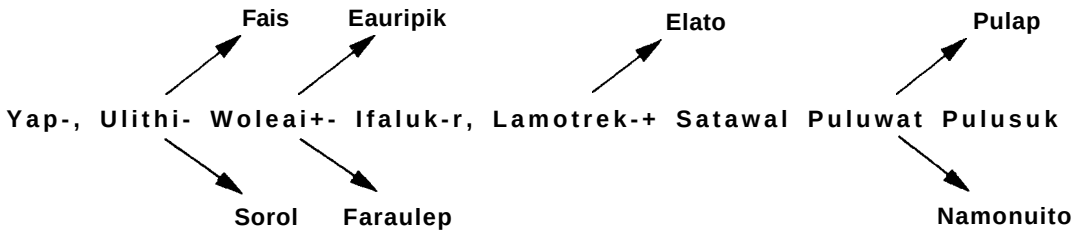



FIGURE 8. Authority within the Yap Empire (after Lessa 1966:39).

permit constant exchange, as seen in other complex societies in the form of frequent energy flow from subservient units to maintain a ruling elite. Apart from the logistical difficulty of constant trade in Yap State, from the perspective of the High Island chiefs such exchange simply was not necessary; inhabitants of Yap Proper were not dependent on resources from the Outer Islands (Lingenfelter 1975: 153-154).

The results of our statistical analysis of regional demography suggest that Yap state was poorly organized for frequent exchange during the twentieth century. Spatial autocorrelation statistics indicate that the state showed either no spatial trend in the distribution of population or a slight trend for negative autocorrelation. Other factors being equal, two types of spatial autocorrelation values would facilitate exchange between places-high positive values, suggesting that demands and potential producers similar in magnitude are in close proximity; and high negative values, possibly indicating a situation where centers are interspersed regularly with smaller population concentrations (the hinterlands to support the centers). Spatiotemporal association statistics, in turn, indicate that regional organization never evolved toward either correspondence between populations and locations or toward an interspersed pattern of large and small populations. In the past, the arrangement of people apparently had little effect on the success of individual places at the regional level. In the present setting where integration of separate components within Yap State is desirable, this regional distribution of producers and demands, coupled with limited regional integration in the past, could pose serious problems for planners and administrators.

## Concluding Remarks

The preceding study has explored regional population change in Yap State, approaching this task from two different perspectives. One was purely demographic, as we summarized regional population changes for eleven census years between 1920 and 1987, and attempted to explain the dynamics observed in terms of demographic processes. The demographic history of Yap State during the twentieth century comprises two main phases: a period of depopulation throughout the region until shortly after World War II, apparently caused by diseases that depressed fertility and increased mortality; and a period of population growth, probably well underway by the early 1950s and apparently the result of controlling disease with modern medical technology. The second perspective was regional, as we examined the changing arrange-

ment of population in Yap State through the application of selected spatial statistics. Our statistical inquiry indicated relatively little change during the twentieth century, with a strong statistical correspondence between the populations of individual places in different census years. Our regional analytic results also indicated a lack of regional homogeneity in terms of the distribution of population, both within particular census years and as the area changed-a situation that could hinder any attempts to integrate the region into a highly interactive, functioning whole.

In the face of increasing pressures from non-Micronesian cultures throughout the past 150 years, the people of Yap State stubbornly retained many of their traditional ways (Useem 1946). In addition to the persistence of sociocultural institutions and behavior, the distribution of population showed a remarkable consistency even during the dramatic changes of the past seventy years. Presently Yap State faces important new challenges, as it attempts to incorporate a rapidly growing population dispersed over a large area of the Pacific Ocean within a single political entity. In similar situations, other portions of Micronesia have experienced rapid migration to urban centers as people attempted to gain access to modern amenities (see Gorenflo and Levin 1989, 1990). Despite Yap State's adherence to patterns of the past, the realities of modern development may lead it down a similar regional evolutionary path. To avoid such developmental directions will require a two-pronged strategy: controlled population growth, so that the region does not exceed its ability to support itself; and carefully selected development in certain Outer Islands, to help minimize both migration to urban centers and the need for constant long-distance interaction with Yap Proper. Yap State plans indeed do consider limited development in the Outer Islands, focusing upon agriculture and fisheries (Office of Planning and Statistics 1985:18-19, 109-113; Yap Office of Planning and Budget 1990). It is through the adoption of carefully devised development strategies, designed in part to avoid the problems encountered by other portions of Micronesia, that Yap State can aim toward a sustainable regional system.

## NOTES

Jane Underwood kindly read an earlier version of this paper and suggested a number of improvements. Five particularly conscientious reviewers also provided helpful comments. The paper in general benefited from conversations with Leo Chiengyen, John Mangufel, Jim Maragos, Len Mason, John Sohlith, and August Van Weston, in which numerous

planning issues were discussed in the context of the demographic evolution of Yap State. Diane LaSauce helped to edit the final manuscript. We alone are responsible for any errors or shortcomings that remain.

1. In the interest of clarity and consistency, when referring to parts of Yap we follow modern conventions and use the term *Yap State* to denote the geographic area of the present state of Yap within the Federated States of Micronesia-even when discussing the region prior to 1979, before the "state" officially existed. We employ *High Islands* or *Yap Proper* for the four closely grouped high islands (also known as the Yap Islands) that traditionally contain the majority of people in the region. Finally, we use *Outer Islands* to refer to the coralline islands and atolls within Yap State but outside of the High Islands (see Figure 1).

2. Whenever possible, we use census data both as points of reference and to calculate measures of demographic trends and characteristics. The intercensal population figures over the past forty-five years vary in accuracy; we present estimates for the entire state but limit our reliance upon them, as the trends they indicate do not always appear valid. For example, the apparent population declines of 1970-1971, 1979-1980, and 1985-1987 may well be the result of mixing de jure estimates with de facto census figures. Ultimately, we treat Yap State as if its population growth has continued virtually uninterrupted since the 1950s with population growth on the High Islands beginning as early as 1946-1947 (Hunt et al. 1954:23, 28; see also Underwood 1969:9).

3. Because this study seeks to examine demographic change within a functioning sociocultural system, we focus exclusively upon Pacific Islanders for 1920, 1925, 1930, and 1935. The number of Japanese residing within the Mandated Territory varied over the three decades that Japan controlled the area. Because these fluctuating numbers of what may be considered imposed in-migrants would cloud our understanding of regional demographic evolution within Yap 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 population. General fertility rate is the number of births in a year per 1,000 women of childbearing age (here taken as ages 15-49). 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 per 1,000 members of a particular age group.

Vital statistics often play an important role in understanding population change. However, it is important to keep in mind when examining the present study that vital statistics in Micronesia often are unreliable. In particular, deaths tend to be reported late if at all, leading to underrepresentation of mortality as a process underlying demographic change.

5. We did not include demographic data from 1920 in any of our spatial statistical calculations, due to the aggregation of data for certain municipalities-as noted earlier in the text and in Table 3.

6. We conducted three tests of significance for 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, or randomized, reference distri-

bution for each pair of matrices examined (see Cliff and Ord 1981:63-65). Significance levels noted in the article invariably refer to the last test, as no cases of the first two tests were significant at $p < .10$ for spatiotemporal association.

7. Ngulu Atoll at one time was a part of the Yap Empire, owing allegiance to the chief of Guror in the Gilman District of Yap Proper. However, the empire usually is considered to consist of the "Woleai" island units and Ulithi Atoll, which ultimately owed allegiance to chiefs from two villages (Gacpar and Wonyan) in the Gagil District on Yap Proper (Lingenfelter 1975: 147).

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