Population Growth in Three Pacific Island Ecosystems: Eauripik Atoll, American Samoa, and Hawaii

Eleanor C. Nordyke and Michael J. Levin

East-West Population Institute

Honolulu, Hawaii 96848

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An island ecosystem is characterized by isolation and limited size (Fosberg 1961:5). The "island model" allows individual decisions of the members of a society to be observed in a nearly closed environment. Choices about marriage and births and about migration determine societal structures. Societies attempt to maintain stability through interdependence and conservation of natural and human resources.

Human survival on islands and atolls is much more precarious than on a larger land mass because of lack of natural resources, limited land, the uncertainties of marine exploitation, and frequent natural disasters, especially tropical storms. It is these same features, however, which contribute to many of the variables found in more complex ecological and demographic situations. Demographic stability on most islands and atolls having these limited resources must be maintained despite population pressure from increased fertility and decreased mortality, and from depletion of limited resources by an intensification of production.

In this paper we will attempt to identify demographic and environmental forces threatening population stability and ecological balance in three distinct island situations: on Eauripik atoll in the Caroline Islands, whose people continue to live at a subsistence level; in American Samoa, which is developing from subsistence to a quasi-monied economy; and in Hawaii, a monied economy dependent on outside resources for food, energy, and manufactured goods (Figure 1). The three societies also differ in their response to the phenomenon of rapid population growth.

Eauripik

Eauripik is the smallest inhabited atoll in Micronesia. On its 10 hectares live just under 150 people. Eauripik has fewer species of plants and animals and is more susceptible to tropical storms and other calamities than larger atolls and islands.

During the 1850s a typhoon devastated the atoll; survivors migrated to other islands. One man, his wife, and the wife's mother returned to Eauripik after some time. The couple's children married individuals from other islands but the grandchildren married each other. By 1900 about 80 persons inhabited the atoll. The population continued to grow slowly until 1950 (Figure 2), when it stabilized at about 150 (Levin 1976:44).

Because the population has remained stable for three decades, it must be assumed that the people either consciously or unconsciously realize there is a "limiting factor" and that no more individuals can reasonably live on the atoll. The amount of fish

available, rather than any particular vegetable product, limits the number of persons who can survive there. The Eauripik people perceive, and frequently mention in conversation, that there is enough fish for only about 150 people to reside comfortably on the atoll. They assume that when they fish, they will be able to catch a sufficient yield; the average person has about one pound of fish available daily. Thus fish is the staple food.

That the population has remained constant at 150 suggests there are mechanisms that maintain it at this level. Eauripik people traditionally practiced a postpartum intercourse taboo; couples waited until one child was old enough to bathe itself in the ocean before they attempted to have another child. But Westernization (and very likely the introduction of Roman Catholicism during the 1950s and early 1960s) caused a weakening of the taboo and a shortening of birth intervals, thus increasing rather than decreasing the birth rate. In addition, because of a more varied diet and improved health facilities in recent years, more persons have reached maturity to have children of their own.

The Eauripik population of 150 persons is maintained by emigration. As the natural population has grown owing to excess fertility, people have left the atoll. Marriage and adoption, traditional reasons for emigrating from Eauripik, have been supplemented by opportunities for education and employment. In many cases emigration is gradual, members of families leaving for a time, returning, leaving for a longer time, and finally becoming residents of another atoll or island community.

In summary, the Eauripik population has been able to maintain equilibrium with its environment through systematic migration.

American Samoa

American Samoa, a territory of the United States of America, is located in the South Pacific over 3000 kilometers southeast of Hawaii. The majority (85%) of its inhabitants are indigenous Polynesians; the rest are persons of part-Polynesian and other ancestry. The basic social unit of Samoan society is the aiga, a group of people related bilaterally by blood, marriage, and adoption. Matais, who are family leaders, head these units. Land is still owned communally, although many other traditional customs and attitudes are less prevalent because of progressive "Westernization" of the population.

The six inhabited islands of American Samoa comprise about 200 square kilometers. The islands include Tutuila, Aunu'u, the three islands of Ta'u, Ofu, and Olosega of the Manu'a group, and

Swain's Island. American Samoa and the now independent country of Western Samoa were united by language and political ties until 1900, when Western Samoa came under the administration of Germany, and later New Zealand, before becoming independent in 1966. American Samoa was administered by the United States Navy until 1951, when the U.S. Department of the Interior assumed control of the territory.

The population of American Samoa has increased more than five times since 1900 when the United States rule began (Government of American Samoa 1976; Levin 1977). The population has grown from 5,679, recorded by the United States Navy in 1900, to about 31,000 in 1979. This represents an annual growth rate of about 2.2 percent. Census records show that the population has been doubling approximately every 30 years, although the rate of growth slowed considerably between the last United States decennial census of 1970 and the special census of 1974. Until the 1940s, the population grew at an annual rate of approximately 2 percent. Improved health conditions, hygienic and sanitary habits, and the establishment of a hospital in the early 1960s helped maintain a high growth rate.

The increase in population that occurred between 1940 and 1950 can probably be attributed to natural increase and to immigration from Western Samoa by people responding to the great demand for labor during World War II. Norma McArthur (1968:144) estimates that natural increase contributed 4,700 out of the 6,000 plus net increase in population recorded for the decade. Between 1950 and 1960, however, the rate of increase was very slow. There was mass emigration, probably owing to an economic crisis following the conclusion of the war and the administrative transfer of American Samoa from the United States Department of Navy to the Department of the Interior.

Population growth increased dramatically during the 1960s, although emigration continued to be high (Park, 1972). During the 1970s the rate of increase has slackened to one percent annually almost certainly because of increased emigration for education and employment. The current population density of 160 persons per square kilometer is too dense to permit much further expansion under the prevailing socioeconomic situation.

Fertility in American Samoa is currently lower than in many other developing areas. During the 1960s the total fertility rate remained above six children in completed families, but it gradually declined. By 1974, total fertility was 5.1 children.

There are many more males than females at birth and at young ages. In older age groups, however, females outnumber males as a large number of young men leave American Samoa to study or work.

Between 1970 and 1974 the growth rate of the population under age 30 was much smaller than for older people. Lowered fertility rates and emigration by young families accounted for this reduced growth.

Mortality levels in American Samoa are very low. Life expectancy at birth is 74.2 years for females and 70.4 years for males. Long life expectancies and low infant mortality rates result from easily available and inexpensive health services.

American Samoa shows many of the characteristics of populations in emerging nations - very low mortality, decreasing fertility, migration for work and study, and increasing interest in economic advancement. With the demand for better education and health services these islanders are finding large families an economic burden; at the same time, their mobility seems to allow for flexibility. As Samoan life continues to move from the traditional aiga system into the space age, this quality may prove increasingly important in American Samoans' adaptation to scarce resources and a dense population.

Hawaii

The Hawaiian archipelago consists of a chain of eight major islands and over 100 smaller volcanic peaks of a submarine mountain range that extends almost 2600 kilometers in the north Pacific Ocean across the Tropic of Cancer. This island group is one of the most isolated water-bound regions in the world, located over 3300 kilometers from the nearest continental land mass.

Polynesians first migrated to these islands about 1500 years ago, establishing a subsistence economy with complex religious, cultural, and social practices (Fornander 1969:2-20; Buck 1933:19-30). There was comparative demographic stability until Captain James Cook's arrival in 1778. Cook and his successors introduced Western ideas and practices, brought foreign diseases that took a heavy toll on the native Hawaiian population, and irretrievably altered the Hawaiian culture (Cook 1880:830).

During the past century, the number of people in Hawaii has grown primarily in response to economic demands for labor (Taeuber 1962:100). The development of a sugar industry in the Kingdom of Hawaii in the 1850s created the demand for a large labor force that exceeded the available supply of native Hawaiians. Subsidized immigrants were imported from China, Portugal, Japan, Central and Northern Europe, and many Pacific Islands. Since the annexation of Hawaii to the United States in 1898, immigrants from Korea, Puerto Rico, Russia, the Philippines, and Samoa have added to the

racial mix. All racial groups in Hawaii are minorities; the high proportion of intermarriages has contributed to the establishment of a unique interracial society (Lind 1967:115).

Since 1900 Hawaii's resident population has grown at the high average annual rate of 2.3 percent, increasing from 154,000 inhabitants in 1900 to 897,000 residents in 1978. There are also approximately one hundred thousand tourists in the islands at any given time, raising the de facto count to almost one million persons (Hawaii 1979:1).

High birth rates contributed to rapid population increase in the early years of this century. First-generation immigrant workers who brought wives or sent for "picture brides" produced large families. The crude birth rate reached 42.0 births per 1000 residents in 1924, fell during the Depression years, rose to about 32 during the post-World War II "baby boom" of the 1950s, and has declined steadily since that time to a low level of about 16 (Nordyke 1977:74-76).

In response to improved health programs and the availability of antibiotics, the annual death rate dropped from a level of 14.9 to 5.5 per 1000 between 1912 and 1978. The young average age of the population (25 years in 1970) and the low infant mortality rate (11.6 deaths per 1000 live births in 1977) have contributed to the current low mortality level (Hawaii, DOH 1977:4). The average life expectancy in Hawaii increased by about 30 years between 1920 and 1975, becoming the highest in the United States (Gardner and Nordyke 1974:77).

In recent years, age-specific fertility rates for all ages have been dropping. Economic pressures from the high cost of living and limited availability of housing, as well as population education, have caused the 1975 civilian total fertility rate to drop to 1.8. If current fertility rates remain unchanged, the eventual result will be a negative rate of natural increase with deaths exceeding births.

Hawaii's recent rapid growth has resulted from immigration from abroad and in-migration from the mainland United States (Hood and Bell 1973; Hawaii DOH 1978:1-7). Changes in United States federal laws in 1965 liberalized immigration policies, and the state of Hawaii has attracted a disproportionate number of alien immigrants. Job opportunities and island quality of life have drawn in-migrants from other states. Net migration averaged 5,200 annually during the 1960-1970 decade, and this has increased to 6,800 in the 1970-1978 period (Hawaii DPED 1979:1).

Tourism and resort development activities - an important source of economic revenue and jobs -- have been identified as the major stimulator to net migration and population growth in Hawaii today (Hawaii DPED 1978c:123). The visitor industry expands population by increasing the number of daily tourists (up from 15,000 to 100,000 daily since 1960), drawing newcomers to the islands who may subsequently move there, and expanding service jobs that attract new residents.

A 1978 state econometric model that integrated demographic and economic variables based on supply and demand for labor clearly associated tourist-related activities with rapid population increase (Hawaii DPED 1978b:16-21, 1978d:5). It indicated that if tourism could he held constant at its current level, population would increase at a rate of 0.6 percent (comparable to the low United States annual growth rate); it also showed that per capita income would be higher than if there were further tourism growth. Conversely, if the visitor industry continues to expand, the model suggests that population will grow rapidly to 1,226,000 (plus a population of 183,000 tourists) by the end of the century, and per capita income will be lower since the average wages of this industry are comparatively low.

Economists have encouraged resort growth on the assumption that more jobs are essential for full employment (Hawaii DPED 1978e:I-27). Tourism in 1970-1978 expanded at an average annual growth rate of 12 percent and the number of jobs has increased more rapidly than the labor force (Hawaii DLIR 1979:2). If the net migration component of population growth rates is to be slowed, the rate of economic expansion in tourism and resort development will need to be reduced.

Pressures of unprecedented rapid population and economic change have created a community awareness of environmental limitations. The traditional philosophy that growth and development are inherently "good" has been replaced by concepts of maximum carrying capacity, recognizing the implications of scarce resources and environmental degradation (Ophuls 1977:46-85).

Technological advances of the last century have permitted Hawaii's population to increase far beyond its natural means of subsistence. The community has become dependent on outside sources for basic supplies of food, energy, and clothing (Schmitt 1977:355,544); and it now relies on modern communication, transportion, and external economic, political, and social cooperation.

The airplane has significantly altered life in Hawaii and facilitated the rapid population expansion. Trans-Pacific air passenger service started in October of 1936; the islands are now served by 19 national and international air carriers handling about 8 million passengers annually. Incoming overseas air cargo grew from about 12 million pounds in 1960 to 136 million pounds by 1976 (Hawaii DPED 1978a:T.312,323). The island economy has become dependent on air carriers for maintenance of the visitor industry and for export income from agricultural products of fresh flowers and fruit. Recent escalating fuel costs and an air carrier strike have accentuated Hawaii's dependence on outside resources for economic stability.

Concern about dangers of growth-induced overloads on resources has caused the state legislature to propose criteria for managing the state's future (Hawaii DBF 1977:9). Particular attention has been focused on limitations of such physical resources as water, energy, and land.

Water. Ecosystem habitation depends on the availability of water. Unlike a large land mass that can draw water from distant regions, Hawaii relies on island groundwater sources, divertable surface water, and a limited reusable supply. Although there are abundant potential sources of ocean, brackish, and reclaimed or recycled water, present demands are limited by energy supply and by the costs of developing alternate delivery systems (Hawaii Water Resources Plan 1977).

The use of municipal water doubled during the 1960-1975 period (Hawaii DPED 1978e:4:III 35-36). Lowered groundwater quality has reduced total available yield. The island basal ground water is susceptible to the intrusion of salt water as a result of excessive well pumping; recent water studies show that if present trends continue, the total estimated traditional supply sources can support an increase in demand only through the end of this century (US HUD 1979:74-75).

Energy. Hawaii is almost totally dependent on energy resources from outside the island ecosystem. Imported petroleum supplies over 95 percent of its energy (Hawaii DPED 1978e 4:II 2). Use of electricity more than tripled between 1960 and 1975, indicating rapidly expanding energy consumption by the growing economy and population.

Although there is abundant potential for alternate energy available in the natural environment, development of these resources is not far advanced. A small amount of hydroelectric power from bagasse (sugar cane residue) is used to power sugar mills and to

pump irrigation water. Wind, sea, biothermal, geothermal, solar energy, and processed sugar cane as gasohol are being investigated, but use of these energy sources is still experimental or in small scale production (Hawaii DPED and Natural Energy Institute 1975:3-6).

Land. The amount of land necessary to support life on a Pacific island is correlated to the land forms, water supply, soil, and mineral resources (Fosberg 1961:35). Quality of life is often altered under population pressure; geologic, climatic, or social and economic changes may severely reduce or destroy biotic use.

Much of Hawaii's land use is limited by physical or economic constraints. Excessively steep slopes preclude housing or agricultural development on about 37 percent of the land. Over 93 percent of the land area is owned by government and large landowners, and use by the general public is severely restricted (Hawaii DPED 1978e 4:II 1, III 38). Some lands are set aside for watershed essential to protect fresh water supplies. Climatic characteristics of excess rainfall in the mountains or floods on the plains reduce land use potential.

Hawaii's population is unevenly distributed, over 80 percent living on the island of Oahu, the business and political center of the state. In 1978 it had a population density of 508 persons per square kilometer in the city of Honolulu, with some sections as thickly inhabited as the most populous areas of the world. Recent state economic measures toward population dispersal to the neighbor islands have accentuated ecosystem imbalance and population expansion from net migration (Chow and Fuchs 1979:30-35).

Discussion

Individuals in human societies make choices about fertility and migration with reference to their surroundings and socio-economic circumstances. The three societies described here -- Eauripik, American Samoa, and Hawaii -- represent a continuum from a simple, subsistence lifestyle (Eauripik) to a Western-oriented consumer culture (Oahu in Hawaii). Other Pacific populations are arranged along the continuum according to their level, rate, and style of economic development. Some, like Western Samoa, Niue, and Tonga, have chosen a course of gradual economic growth, attempting to alleviate many of the problems associated with rapid technological advancement and social change. Others, like Guam, Tahiti, and the Northern Marianas have chosen more rapid development, prefering to adopt Western innovations and inventions with the expectation that social equilibrium can be maintained through traditional family structures.

The three places described here show declining fertility and reduced mortality rates (Table 1). In Eauripik and American Samoa, relatively high fertility rates are offset by emigration: migrants are going from Eauripik to other places in Micronesia, and American Samoans are moving to Hawaii and the United States mainland. Currently, only Hawaii is experiencing rapid population growth through net migration; but as different island groups continue to develop economically, demand for labor may stimulate immigration to fill jobs, which in turn may necessitate additional immigrants to provide goods and services for the people -- both residents and tourists -- in these islands.

This study presents a brief demographic and environmental review of three Pacific island areas restricted by their ecological settings. The Micronesian atoll Eauripik has achieved stability of its subsistence economy by establishing a maximum population of fewer than 200 inhabitants and sending its excess numbers to other islands. American Samoa, a quasi-monied society, relies on other regions in the world to absorb its emigrants, since high fertility rates within the territory strain the ecosystem balance. Hawaii, with a population almost seven times the number that resided in these islands at the start of the century, is a rapidly expanding economy dependent on precarious technological means to maintain an artificial equilibrium with its resources.

The phenomenon of rapid population increase focuses attention on environmental and natural resource limitations of island communities. Reductions of water supply, shortages of imported fuel and alternate energy sources, and constraints in agricultural production and in transportation of food supplies have sharpened the awareness that these islands are a very small segment of a large world system.

Thus, demographic and economic trends indicate the potential future of the Pacific island biological ecosystems. Statistics on the components of demographic growth may present new perceptions to persons concerned with social, economic, and cultural problems caused by population increase. Other Pacific and Asian communities may observe these ecosystems as prototypes of change. An ethic of population stabilization and a planned steady state economy that recognizes sustainable limits and fosters conservation can offer hope for protecting and preserving the environment and quality of life for future generations.

Figure 1. Eauripik, American Samoa, and Hawaii

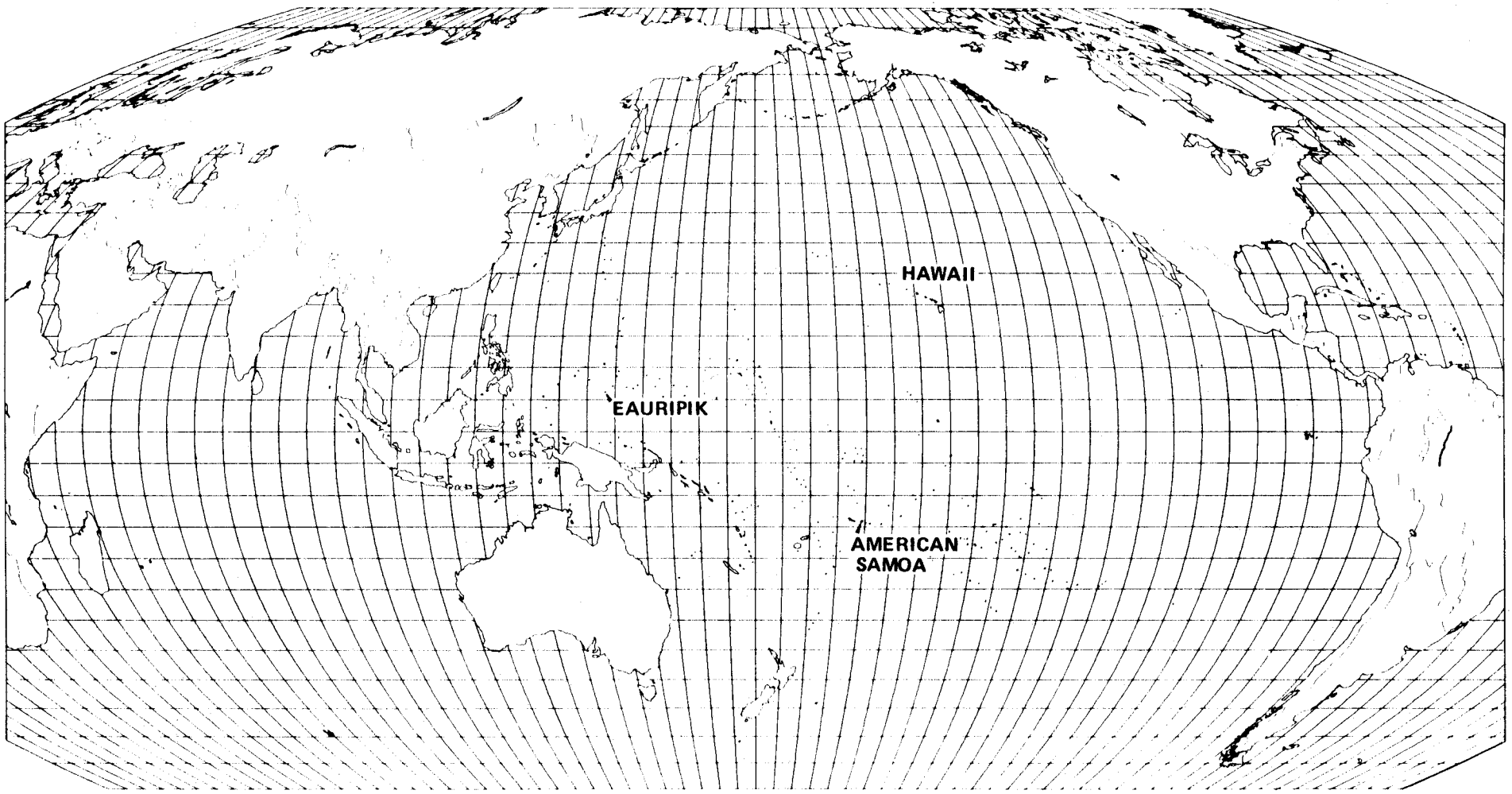
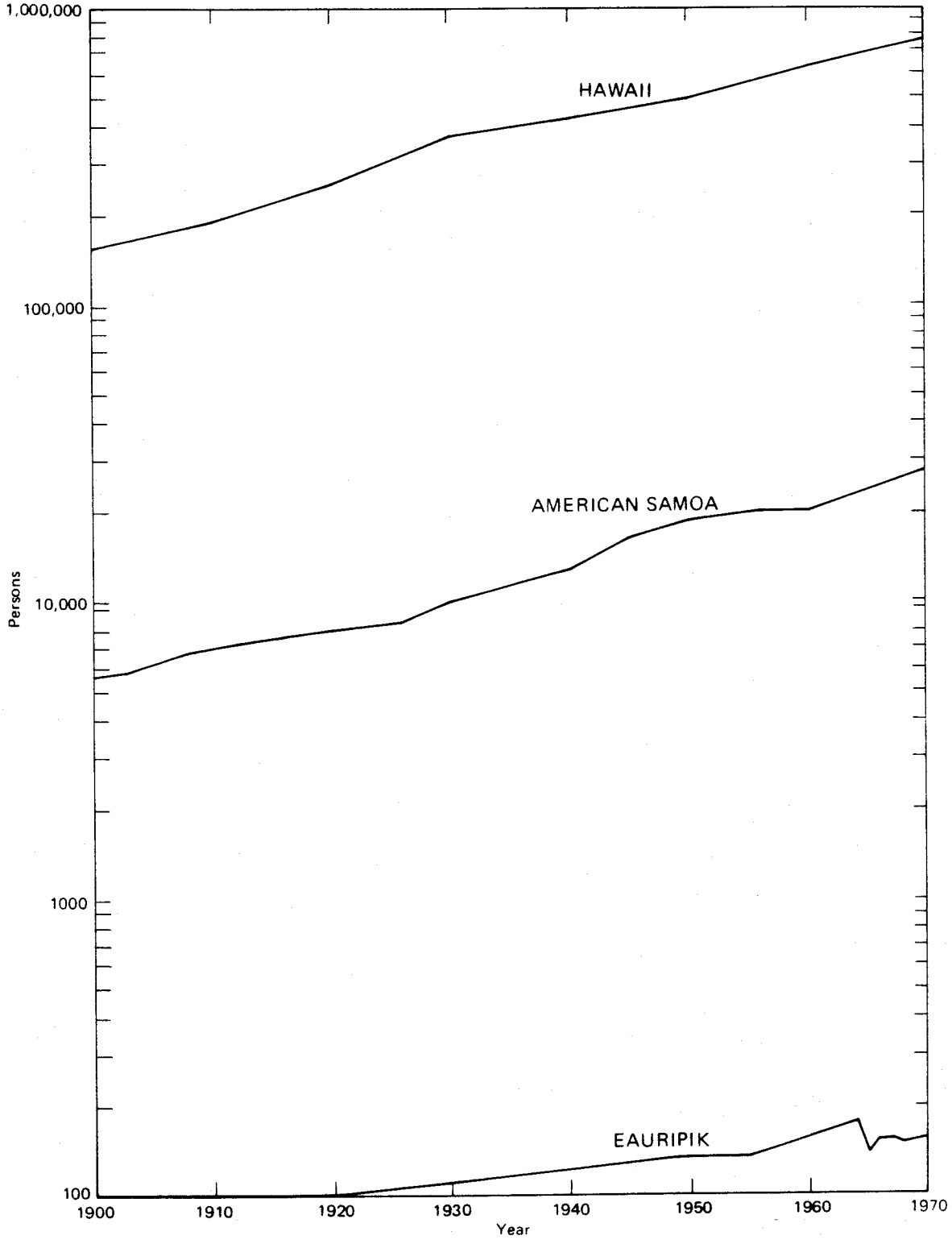


Figure 2.

Comparison of Population Change for Hawaii, American Samoa, and Eauripik: 1900–1970



Source: Levin 1976:53; Levin 1977; Nordyke 1977: T-2.

Table 1. Selected demographic variables for Eauripik, American Samoa, and Hawaii.

	Eauripik		American Samoa		Hawaii[b]		
	1950	1979	1950	1970	1950	1970	1975
Population	138	156	20,051	27,159	499,794	769,913	864,900
Birth rate (per 1,000 persons)	30	24	42.7[a]	38.4	282	21.3	18.1
General fertility rate (per 1,000 women of childbearing age)	-	-	199.0	192.0	125.0	96.1	77.9
Death rate (per 1,000 persons)	8	7	5.4[a]	5.2	5.9	5.4	4.9
Total fertility rate (per 1,000 women of childbearing age)	-	-	-	-	3316.0	2728.5	2095.0[d]
Growth rate, annual, percent	-	1.7	2.8	2.2	1.7	2.0	2.3
Population 2000 A.D.	-	150	-	52,500[c]	-	1,226,000[e]	-
Infant mortality (per 1,000 live births)	N.A.	N.A.	N.A.	17	23.7	19.1	13.8
Life expectancy: Males	N.A.	70	N.A.	70.3	67.8	71.0	74.0
Life expectancy: Females			N.A.	74.2	71.3	76.8	77.9
Median age: Males	18.5	17.0	14.6	16.1	26.2	24.7	27.3
Median age: Females	24.5	17.5	17.0		23.6	25.5	
Density per sq. km.	1332	1448	101.9	138.0	30.0	46.2	55.6

Sources: Gardner and Nordyke 1974:4-5, 70-71, 74-75; Hawaii 1978d:5; Levin 1976:56, 68, 111; Nordyke 1977:T.2,5,7,9; Park 1972:6,70,79,87; Schmitt 1977:23-24.

N.A. Not Available

[a]1960 figures.

[b]Resident population (excludes visitors) with 1950 and 1970 figures from April 1 census and 1975 figures from July 1 state estimate.

[c]Assumes declining fertility and no migration.

[d]Total fertility rate for civilian population is 1821.5 and for military population is 4130.5.

[e]Assumes a total fertility rate of 2.1, low mortality corresponding to a U.S.A. national series, and net migration based on the interaction of the supply and demand for labor according to a "most likely tourism growth" assumption that declines from a 7 percent growth level in 1977 to 1 percent growth by 2000 A.D.

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