DEMOGRAPHIC AND KINSHIP ANALYSIS OF
DEPOPULATION IN SMALL POPULATIONS

by
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ABSTRACT

During the post-contact period, between 1822 and 1867, Bishop Venaminoff recorded demographic information about the Aleuts in the Russian parish records. Albert B. Harper used these Russian Orthodox Church records to calculate post-contact life expectancies for Aleut populations.

This thesis uses a computer simulation, based on Harper's data, to test whether Aleut population losses due to European epidemics could possibly have caused changes in general demographic rates, in household composition and in kinship. The goal of this study was to investigate demographic changes at both the macro-level and the micro-level. Demographic studies that have dealt with depopulation in the New World from European contact have focused on the changes indigenous populations have experienced at the macro-level, such as changes in measures of population structures. In addition to discussing changing patterns of demographic rates at the macro-level, this thesis examines possible changes in household composition and in kinship relationships.

A computer simulation was used to test whether the hypothesis that large scale population reductions, as simulated by increasing infant mortality levels, would cause changes in general demographic rates, in household composition and in kinship. Analysis shows that major changes could have taken place at the family level, such as reductions in the chances of knowing older kin, a reduction in the number of the elderly within the society and a reduction in dependency ratios. These smaller scale demographic changes may impact on the overall success of a population and should be examined in conjunction with the larger scale population changes.

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Dedication

I would like to dedicate this thesis to Jessie Morgan, James Morgan and Gil Field for their support and understanding throughout the past two and a half years.

Chapter I

INTRODUCTION

Epidemics affect many aspects of a society. The cultural aspects of a society are often altered or lost when epidemics strike. Diseases affecting specific cohorts within a traditional population can deplete the community's specialized sources of knowledge. Much of the ritual knowledge, medical knowledge and subsistence knowledge may be lost if it is known only to a specific group of people. For example, the Huron's religious knowledge was held by their chiefs (Trigger 1985). When many elders died from epidemics, much of the Huron's religious knowledge was also lost.

The importance of the elderly in hunter-gatherer societies can be measured socially and demographically. Both the !Kung San of the Kalahari Desert in southern Africa and the Coast Salish Indians from western British Columbia value and respect the old people within their societies. The aged in !Kung society provide knowledge essential for the community's social and economic continuation. Biesele and Howell (1981:97) have identified five roles the elderly play within !Kung society:

(1) Stewards of rights to water and resources of an area,

(2) Repositories of knowledge, skills, and lore,

(3) Teachers and minders of children,

(4) Spiritual specialists and healers, and

(5) Ritually privileged figures.

Through these activities the elderly become role models for younger generations. In addition to passing down important economic and social information to the youth, !Kung kinship provides further bonds between the old and the young. A new born child must be named after a relative, but can not bear the name of his/her parents. The custom of namesakes further strengthens the bonds between the old and new generations (Biesele and Howell 1981:87).

The Coast Salish Indians also acknowledge the important contributions the elderly make to their society. The prestige and high social rank elders are accorded has remained intact during the post-contact period, although the qualities that earned them this higher status have changed. During the pre-contact period older people were valued for their economic skills. The elders possessed knowledge about the subsistence base and canoe construction which was highly valued by the Coast Salish Indians. After contact by Europeans, economic changes took place within Coast Salish communities. These changes decreased the value of the elders' economic contributions, but they maintained their higher status through their ritual and spiritual knowledge (Amoss 1981:227).

The Aleuts have achieved higher average life expectancies than other populations within similar northern regions (Laughlin and Wolf 1979:10). Harper (1979) attributes these higher rates to the Aleuts' ecological-cultural adaptations. He also asserts that the successful continuation of the Aleut population can be attributed to the economic functions their elderly perform within the society.

Epidemics would severely affect the proportion of the elderly within the population. Much of the knowledge retained by the elderly would be lost, their economic contributions would be reduced and kinship patterns would be altered.

Other demographic changes also occur as a result of epidemics. Family structures may be affected by changes in mortality rates resulting from epidemic diseases. Reductions in various types of kin alter the social and economic roles of family members. Changes in the roles assumed by members at the family level can have implications for the whole population.

In the past, anthropologists have analyzed demographic changes through the use of historical (Mooney 1910, 1928; Kroeber 1939; Rosenblat 1954) and archaeological data (Ramenofsky 1982). Historical and archaeological information has been used to support a wide range of population estimates. Disagreements about initial Native American population figures and the number of natives dying as a result of European contact make it difficult to determine the demographic effects of epidemics. Most of the population estimates obtained through archaeological research were based on ethnographic analogies. Thus, these studies produce static models that make it difficult to analyze changes that occurred at the micro level.

Computer simulation models provide an alternative to the historical, ethnographic and archaeological methods of analyzing demographic changes. Several studies have discussed the population changes that occur at the macro level during times of sudden depopulation (Kroeber 1934, 1939; Cook 1937; Borah 1964; Dobyns 1966; Ubelaker 1988). However, few researchers have looked at the changes in household composition during times of sudden depopulation. This thesis examines the utility of computer simulation in analyzing demographic changes that take place at the household level by modelling changes that occur in family structures during times of population stress. It also examines some possible mechanisms societies may use to cope with rapid population change.

This study developed out of Harper's (1979) work on Aleut life expectancies and bio-behaviourial adaptive strategies. The primary aim of Harper's study was to assess the relative success of various populations' adaptive strategies through the application of demographic variables. Harper's results led him to speculate about the roles of various family members in the Aleuts' adaptive success. Harper measured the adaptive success of the Aleuts and the Arctic Eskimos by using a life expectancy model. Life tables allowed Harper to compare the degree of adaptive success between these populations as measured by average life expectancy at birth. According to Harper's data, the Aleuts had higher longevity rates than the Eskimo populations who occupied a similar environment.

This thesis integrates Harper's data with a computer simulation model to examine the impact of childhood epidemics on an hypothetical Aleut population. The demographic and kinship information derived from two computer simulations are quantified and compared at three levels. Selected demographic parameters, such as the population size, total fertility rate, crude birth rate and crude death rate, are summarized and compared.

Changes in these general demographic rates show how increases in childhood mortality levels affect the whole population. The analysis then becomes more specific and comparisons are made at the household level. The comparison of households by size illustrates changes in living arrangements when mortality levels are altered. Lastly, and at its most specific level, this study examines changes that take place within kinship structures when epidemics strike a population. The simulation data are used to examine the extent to which kinship structures are affected by increases in mortality. The second chapter of this thesis begins by outlining some of the approaches anthropologists and historians use to estimate the original size of aboriginal populations. Historical and archaeological data are the most commonly used methods currently used to assess the degree of depopulation that occurred during the European conquests and discoveries of the New World. The chapter considers the degree to which archaeological information can be used to support Native American population estimates. The diachronic nature of archaeological data may allow for more accurate assessments of population stability from pre-contact to post-contact periods. It also discusses the role Old World pathogens play in native depopulation. It concludes that anthropologists' assumptions about the impact of disease on pre-contact population structures influence their reconstructions of native populations.

Chapter III provides background ethnographic information on Aleut populations during the pre-contact, Russian occupation and American contact periods. This chapter discusses Aleut population estimates obtained from paleodemographic studies and historical reports. Also, aboriginal family structures and household sizes and compositions as cited in the 19th and 20th century historical documents are discussed.

Chapter IV discusses the uses of computer simulation models in anthropology. Computer simulations offer an alternative method to the study of the effects rapid depopulation has on populations. This method allows researchers to examine the changes in family composition that occur as a result of depopulation. The focus of this section is on AMBUSH, the stochastic simulation program used in this study (Howell 1979; Howell and Lehotay 1977, 1978). The chapter also outlines the theory behind stable population models. AMBUSH uses stable population theory in combination with stochastic fluctuations to determine the range of variation within Aleut demographic parameters.

Chapter V describes the simulation framework for analyzing family structural changes. This chapter includes a discussion of the input parameters used in the two computer simulations. Also described are the sources of input parameters used in this model and the statistics used to summarize the information from the computer trials.

Chapter VI compares the patterns of demographic change among the two computer simulations. This chapter summarizes demographic changes occurring during the simulation period. It also highlights the differences in household composition, kinship structures and general demographic rates between the first and second simulation. These differences are then analyzed to determine if they are statistically significant at the .05 probability level. Significant differences illustrate specific effects of increased mortality levels on the population.

Chapter VII summarizes the study's results and discusses some of the implications raising the mortality level had on the simulated population. This chapter also suggests the types of response populations may make to structural changes occurring within and between family groups. Specifically, this final chapter discusses the ways in which populations adapt to these dramatic demographic changes.

Chapter II

EPIDEMICS AND NATIVE POPULATIONS: AN OVERVIEW

Why were the Europeans able to conquer America so easily? Anthropologists and historians have tried to explain the quick defeat of the Amerindians by the European armies (Kroeber 1934, 1939; Steward 1949; Dobyns 1966, 1983; Cook 1976; Borah 1976). Advanced technology and better modes of transportation undoubtedly increased the European's chances for success. However, the European's military superiority was not the only factor in the defeat of the Amerindians. The rapid spread of Old World diseases also played a role in the European conquest.

The introduction of European diseases caused the decimation of many Indian populations. These diseases enabled Cortez, with fewer than 600 men, to conquer the Aztecs. A smallpox epidemic in Tenochtitlan was instrumental in the destruction of the Aztec empire by the Spanish conquistadors (McNeill 1976:1). Diseases introduced by the Europeans caused epidemics throughout the Americas.

Several researchers (Mooney 1910; Kroeber 1934, 1939; Cook 1937; Cook and Simpson 1948; Steward 1949; Cook and Borah 1963; Borah 1964; Helm 1965, 1980; Dobyns 1966; Ubelaker 1988) have debated the original sizes of indigenous American populations before and at the time of European contact. Researchers now believe that indigenous populations in the Americas, during the prehistoric and proto-historic periods, were larger than indicated by the earlier anthropological population estimates (Borah 1964; Dobyns 1966, 1983; Crosby 1986).

Earlier population estimates influenced anthropologists' reconstructions of pre-historic native societies. These smaller population figures helped to perpetuate the images of Native Indians created by colonial government officials. By portraying the New World as a sparsely populated area inhabited by savages, colonists successfully defused much of the criticism from abroad.

The issue of whether or not there were massive epidemics during the proto-historical period also has methodological implications. For example, if large numbers of people did not die from European diseases, post-contact demographic continuity can be assumed. This assumption allows anthropologists to draw conclusions about pre-contact populations from more recent demographic data. However, if European diseases reduced native populations, modern figures cannot be used to estimate North American population sizes for the pre-contact period.

Kroeber (1934, 1939), Steward (1949) and Helm (1965, 1980) do not believe that disease played a major role in the early post-contact period. Although these researchers do acknowledge a decline in aboriginal populations after European settlement. Ethnohistorians, such as Dobyns (1966, 1983) and Krech (1978, 1983), attributed the depopulation of American Indian settlements to infectious diseases. They believe that the decrease in populations began before the historical period. The historical demographers Cook (1976) and Borah (1976) agree that pre-historic epidemics caused a large decrease in native populations. If this assumption is correct, our earliest population records understate total indigenous populations for the proto-historical period (Ramenofsky 1987).

2.1 Discrepancies in Native Population Estimates

Discrepancies in population figures for the early American colonial period forced several researchers to reassess the source data used in earlier demographic studies. Anthropologists' estimates of Native American populations at the time of European contact vary. Kroeber (1939) estimates a total hemispheric population of 8.4 million at the time of contact and Dobyns' (1966) figures range from 90-112.6 million. As Ubelaker (1976:661) notes, "These estimates imply population densities which vary from relatively sparse occupation of two persons for every 10 square kilometres to a relatively dense population of 21 persons for every 10 square kilometres". The range of the population estimates is so great that an average figure based on a compilation of the available numbers would be meaningless.

Mooney's 1910 article "Population", was one of the first systematic demographic studies conducted on aboriginal populations. In his article, Mooney estimated there were 1,150,000 Indians in North America at the time of European contact.

In 1928, Mooney increased his total population estimate of pre-Columbian, North American Indians to 1,153,000. Mooney's estimates illustrate some of the problems associated with many of the early population figures. According to Spinden's (1929) archaeological evidence, there were several million Native Americans in the eastern agricultural area alone. Spinden estimated the Western Hemispheric figure as ranging from 50 to 75 million people. Spinden (1929) based his estimates on the number of burial mounds in the Ohio Valley region.

Since Mooney's population tables lack specific citations, it is difficult to draw conclusions about his methodology. Jennings (1975) notes that Mooney's estimate of 25,000 original Indian inhabitants in New England is about half of Palfrey's (1858-1890) figure for native New Englanders. Jennings therefore concludes that Mooney relied on European historical sources as the basis for his population estimates. He randomly altered the figures according to his evaluation of the particular historian's credentials.

Later, Kroeber (1939) used Mooney's estimates for his work entitled Cultural and Natural Areas of Native North America. As Ubelaker (1976) notes, "The Mooney-Kroeber conservative interpretation of prehistoric population numbers strongly influenced anthropologists' estimates for the following twenty years (Rosenblat, '45; Steward, '45, '49; Wilcox, '31)". These early figures were first critically analyzed in the mid-1960's. In 1966, Dobyns criticised Kroeber's omission of diseases. Dobyns particularly thought Kroeber should have included epidemics as a major variable in his population reconstructions.

Both Borah (1964) and Dobyns (1966) challenged other estimates of early Indian population sizes. Borah and Dobyns based their own population reconstructions on a wide variety of historical sources. They used missionary records, tribute lists, baptismal records and censuses. Dobyns also employed statistical techniques developed by Cook (1937), Cook and Simpson (1948), and Cook and Borah (1963) for estimating the depopulation experienced by Californian and Meso-American natives.

Dobyns (1966) determined the demographic nadir (the lowest population of Indians) in specific regions of North and South America during the historical period. Dobyns derived these figures from census data. He then calculated a measure of population loss from all factors for the region. Dobyns expressed these figures as ratios for successive temporal periods. Dobyns calculated average depopulation rates from these series of ratios. The average rates allow for the calculation of high and low population estimates by multiplying the nadir figure with the derived measure of depopulation. For example, based on depopulation ratios of 20 to 1 and 25 to 1, the population low for pre-Columbian North

America is 9,800,000 and the population high is 12,250,000. Using this technique, Western Hemispheric totals of 100,000,000 (Borah 1963) and 90,043,000 (Dobyns 1966) have been estimated.

Denevan (1976) estimated that in 1492, the total hemispheric population consisted of 57,300,000 people. There were 4,400,000 people in North America, 21,400,000 in Mexico, 5,560,000 in Central America, 5,850,000 in the Caribbean islands, 11,500,000 in the Andes, and 8,500,000 in the lowland areas of South America. Although Denevan's estimates are more conservative than Borah's or Dobyns' figures, they still reflect a significant increase from the earlier totals of Mooney and Kroeber.

What caused these discrepancies between early and more recent population estimates? Part of the explanation lies in anthropology's changing theoretical perspectives during the last 80 years. Kroeber's and Steward's grounding in anthropology began with the American Historical School. Their main goal was to reconstruct the native populations as they existed on the eve of European contact. Kroeber (1925) recognized that contact with the Europeans had an enormous impact on the Indians, but he felt that a description of these changes was less important than gathering ethnographic information from the surviving natives before their culture completely died out.

During the 1930's anthropologists in the U.S. and England became increasingly interested in acculturation and the effects of contact between two cultures. However, increased interest in the effects of colonization on aboriginal populations did not alter the fact that demographic studies of Amerindian populations were still based on written European sources.

Cyclical "fashions" in academic interests are partially responsible for variations in population estimates. Several shifts from liberal to conservative population estimates occurred over a 60 year period (Ubelaker 1976). These shifts varied from conservative in 1910 to liberal in the 1920's, conservative in the 30's and 40's and back to liberal in the 1960's.

On the other hand, the variance may reflect a conservative trend from 1910 until the late 1940's, with a more liberal perspective developing in the 60's. The two "liberal" figures from the 1920's were proposed by Sapper (1924) and Spinden (1929). Sapper's estimate of the North American population at the time of European contact was 2.0-3.5 million. He also suggested that the

Western Hemisphere's population was 40-50 million. Spinden based his estimate of 50-75 million people for the Western Hemisphere on an ecological analysis. These figures represent the maximum population that the land could support at the time. Although Sapper's and Spinden's population figures could represent a liberal trend in population reconstructions, they most likely represent isolated deviations from consistently conservative estimates of aboriginal population sizes.

Another example of an aberration from popular trends in population estimates is the work of the Latin American specialist Rosenblat (1954). Rosenblat defended earlier population statistics well into the 1960's. "He has accused Sherburne Cook and Woodrow Borah of discarding the testimony of respectable witnesses ("el testimo de respectables testigos") in their computations to arrive at high estimates of pre-conquest populations in central Mexico, in Hispaniola, and the whole Western Hemisphere" (Jacobs 1972:124). Rosenblat supports the earlier population figures of Mooney and Kroeber. Jacobs (1972) finds Rosenblat's criticism of Cook and Borah's findings unconvincing. According to Jacobs, Rosenblat does not address the demographic methodology or the financial records underlying the estimates provided by Cook and Borah.

Current revisionist writers (Dobyns 1966; Jacobs 1972; Jennings 1963, 1975; McNeill 1976) have questioned the authenticity and the motives of several of the authors of earlier historically-based population studies. These writers recommend that their colleagues undertake more critical analysis of source documents in future population reconstructions. They also encourage changes in methodology. One avenue being explored is population estimates based entirely on archaeological data. Some researchers are also using ethnographic information for their reconstructions of early native populations. Finally, many anthropologists are turning to the use of statistical methods, such as those employed by Dobyns (1966).

2.2 New World Epidemics

Differences in technology and social structures undoubtedly contributed to the success of European's domination of the indigenous North American populations. However, epidemic diseases also played a crucial role in the European conquest. Most of the recent research in this area reveals the devastating role of disease in America's prehistoric and contact periods.

There have been many studies describing the devastation that results from the introduction of new diseases to previously unexposed populations (Crosby 1972; Dobyns 1963b; Jacobs 1972; Jennings 1975; Krech 1978, 1983; McNeill 1976; Meister 1976; Ramenofsky 1982, 1987; Stearn and Stearn 1945; Trigger 1985; Ubelaker 1976). For example, Cook and Borah (1972) estimate a population loss of up to eight million people in Hispaniola (Haiti and the Dominican Republic) during the pre-Columbian period. Cook and Borah attribute the dramatic depopulation that occurred in this region to several factors. Disease and exploitation by the Spaniards are cited as the major causes of aboriginal depopulation. However, smallpox appears to have affected millions of Indians in the Caribbean. Smallpox also had a devastating effect on the indigenous populations of Meso-America and North America (Dobyns 1966).

Disease weakened the native peoples' capacity to oppose early European expansion (Trigger 1986). Diseases that were relatively benign in Old World populations became lethal when introduced to previously unexposed groups. European childhood diseases such as measles, rubella, mumps, smallpox and chickenpox can be fatal to both adults and children when introduced to an unprotected population. If endemic, smallpox produces a low but steady death rate. It can cause death rates of up to 30% when introduced to previously isolated groups. When smallpox was first introduced in Icelandic populations in 1707, 18,000 of 50,000 inhabitants died within two years (Stearn and Stearn 1945:14).

Epidemics of European origin appear to have spread throughout North America between 1520 and 1918 (Dobyns 1983:8). However, it is often difficult to identify the specific diseases present in each area at the time of initial contact. It is also difficult to determine the number of people killed by these epidemics, or even their duration. Many of the records available for this period lack detailed descriptions of the specific diseases. The limitations of seventeenth century medical knowledge also make it more difficult to determine the causes of death for Native American populations. It was not until the 1500's that measles and smallpox were identified as separate diseases (McNeill 1976:105).

The Coast Salish also experienced socio-cultural changes after European contact in the late 1800's. After the establishment of white economic and political structures, the Coast Salish elders lost their economic and social status within the society. The Coast Salish abandoned their traditional religious beliefs in favour of the newly introduced religion of the Shaker Church. The once prominent religious roles held by the old people in the traditional culture rapidly decreased in importance with the shift in religious beliefs. The abandonment of the old religious ideas resulted in the abandonment of other traditional items such as baskets, tools and their old language. The elderly, who were the repositories of the old knowledge, were also ultimately rejected (Amoss and Harrell 1981).

2.3 Amerindian Depopulation and Epidemics

Recognition of the Amerindians' demographic collapse and its causes will have a profound effect on anthropologists' interpretations of native social structures. It will also affect our reconstructions of Native American and colonial history. Changes in population size and demographic composition play a key role in determining cultural changes within and between specific settlements.

> There is no problem more important for understanding the history and social organization of native American peoples than determining the magnitude of the demographic collapse following

> the European rediscovery of the New World in the fifteenth century (Trigger 1985:354).

Depopulation, specifically due to epidemics, can radically affect a culture. Sudden changes in population size can cause spiritual and psychological disruptions within a society (Trigger 1985).

Economic and political changes also occur as a result of sudden depopulation. The Huron experienced several economic and political changes following the introduction of European diseases (Trigger 1985). Epidemics forced the Huron to move sooner than normal to escape their half-empty settlements. The epidemics also affected Huron population structures unequally. Childhood and elderly mortality levels show the greatest increase during epidemics. For the Huron, the cohort-specific mortality change resulted in the demise of large numbers of their chiefs. Culturally, this meant the loss of much of the group's religious knowledge. A decline in future military strength also occurred due to higher infant and child mortality rates (Trigger 1985).

Although epidemics cause many societal changes, much of a society's culture remains intact. For example, the resilience of Huron religious beliefs (Trigger 1985). Many Huron religious beliefs survived despite the severity of the epidemics. As the epidemics ran their course, people's confidence in traditional curing rituals was restored.

> The failure of particular rituals to cure the sick did not discredit the Huron religion. Instead, it spurred shamans to communicate more intensively with the spirit world in an effort to discover rituals that would be effective. While many of these were in turn discredited, each epidemic did eventually subside, thereby giving credit to the rituals that were performed at that time and reinforcing the traditional beliefs on which they were based (Trigger 1985:248-9).

Thus while changes did occur in specific spiritual ceremonies, the larger religious structures remained intact.

Sudden increases in mortality rates also produce changes in the numbers and types of kin at the family level. These kinship changes can have social and economic implications for the entire population. Several studies (Burch 1967; Wachter et al. 1978) have examined the relationship between increases or decreases in population size and household structures. Goldman (1986) studied the effects of increases in life expectancies and decreases in total fertility on kinship composition in the Republic of Korea. Goldman's results show that reductions in fertility cause decreases in the number of daughters, sisters, nieces, aunts and cousins. Similar changes in the kinship structure of a population also occur as a result of sudden depopulation if large numbers of fecund women in the society are affected.

Goldman also lists possible scenarios that may occur if a population's mortality rate is suddenly increased:

> Will the reduction in the number of sisters, aunts and cousins strengthen emotional and financial ties between parent and child, or between grandparent and child, and thereby strengthen parental influence over children? Or will non-relatives assume some of the social and economic responsibilities formerly assumed by family members? (1986:87).

These questions remain largely unanswered since few studies have been conducted on the changes occurring at the family level as a result of sudden depopulation.

Lastly, cautions about the potential for the misuse of epidemic explanations should be noted. Trigger (1985:117) worries that the pendulum is swinging the other way and that epidemic causes will be uncritically attributed to any population or cultural shift observed in archaeological or historical records.

The North American contact period still sparks debate in anthropological and archaeological circles. Although anthropologists now accept the higher Indian population estimates, the full effects of the epidemics which the

Europeans brought to North America are still a subject of considerable debate. The extent of the aboriginal depopulation is still uncertain.

Methodological issues involved in population reconstructions have not yet been resolved. Population studies based on historical records leave many questions unanswered. These sources contain biases which could affect aboriginal population size and structure estimates. Archaeological studies could help to shed some light on the Native American pre-contact and pre-historic periods.

Archaeological evidence would be especially useful in determining the effect of epidemics before the early historical period. More recent studies based solely on archaeological data, such as Ramenofsky's 1982 doctoral dissertation, have provided such evidence. Evidence which points to the introduction of European diseases before historical documentation may cause researchers to reevaluate much of the early historical data.

In the past, anthropologists and historians used early historical records to calculate aboriginal population sizes from the period before European contact through to historical times. Other methods, such as regional archaeological studies based on archaeological evidence alone, should be used to reevaluate earlier native population estimates compiled for the for the pre-contact, proto-historic and historic periods.

Population estimates based on ethnohistorical and ethnoarchaeological data can also be used for evaluating the accuracy of pre-historic and proto-historic native population figures. The use of other sources of information may permit more accurate and less biased estimates of Native American populations. In turn, these revised population estimates will allow anthropologists to describe in more detail the demographic and cultural changes that occurred among the early native populations as a result of contact with Europeans.

2.4 Historical Data

Early estimates of Native American populations prior to contact tended to understate the size of indigenous populations (Borah 1964; Dobyns 1966, 1983). Many population estimates were based on missionary or government documents. It was often in the authors' interests to underreport Indian populations. Propaganda to justify European policy was often intentionally placed in colonists' accounts (Jenning 1975). It was important to preserve the myth that colonization served to save the "heathen savages" from themselves in the name of God.

In addition, the New World was portrayed as virgin land. The basic conquest myth suggested that the New World was a wilderness inhabited by savages incapable of producing a civilized culture (Jennings 1975:15). Many people rationalized the decimation of indigenous populations as a punishment from God. As a result of the Indians' resistance to God and the Europeans, the Native Americans deserved to perish. This propaganda was so pervasive that it was eventually used to justify the European's claims to Indian territory (Jennings 1975).

Historical documents often contain only partial population estimates of aboriginal communities. Many of the records and journals from missionaries, traders and government officials provide only estimates of total adult populations within specific regions. Internal proof of historical data obtained from these types of sources is usually impossible (Meister 1976).

Researchers' uncritical acceptance of colonial conditioned reporting has been criticised by revisionists (Jennings 1975). McNeill (1976) also points out that many historical records neglect the impact of diseases on native populations. He reminds researchers of the psychological implications of epidemics.

In addition, the problem of interpreting the results of contact between Europeans and indigenous people can be partly attributed to the types of populations involved. While Native Indian populations were traditionally studied by anthropologists, European populations fell mainly within the realm of historians and historical and classical archaeologists. According to Simmons (1988:2), "Efforts to understand the encounter between Europeans and indigenous people are affected by the distances between these research traditions and by the communication between them".

Social scientists' interpretations of native societies are also affected by the researchers' beliefs about the size of pre-contact and post-contact aboriginal populations (Dobyns 1966). Some social scientists have used smaller indigenous populations to substantiate the view that Native Indian cultures were less developed than European cultures (Naroll 1956; Ember 1963). The degree of sophistication and civilization of a society was often equated with population figures.

Jennings reversed Dobyns' supposition to describe another form of scholarly bias. "The idea that scholars hold of New World cultures directly affects their interpretation of the size of aboriginal populations" (Jennings 1975:16). If the researcher believes that

Indian societies were not capable of supporting large numbers of people due to their cultural inferiority, then population estimates must remain conservative to support this supposition.

2.5 Archaeological Data

By comparing population estimates based on ethnographic and historical data with estimates based on archaeological data, biases inherent in historical records can be identified. Unfortunately, little archaeological work has been done on the American prehistoric and post-contact periods. The demographic studies conducted by archaeologists on the precontact periods use ethnographic analogies to derive their population estimates. These techniques result in population estimates at the ratio level, but they are based on the same assumptions inherent in the ethnographic data. They assume that population structures and totals remained constant from prehistoric periods through historic times.

Therefore, the emphasis on ethnographic analogy for formulating Native American population estimates prevents archaeologists from entering the debate about the accuracy of the historic documentation. Such reliance on historical sources may obscure evidence of population changes which might otherwise be found in the archaeological record (Ramenofsky 1982). The problems associated with the use of ethnographic information in archaeological investigations have been discussed by several anthropologists and archaeologists (Binford 1972; Cordell and Plog 1979; Gould 1980 and Trigger 1981).

In addition, population estimates based on archaeological information require detailed regional surveys and specific site analysis of settlement patterns. Distinctions must be made between permanent sites that were inhabited throughout the year and seasonal sites used for specific subsistence or technological purposes (Williamson 1983). This type of careful survey is required for accurate population estimates. Mortality rates can also be derived from skeletal material although restrictions due to unfavourable preservation exist in many areas. Preservation problems associated with osteological evidence are reduced if mummy caves or ossuaries were used by the inhabitants of the region.

Ramenofsky (1982) has tried to address some of the problems associated with archaeological population reconstruction. In her doctoral dissertation, Ramenofsky examines the collapse of the Native Indian population in North America and the affects of infectious diseases on native populations. Ramenofsky's sources exclude the ethnographic record. She examined regional settlement patterns using three test cases: Central New York, The Lower Mississippi Valley, and The Middle Missouri region. Ramenofsky's concern is that the over representation of historical settlement records for these areas would result in misleadingly high native population estimates for the contact and post-contact periods. Since more historical sites have been studied a bias could result in favour of a native population increase at contact.

Ramenofsky's method of analyzing the epidemic component of her study involved examination of any evidence of rapid population declines. She believed that changes in population structures over a period of a few generations show that a severe disease had infected many of the people in the society.

After analyzing the archaeological records from the three test cases, Ramenofsky concluded that regional populations suffered severe depopulation before and continuing throughout initial census reporting. Populations experienced many structural changes during this period. Relocation, immigration and the merging of previously separate groups continued throughout this transitory period. Infectious diseases also played a large role in the decimation of the aboriginal populations (Ramenofsky 1982).

Population studies based entirely on the archaeological record can provide data which can be compared to historically derived population figures. Such comparative analysis should help to clarify the current discrepancies that exist in native population estimates for the pre-contact and proto-contact periods in North America.

In addition to sheer population numbers, it is important to consider the effects of depopulation on actual kinship within the population. Many studies (Burch 1967; Wachter et al. 1978; Goldman 1986) have examined the relationship between household structures and increases or decreases in population size. Likewise, this thesis examines the effects of depopulation on kinship structures.

This study uses a computer simulation to analyze the impact depopulation has on kinship structures. Simulations do not recreate populations. Simulations allow researchers to model a population's characteristics in order to approximate reality. In this study, computer simulations are used to compensate for the small data base available for the Aleut region. Incomplete records of vital statistics prior to and after European contact does not allow for accurate assessment of the effects depopulation had on Aleut family structures using standard demographic techniques. Previous studies (Roth 1981; Hammel 1980; Howell 1982) have shown that computer simulations can be successfully used to overcome problems such as small data bases and incomplete reporting of vital statistics.

The computer program used in this thesis is called AMBUSH. It is a simulation model developed by Howell and Lehotay in 1977. AMBUSH simulates an experimental history based on ethnographic and historical data. AMBUSH is a computer model which provides demographic and kinship information for small human populations. The kinship information provided by AMBUSH will help assess the changes that occur within a population when mortality rates have been increased. Increases in infant mortality reflect the demographic changes that occurred in Aleut populations during the post-contact period.

Chapter III

ALEUTS

3.1 Prehistory and History

The Aleuts inhabit the Aleutian and Pribilof Islands in Alaska and the Commander Islands in the Soviet Union. The Pribilof and Commander Islands were uninhabited when discovered but the Aleuts were later relocated to these Islands by the Russians.

The Aleuts have a Mongoloid and Asiatic ancestry. Specialists in Arctic prehistory believe that the Aleut's ancestors can be traced back to the "Eskimo maritime adaptation" (Laughlin 1980). Some researchers (Dumond 1977, McGhee 1978) believe that the Aleuts may have become a distinct group about 5,000 years ago in northern Alaska.

Both Harper (1979) and Laughlin (1980) divide the pre-contact populations into two subgroups: the earlier Paleo-Aleuts and the later Neo-Aleuts. Harper places the Paleo-Aleuts back as far as 4,000 B.P. Harper and Laughlin propose that the Paleo-Aleuts evolved into the Neo-Aleut populations shortly before the Russian contact period. This evolution took place in the eastern

Aleutian Islands and the Neo-Aleut populations then migrated west along the Aleutian archipelago around the time of European contact.

3.1.1 Russian Occupation: 1741 to 1867

The Aleuts have a long history of contact with Europeans. The first contact with outside cultures occurred in the form of Russian missionaries, traders and government officials in the eighteenth century (Veniaminov 1984:249).

From 1741 until the latter part of the nineteenth century, the Aleuts were in constant contact with Russian representatives. Vitus Bering was the first to record the location of the Aleutian Islands (Collins, Jr., Clark and Walker 1945:7-11). After Bering's initial sighting of the Aleutians in 1741, several hunters specializing in the fur trade made voyages from Siberia to the Aleutian Island chain.

Emel'ian Basov, a resident of the Kamchatka Peninsula, was the first fur trader to recognize the resource potential of the Islands. In 1745, Basov conducted the first fur hunting voyages of the Aleutian Archipelago (Collins, Jr., Clark and Walker 1945:12; Jochelson 1966:2).

The Russian treatment of the Aleuts during the initial free trade period was harsh. From 1745 to 1799 the Russian hunters decimated the Aleuts' marine resources. The Russians also dominated the native populations through brutal killings, forced labour and theft of property and possessions (Collins, Jr., Clark and Walker 1945:12). Russian contact also introduced diseases to the area which devastated the Aleut populations.

During this period, the Russian presence caused severe depopulation within Aleut communities. Some estimates cite reductions in Aleut populations of approximately 10,000 people. According to Hrdlicka (1945:32-33), the population fell from about 12,000 to 1,900 Aleuts.

The Russian government, in anticipation of British and American opposition, granted a charter on trade in the area to an independent company. In addition to the trade monopoly, the government empowered the Russian-American Company to act as the local government for the Aleutian region. Setting up a private Russian-owned business monopoly in North America was a shrewd political move on the part of the Russian government (Black 1980).

Unfortunately, the Aleuts continued to suffer from their contact with an outside culture. During this period of regulated trade the Russians halted some of the severe exploitative actions perpetrated against the Aleuts. Although changes, initiated by the Russians, continued to take place, most changes in the Aleut's precontact state were cultural in nature. For example, to diffuse the power of a centralized authority figure, company managers developed a hierarchic political system for the Aleuts. The Russians changed the native aboriginal political system from a one-chief to a three-chief system. This change was designed to weaken aboriginal leadership by dividing the powers associated with village leaders among several people. The Russians weakened the influence of traditional leaders in order to make it easier for the Russians to maintain control over Aleut villages (Black 1980).

By the mid-1800's, Russia had become overextended and they were finding it increasingly difficult to defend the Russian empire. At this time, America was expanding its boundaries and Russia decided to sell Russia America to the United States for diplomatic reasons (Black 1980).

3.1.2 American Period: 1867 to present

In 1867, America purchased Alaska from Russia. The Aleut population continued to diminish during the early American period and the increased exposure to Europeans after the United States' purchase increased the incidence of epidemics. Although tuberculosis was the primary cause of depopulation at this time (Black 1980), other epidemics also took their toll on the indigenous populations. The measles epidemic in 1890 resulted in the death of approximately one-third of the Unalaska population. In 1919, Unalaska lost an additional one quarter of its population from the influenza epidemic (Jones 1969:52).

Malnutrition was another important factor in the increased mortality rates. Depletion of game used for food, for transportation materials and for trade contributed to the malnutrition and starvation experienced by the Aleuts. The reduction in the numbers of game affected the post-contact Aleut mortality (Black 1980).

Under Russian rule, sea lion skins were given freely to the Aleuts by government officials. The Aleuts used sea lion skins to make canoes. Under American rule, Aleuts were forced to buy these skins from the company that was leasing the Pribilof Islands. This company would only sell skins to Aleuts who brought in all of the skins they obtained through hunting to the company. The American government also lifted the restrictions imposed by the Russians on the numbers of sea otters and seals fur hunters could kill. With no government restrictions on the number of fur animals available for hunting purposes, sea resources rapidly diminished (Black 1980).

3.2 Historical Population Estimates

Aleutian history is divided into three periods: the pre-European/Russian contact period, the Russian occupation from 1741 to 1867 and the American period which spans from 1867 to the present. Albert B. Harper's article "Life expectancy and population adaptation: the Aleut centenarian approach" (1979) cites life expectancy figures for both the pre-contact and post-contact periods based on a large skeletal series and detailed parish records. These figures illustrate the dramatic decline in population during the post-contact period as a result of contact with Russian missionaries and explorers.

Skeletal remains from middens and mummy caves provide the data for the pre-contact Aleutian population figures. The skeletal materials were well preserved because of the calcium present in the middens and the protection the caves provided from the elements. These favourable conditions enabled researchers to recover a large, well preserved skeletal series (Harper 1979:318). Site specific information for the skeletal remains used to determine the pre-contact life expectancy figures is not given in Harper's article, but he does indicate that the population figures and life expectancies for the pre-contact period are based on remains from the Aleutian Aleuts.

Accurate figures for the pre-contact, 0-9 age groups were not available because of differential preservation and difficulties in distinguishing young Paleo-Aleut and Neo-Aleut skeletal material. Instead, figures for cohorts aged ten years are used for mortality comparisons. The pre-contact group had average life expectancies of 35.77 years for males and 37.71 years for females at age ten.

For the post-contact period, Russian orthodox parish records provided information about ages at death and numbers of deaths. The Russian Church was established in the Aleutian area at the end of the eighteenth century. Church records were kept by Bishop Veniaminov for the years 1822 to 1867.

The later Aleut groups, immediately preceding and during contact by the Russians, suffered a reduction in life expectancy rates. The Aleuts attribute these decreases to internecine wars, Russian contact, and epidemics (Veniaminov 1984:248).

During the early 1800's, Aleut life expectancies increased slightly and then stabilized. Two epidemics struck the Aleutians during the mid-1800's reducing the life expectancy rates for both males and females. By the end of the 19th century the Aleuts appeared to recoup their population losses - there was even a slight incline in the average life expectancy curve.

The curve dips again in 1948 as a result of influenza and tuberculosis. The Aleuts managed to regain these losses and record their highest life expectancy rates in the 1970's as a result of modern medical care and packaged foods (Harper 1979).

Total population numbers also reflect the depopulation that occurred as a result of contact with Russian explorers and missionaries. Some researchers (Petrof 1884; Kroeber 1947) estimated that the total number of Aleuts exceeded 16,000 before Russian contact in 1741. Earlier estimates (Veniaminov 1984) cite even higher population figures of over 25,000 people during the pre-contact period.

Aleut populations were severely reduced in only half a century. Total Aleut population figures fell to 2,500 because of disease and violence. Sarychev recorded this figure of 2,500 Aleuts in 1792. Veniaminov reported an Aleut population figure of only 2,024 by 1834.

Practically every island was inhabited when the Russians first reached the Aleutian Islands in 1740. Agattu Island had thirty-one villages and there were twenty-four villages on Unalaska. By 1841, natives occupied only sixteen islands and Unalaska had only ten villages. The total population numbered less than 2,000 people. In 1945 only Akun, Akutan, Sedanka, Unalaska, Umnak, Atka and Attu had permanent native settlements. In 1942, the Japanese captured the Aleuts on the island of Attu (Collins 1945:20).

Many young people died from diarrhea during the years 1807 to 1808. Smallpox epidemics also severely affected Aleut populations. Epidemics of smallpox, measles and pneumonia occurred in the Aleutian Islands during three periods: 1838 to 1839; 1843 to 1844 and

1880 to 1884 (Bank 1953). The third epidemic was less severe than the first two bouts of smallpox as a result of vaccinations provided by Russian physicians. Measles, tuberculosis and venereal diseases also took their toll on the indigenous populations. A measles epidemic in 1900 and an influenza epidemic in 1919 killed many of the unimmunized Aleuts. Spanning about two centuries, from the mid-18th century to the start of the 20th century, epidemics dramatically reduced Aleut populations.

During these periods other events also resulted in losses of human life. Deaths resulting from accidents, wars, reprisals, massacres and volcanic eruptions also reduced the Aleut populations (Robert-Lamblin 1982:108).

An investigation of other historical native American demographic studies reinforces the assumption that disease had devastating effects on native populations in general. In the past, historians have often estimated total population sizes and depopulation rates through the use of historical records. Cook (1973) used missionary records and explorers' journals to determine native American population figures for pre-contact periods in California. As noted in Chapter II of this thesis, tribute lists, military records, baptismal records and censuses aided Cook and Borah (1960) and Cook and Simpson (1948) in their population estimates for central Mexico. Major diseases introduced through cultural contact also had devastating effects on Aleut populations. There were only 1,680 Aleuts by the end of the nineteenth century. Today there are fewer than 1,200 native Aleutians.

3.3 Aleut Life

3.3.1 Subsistence

Fishing and sea mammal hunting are the Aleuts' primary means of subsistence. A sea economy has endured in the Aleutians since aboriginal times (Harper 1979). Collective sea mammal hunting has served a dual purpose within Aleut society, providing food and helping to bind communities together.

All Aleut groups exploited marine resources. Aleuts fished mainly for sea fish such as halibut, cod and sculpin from skin boats on the open sea (Jochelson 1925:23). Early Aleuts also ate sea mammals, sea birds, sea urchins and mollusks (Elliott 1886:154; Collins 1945:21). Also, the sea provided the Aleuts with the material for their clothing, boats, weapons and houses. The skins of sea mammals and birds were used for clothing and driftwood and skins were used to make boats. Seaweed was used for fish lines and snares for land birds (Black 1980). Driftwood and bone were also used for weapons, utensils and houses (Collins 1945:21; Black 1980).

The Aleuts had two main types of boats. Baidaras were large skin boats which transported people and supplies between summer and winter villages. Baidarkas were used for daily sea mammal hunting and deep-sea fishing. Baidarkas were similar to kayaks and held from one to three people.

3.3.2 Residences and Households

The Aleuts referred to their houses as either ouliagamakh - which means ancient dwellings - or yurts (Coxe 1804, Sarytchev 1807, Veniaminov 1984). Barraboras (Muir 1917:13, Elliott 1886:122) was also an alternative term for ancient Aleut dwellings. Whalebone or driftwood was used in the construction of these traditional dwellings. The Aleuts covered the skeletal structure with mud and grass. Aleuts entered the yurt through an opening near the top of the structure. Residents climbed down a beam that reached from the top of the hut to the floor of the yurt (Coxe 1804:183; Sarytchev 1807:8). According to Coxe (1804:182-3) Aleuts built their dwellings in the following way:

> having dug a hole in the earth proportioned to the size of their intended habitation, of twenty, thirty, or forty yards in length, and from six to ten broad, they set up poles of larch, firs, and ash, and lay planks across, which they cover with grass and earth.

The dwellings also had one or two small windows made out of glass or blubber (Muir 1917:13).

Yurts were communal dwellings that were mainly found in the eastern Aleutian Islands. Families shared these dwellings during the winter and set up single family dwellings during the summer. The Aleuts to the west occupied single family dwellings during both the winter and summer months.

Yurts were sectioned into sleeping and working units by grass mats. Each family occupied a separate section of the yurt. Small spaces dug out in the back of the sleeping areas were used as storage space, hiding places for children during enemy raids and sometimes for burying the dead (Morgan 1980). Rush mats covered the floors and residents used these mats as beds (Sarytchev 1807:8). The floor of the dwelling was located two to three feet below the earth's surface (Muir 1917:13).

Yurts housed a maximum of thirty to forty-five families. Families that shared a dwelling were usually from the same kindred (Veniaminov 1984). Household occupants formed a more tightly knit unit than the actual family group (Shade 1951). Ties were strongest with the people who shared the same yurt.

3.3.3 Villages

Aleuts usually located their traditional villages along the seashore, in bays and gulfs. The convenience of the location for docking vessels usually determined the locale (Collins 1945:21; Veniaminov 1984:200). The distances between villages varied. Villages were between seven and seventy versts apart (approximately 4.6 and 46 miles). Given these distances, travel between different villages by foot was impossible (Veniaminov 1984:200).

During the post-contact period the Russians relocated many Aleutian villages. Once situated along the seashore, Aleut villages were now mainly located along valleys and river mouths. One advantage of these relocations for the Aleuts was that the new locations enabled harvesting of salmon during spawning and migratory seasons (Collins 1945:21; Jochelson 1925:23).

Before the Russian invasions, Aleuts only visited river locations. Aleuts never settled permanently along river banks. Village locations usually met the following criteria: easy access to a fresh water supply, a beach front for landing boats, safety from surprise attacks. Therefore, villages were often in exposed areas such as sand spits, isthmuses and narrow necks of land. Aleuts preferred areas accessible to two bodies of water. If the village was attacked, boats could be carried to the other body of water and the villagers could escape (Collins 1945:21).

Ancient Aleut villages were not very populous. About forty to sixty people lived in two or three earth dwellings. Russian conquerors set up larger settlements of two hundred to four hundred men. The Russians gathered the small scattered Aleut groups together so it would be easier to control them (Jochelson 1925:119). These larger villages varied in size from one to six dwellings or yurts (Coxe 1804:226; Veniaminov 1984:119). In 1840, Veniaminov wrote of his voyages to the Aleutian Islands from 1823 to 1834. He compared the villages of this period to earlier Aleutian villages.

> The villages of the former Aleuts consisted of one, two, and even six yurts, but they were very large ones so that from 30 to 45 families dwelt in each one. The present villages of the Aleuts consist of two and even ten yurts, but they differ from former days in that each yurt holds no more than two families (Veniaminov 1984:199-200).

During the early 1800's the largest village in the Aleutian Islands was the main settlement of Unalaska Island. Other large villages were: Unginsky, Belkovsky, Recheshnoe on Umnak, and Pavlovsk. Before this time, Pogromsky and Tulik on Unimak Island had been the largest villages (Veniaminov 1984:200).

The Fox Islands were very populous in the second half of the eighteenth century. Unalaska is the largest island of this group. This island supposedly had several thousand inhabitants. These people lived in communities composed of between fifty and three hundred persons (Coxe 1804:225). There were 16 villages in Unalaska during this period (Coxe 1804:256). The village of Unalaska, or Iliuliuk in Aleutian, had a population of 281 by 1909. Of this total population figure of 281, 242 were Aleuts and 39 were whites

(Jochelson 1925:13-14).

During the early 1870's to early 1880's, Belcovsky was the largest centre in the Alaska Peninsula area. Belcovsky, built on the top of a bluff, was now the chief settlement for the sea-otter hunters. About 260 sea-otter hunters and their families lived in Belcovsky. Dwellings consisted of both frame houses and semi-subterranean earth dwellings called barraboras. There was also a new church, constructed between 1880 and 1882. This port also had two warehouses constructed by rival trading firms (Elliott 1886:119-20).

Belcovsky was an opulent but dissolute village (Elliott 1886:121). Another wealthy but dissolute village was Protassov or Morserovie (Elliott 1886:121; Petroff 1884:19). Situated at the far western end of the peninsula, Protassov had a population of nearly one hundred natives. The average family income was about $1,000 - a very good wage in this region during the late 1800's. In spite of the native's wealth, a government agent expressed shock at the people's "abject physical misery and that excessive debauchery" (Elliott 1886:122; Petroff 1884:19).

Delarov Harbor was not as wealthy as Belcovsky or Potrassov. This village was on Oonga Island and it consisted of 14 frame houses, 20 barraboras and a church. The average income of a family in Delarov Harbor was about $600.00 (Elliott 1886:122).

Many of the Aleutian Island's larger settlements were either moved or diminished after contact with the European traders. By the late 1800's, Akutan was a poverty stricken area with only 65 Aleuts remaining on the southwest shore of the island. During the early 1800's there had been seven settlements spread along the island's entire coastline. The earlier population exceeded 600 people in size and most of Akutan's residents were whale hunters (Elliot 1886:153).

The village of Akoon, once with a population of several hundred people, also underwent a drastic reduction in size. Elliott (1886:154), who visited the area in the early 1870's, believed that Akoon was also once a thriving whaling village like the villages on Akutan Island. Elliott estimated that Akoon's prehistoric population numbered five or six hundred Aleuts. By the 1870's the population had diminished, only a few small settlements remained.

Although the island of Akutan and the village of Akoon suffered severe reductions in population size, Elliott (1886) describes Avatanak as the worst village in the archipelago. As Elliott (1886:154) states, "The most revolting chapter in the long story of Russian outrage and oppression of Aleutian natives is devoted to a recital of the savage brutality of Solovaiyah and Notoorbin, who lived here during the winter of 1763". The island of Avatanak had three settlements prior to Russian contact. In less than 100 years the island's population was reduced to a total of 19 people.

The islanders of Attoo also experienced population decreases. Attoo Island was the first land mass discovered by the Russians. The Russian, Michael Novodiskov, was the first to reach Atto. Novodiskov sailed with Vitus Bering and outlived Bering and survived the wreck of the St. Peter in 1741. A few years later in 1745, Novodiskov set off from Lower Kamchatka for Atto. During the mid 1700's, large numbers of Aleuts lived in this region. By the 1870's, there were only about 100 Aleuts on Attoo (Elliot 1886:179).

3.4 Social Structure

Ancient Aleut elders or chiefs, known as tu'kux' by the Aleutians, ruled over a small number of families. These families were usually all related. According to

Jochelson (1925:119), an average village numbered between forty and sixty people in size and occupied two or three dwellings. After the council of elders, the next powerful person in the village was the shaman, but during warfare the chief had the ultimate power (Antropova 1964:884).

Aleuts often captured slaves during battles. Only members of the privileged groups could only own slaves. The one advantage of European contact for the Aleuts was the cessation of the Aleut internal wars (Collins 1945:21; Jochelson 1925:23).

Several references to the Aleuts having clans have been made in the literature (Antropova 1964, Veniaminov 1984). A detailed description of the clan organization is not provided in these sources. The lack of detailed information makes it difficult to determine the actual structural type of the clans (patri-clans, matri-clans, avuncu-clans).

Black (1980:88) does not specifically use the term clan but instead refers to the development of an "endogamous agnatic lineage (sic), linked to a territory". Black concluded that these lineages resulted from the prolonged practice of patrilateral cross cousin marriage. "Dispersed in many villages, these kinship groups controlled large territories through numerous ties of consanguinity and affinity" (Black 1980:88).

There are several references to clans in Veniaminov's (1984) Notes on the Islands of the Unalashka District. When describing community structure Veniaminov (1984:167) notes:

> A few villages, the inhabitants of which had sprung from one family, formed a state or community in which the oldest chief, descended in a direct line from the forefather who had first settled the island, was the ruler. If no descendant was available, the head chief was selected from among the chiefs for his wisdom, true valour and superiority in the art of hunting.

Then in another context, Veniaminov (1984:166) mentions that "The former government of the Aleuts might be called patriarchal. Every village consisted of kinsmen and formed only one family, where the elder of the clan, called Toen (Toukkoukk), had power over all ...." Veniaminov (1984:201) also mentions that the settlements of Pavolvsk and Tigalda both had clan chiefs and in terms of military leaders, they were always the clan chief or his elders or nephews (Veniaminov 1984:99-100). In the case of the latter comment regarding clans, the footnote in the translation that the term clan presumably refers to local group. Veniaminov also mentions clans when describing houses and wars. "The chief or elder of the clan lived with all his wives and children on both sides of the forward or eastern side of the yurt. His kindred or following occupied the rest of the yurt; ... " (Veniaminov 1984:206-7). In terms of warfare, internecine wars were fought between clans and tended to arise first between individual members of families and then escalated to the level of the family, clan and tribe (Veniaminov 1984:93-5).

Antropova (1964:884) provides the most detailed information about clan organization in the Aleutians:

> At the time of the Russian arrival, the Aleuts lived under a system of clan organization. The members of a clan lived in the same village and had their clan hunting territories. The oldest and most respected member of the clan was the clan elder. His sons and nephews and the older members of the clan were a privileged group. Numerous interclan and intertribal wars were caused by the seizure of hunting and fishing grounds, clan vengeance, and so on.

Antropova claims that this type of social organization was typical for the Aleuts at the time of Russian contact. It is difficult to evaluate the accuracy of Antropova's descriptions of the clan system in that no dates are given for when this information was collected. In addition, there are no references within the body of the text as to who provided the written accounts of these clans and which part of the Aleutian chain these clans represent.

In contrast to Antropova's descriptions of Aleut clans, Hrdlicka (1945), in writing about his research in the Aleutian Islands during the years 1936 to 1938, did not find any evidence of clans. Hrdlicka writes (1945:25-26):

> In the earlier times the Aleut had apparently a loose yet in general binding social organization, resembling in essentials that within other American and Siberian native groups.
>
> The real authority in each settlement, as generally in America, was the council of the elders; and the next in power in a village was the shaman; in war, however, it was the chief who had the authority.
>
> As to more detailed organization, the presence or absence of clans, etc., there is no information.

This lack of information regarding clans may indicate that the corporate structures that once existed were disbanded at some point, probably at or after contact with the Europeans.

Antropova (1964) suggests that the corporate groups that existed during the pre-contact period but may have broken down during the contact period. According to Antropova (1964), the Russian presence also disrupted the Aleut clan organization. Traditional clans were not preserved after Aleuts were relocated by Russian officials. Dall (1870) also offers support for a breakdown in traditional structures as a result of arbitrary relocation of whole villages by Russian government officials. These relocations blurred clan and tribal distinctions.

3.4.1 Kinship

Based on the kinship terms gathered by Jochelson (1968), the Aleuts had an Iroquois system based on cousin terminology. Variance from the standard Eskimo terminology was also noted for the Sivokakmeit of St. Lawrence Island. According to Hughes (1960) the Sivokakmeit also had an Iroquois pattern. Researchers have noted that other Western Eskimo groups also do not have an Eskimo terminology system (Giddings 1952, Lantis 1946). Hughes suggests (1960:233) that Murdock's proto-typical "Eskimo" classification of kinship terminology may only apply to the Eastern and Central groups.

3.4.2 Terminology

The following Aleut kinship terms were recorded by Jochelson (1968:69-71) from his expedition along the Aleutian archipelago in 1909 and 1910 and from mythological texts.

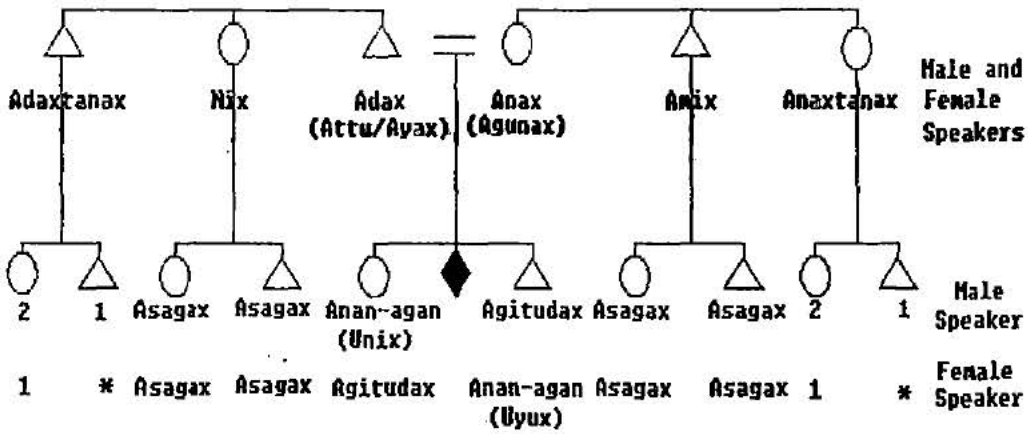
1)	Ayagax'	Wife or woman
2)	Ayagatanax'	Possible/substitute wife (brother's wife, wife's sister, wife's brother's sister)
3)	Ugix'	Husband
4)	Ugixtanax'	Possible/substitute husband (sister's husband, husband's brother, sister's husband's brother)
5)	Adax' (Attu, Ayax)	Father
6)	Anax' (Agunax)	Mother
7)	Amix'	Mother's brother
8)	Anaxtanax'	Mother's sister/ Father's brother's wife
9)	Quligax'	Mother's brother's wife
10)	Adaxtanax'	Father's brother/ Mother's sister's husband
11)	Nix'	Father's sister/ a female's brother's child

12)	Latux'	Grandfather (father's or mother's father)
13)	Kukax'	Grandmother (father's mother or mother's mother)
14)	Agitudax	Brother or sister (a male's brother or a female's sister, i.e. same sex sibling)
15)	Uyux/huyux	Woman's brother
16)	Unix/hunix	Man's sister
17)	Anan-agan	Brother or sister (a male's sister or a female's brother, i.e. cross sex sibling)
18)	Agitudaganax/ Agitutaxtanax	Cousin (male's father's brother's son and mother's sister's son or woman's father's brother's daughter and mother's sister's daughter, i.e. same sex as speaker's parallel cousin)
19)	Asagax (Acax/ayax)	Cousin (father's sister's child and mother's brother's child, i.e. cross-cousin)
20)	Uniganax/ huniganax	Man's father's brother's daughter and mother's sister's daughter
21)	Umnix	Man's sister's child
22)	Asxinuxtanax	Man's brother's daughter or woman's sister's daughter
23)	Lax'	Son
24)	Laxtanax	Possible/substitute son (a man's brother's son and a woman's sister's son)
25)	Asxinux'	Daughter
26)	Ilgux'	Grandchild

I constructed a kinship diagram (Figure 1) based on Jochelson's (1968:69-71) list of terms. This diagram lists two generations of kinship terms for both male and female speakers. The Aleuts had an Iroquois system based on cousin terminology. According to Murdock (1960:223), an Iroquois system is present when the same terms are used for ego's father's sister's daughter and ego's mother's brother's daughter. These cross cousin terms must also be differentiated from the terms used for parallel cousins and for sisters. In Aleut, ego addresses his/her father's sister's daughter as "Asagax" and also his/her mother's brother's daughter as "Asagax" (see Figure 1).

In an Iroquois system, the terms for parallel cousins are often the same as the terms for sisters. The Aleuts had different terms for their parallel cousins than for their sisters (see Figure 1). A male ego called his father's brother's daughter "Uniganax" and his father's brother's son "Agitutaxtanax" or "Agitudaganax". He used these same terms for the children of his mother's sister. Whereas a male ego would address his sister as Anan-agan. Although there seems to be some relationship between the term a female ego would use for her father's brother's daughter and

Figure 1: Aleut kinship terminology



Kinship Terms:

1 = Agitutaxtanax/Agitudaganax
2 = Uniganax
* = missing term (term not recorded by Jochelson)

(Jochelson 1968:69-71)

her mother's sister's daughter ("Agitutaxtana" or "Agitudaganax") and the terms she would use for her sister ("Agitudax").

Although the Aleut cousin terminology suggests an Iroquois system the application of the Aleut word "Nix'" to both a father's sister and a female's brother's child hints at an Omaha system which is usually patrilineal. In Omaha systems the mother's patrilineal kin are equated across generations. The use of the Aleut term "Nix'" represents a three generational skewing such as that found in Omaha systems.

Based on Jochelson's (1968) material, the Aleuts had a lineal descent system. Evidence for an Aleut unilineal system comes from three areas. First, the Aleuts had an avunculocal extended family, also typical of Haida society, where the boys would live with and receive training from their maternal uncles. Second, the Aleut's pre-contact system of clan organization suggests unilineal descent. Lastly, Iroquois terminology, which distinguishes between parallel and cross cousins, provides evidence for a lineal system.

It is possible that the Aleuts had a matrilineal descent system, based on the strong relationship between males and their mother's brother's (Veniaminov

1984:108). Although the importance of the maternal uncle in Aleut society would indicate that a matrilineal system was present, no other evidence suggesting a matrilineal system exists.

The Aleut's kinship terms and clan organization reflect a lineal system. But the first-hand information gathered in the mid-1800's about Aleut clans was lacking in detail (Veniaminov 1984) and later researchers did not find evidence of clan organization (Hrdlicka 1945) whereas the Iroquois kinship terminology remained in the society until at least as late as 1909 to 1910. The reason for the lack of detailed information about clan structures could be due to changes in the Aleut's social structures around the time of contact. Aleut society may have been undergoing a change from a lineal system to another type of descent system.

In sub-types or variant types of societies with an Iroquois type of social organization, the disappearance of clans can be expected (Murdock 1960:243). The variations found among sub-types often are indicative of the type of system into which the existing system will eventually evolve into (Murdock 1960:227). Corporate groups would disappear first during a change from one system to another, while the residual kinship terms of the old system would remain in the language for a longer period of time.

3.4.3 Terminology and Behaviour

In terms of close relatives, the uncle on the mother's side and after him, the paternal uncle had a lot of control over their nephews and nieces (Veniaminov 1984:108). At one time, the maternal uncle supervised the training of children of both sexes. Nephews would live with their mother's brother and receive instruction from their uncle in religious matters and traditional customs (Veniaminov 1984:71-72; Jochelson 1933:71). Mothers and grandmothers provided the training for girls under the supervision of the maternal uncle. If no uncles were available to train the children, the father assumed this task (Veniaminov 1984:72).

Changes in the roles of kin members were already evident by the time of Veniaminov's voyages to the Aleutian region between 1823 and 1834. Veniaminov (1984:72) observes that "at the present time uncles have almost completely ceased to assume this obligation of training, but leave it to the godfather or the parents themselves".

Children also received another type of education. A form of communal education took place inside the yurts where the old men would instruct the young (Veniaminov 1984:143-144). There was also another type of association between elderly men and young children. Fathers and uncles would obtain saliva from an old man renown for his health and give it to their children to swallow. The saliva was thought to guard the child against infection and epidemic diseases (Veniaminov 1984:134-135). Elderly women also played an important role in Aleut medical practices. Old women exclusively practised the healing of internal ailments (Veniaminov 1984:263-264).

Flexibility in the kinship system is evident in the giving of the child's name. The giving of the name was the privilege of the maternal or paternal grandfather. If neither grandfather was alive, an uncle or other kinsman would give the name, although the name would usually be derived from the father (Veniaminov 1984:70).

3.4.4 Marriage

Males usually remained within the village of their birth. Females would marry men from other villages, thus becoming members of new villages when they became wives (Laughlin 1949). A wife would reside at her father's house for a given period after marriage. While living at her father's house, her husband was able to visit her (Veniaminov 1984:282). During this period, usually one or two years, the husband would hunt for the kinsmen of his bride (Veniaminov 1984:75-6). This bride service would continue until his wife gave birth to their first child. This fully confirmed their marriage and gave the husband the right to take his bride home (Veniaminov 1984:282).

Initially, after Russian contact all inter-village contacts were cut off in order to stop inter-tribal warfare. Aleuts were not able to travel between villages without special permits from the Russian authorities (Jones 1969:43). As a result of the prohibition against travel, Aleuts were forced to marry within their own villages. Endogamy produced homogeneous villages where most inhabitants were kin.

The preferred form of marriage was between cross cousins. As with Aleut kinship, controversy also surrounds Aleut marriage patterns. Sources vary as to whether patrilateral or matrilateral cross cousin marriage was preferred. According to one source, the best possible bride for a man would be the daughter of the man's uncle (Veniaminov 1984). Another source indicates that marriages generally took place between patrilateral cross cousins (Black 1980).

The only sex taboo in Aleut society existed between offspring of the same mother (Jones 1970). Men were able to engage in sexual activities with their own wives, their brother's wives, their wife's sister, concubines, transvestites and slaves (Jones 1970). The Aleuts also practised levirate marriage, where if one brother dies, the other brother must marry his brother's widow (Veniaminov 1984:9).

The Aleuts also practised polygamy. Both sexes were able to have more than one spouse. In polygynous situations, men had up to six wives (Veniaminov 1984). In polyandrous situations, women had up to two husbands (Coxe, 1804). One husband was the chief husband and could exercise complete control over the household. The second husband was the chief husband's assistant (Sarytchev 1792). Sources do not say if there was usually a kinship relationship between the two husbands in a polyandrous situation.

The Russian Orthodox church strongly discouraged polygamy and marriages between close kin. Chiefs eventually forbade intra-village marriages to please the church and to resolve the problem of villages becoming overly homogeneous (Jones 1969:43). Monogamous marriages were also encouraged. Again, the church prohibited polygamy and encouraged the development of the nuclear family. Also, the number of females available for marriage decreased because of the increased closeness of familial ties within villages. The number of women available for marriage was also reduced due to epidemics.

3.4.5 Adoption

Children could live with their mothers, fathers, uncles, godparents, grandparents or anyone else (Jones 1969:34). Children were often given to relatives and sometimes even strangers for training. Parents would also give their children to others for adoption, sometimes as a gift or sometimes in exchange for some articles (Veniaminov 1840:10-11). According to Shade (1949) six of fifteen children in one village were living with guardians. These children were well cared for by their guardians (Shade 1949:68). Ransom (1947) disagrees with Shade as to the type of care guardians provided for the children. "To be without relatives is a state particularly pitied by the Aleuts, since the whole life of the people is centred about the family. To be an orphan living with an adoptive family is to be a virtual slave, a drudge throughout the duration of childhood" (Ransom 1947:67).

3.5 Changes in the Kinship System

Demographic and societal pressures can have a profound effect on kinship (Eggan 1937:51). Changes in kinship structures can occur as an adaptive response to these population pressures. Populations with matrilineality and matrilocality are likely to adopt bilaterality and neolocality (Spoehr 1947) and descent may change before changes in residence rules take place (Schmitt and Schmitt 1952:60-61). Also, the more acculturated a society is, the faster its people are to adopt new systems (Bruner 1955).

A variety of post-contact factors caused bilaterality among Arctic drainage Athapaskans. These factors included: the length of time the Athapaskans were exposed to disease and the ensuing population reductions, and the new pressures on the society from changes in the caribou herds and the emphasis on European fur trade (Krech 1978). Bilateral kinship is a key adaptive response to socio-economic stress because it allows for societal mobility (Savishinsky 1971).

Previous theoreticians did not believe matrilineality occurred in precontact Athapaskan populations because the environment was assumed to be too unstable during this period (Helm 1965; McKennan 1969). In fact, it was believed that the environment, in both aboriginal and post-contact periods, was conducive to bilocality and bilaterality. The environmental severity occurring in pre-contact times was thought to be a result of famines and warfare (Helm 1965, McKennan 1969). This view regarding environmental severity during the precontact period and bilateral organization was widely accepted (Hultkrantz 1973; Morris 1972/73; Savishinsky 1971, 1974; Sharp 1978; Smith 1975, 1976, 1978).

Krech (1978) challenges this assumption about precontact environmental instability based on his studies of the Kutchin. Krech describes a different type of environmental severity during the post-contact years caused by increases in mortality from diseases and starvation and other social changes as a result of trade with Europeans.

Krech (1978) challenges the prevailing theory which states that bilaterality and bilocality represent the norm in terms of hunter-gatherer social organization. Krech suggests that although this model may be useful in terms of ethnographic analogy for some prehistoric populations, that we cannot indiscriminately apply this model to all hunter-gather groups.

Based on evidence of matriorganizations in Eastern Subarctic Montagnais-Naskapi societies (Leacock 1969), Cree societies (Bishop n.d.), one report for Central Eskimo groups (Boas 1964:171) and from some South American hunting-gathering societies (Martin 1969), Krech suggests that perhaps matriorganization was present in more societies than we currently believe. Krech states that many groups may originally have had matrilineal and matrilocal structures and that bilaterality may have been a recent development.

Krech (1978) believes that the contemporary Arctic Drainage lowlands groups are bilateral and bilocal, whereas most other Northern Athapaskans have a system of matriorganization, with matrilocality and matrilineality. He feels that these groups have bilateral kinship mainly as a result of European contact. Krech also cites evidence of matrilocality in early historical periods for Northern Athapaskan populations (de Laguna 1975; Dyen and Aberle 1974; Krech 1978) and matrilineal descent in Cordilleran and Pacific Drainage ecozones (Krech 1978). Krech (1980) believes that the views that assume similar environmental conditions and economic strategies existed in both precontact and post-contact periods are naive.

Krech (1978) points out that numerous changes have occurred in native populations since contact. He focuses on the changes in native societies produced by epidemics. Epidemic diseases reduced the Kutchin population by approximately 80 percent. Diseases also affected food acquisition and coincided with starvation within aboriginal populations. The fur trade and the reduction in caribou herds also had an impact on the traditional culture (Krech 1978; Bishop and Krech 1980). Also, the effects of European intrusions and the resulting changes in social organizations caused the erosion of matrilineality in other Northern Athapaskan groups: the Upper Koyukuk River Koyukon (Clark 1975), the Tanaina (Townsend 1970a, 1970b, 1970c) and the

Kutchin (Krech 1978). Yerbury (1986) offers a good summary of the literature regarding a possible matriorganization for most precontact Athapaskans and Northern Algonquins in the subarctic.

The importance of separating aboriginal conditions from post-contact conditions may also apply to the Aleuts. This distinction is especially important when the population has been exposed to outside influences such as epidemics and the European trade economy as the Aleut populations had been. Theories of aboriginal social organization and the interpretation of the processes of social change and adaptation during the post-contact period are difficult to develop when only limited data is available in archival collections.

It is possible that the traditional Aleut kinship system was altered as a result of European contact. Lantis (1970:227-235), Jochelson (1933:71-72) and Sarychev (1807:77) suggest that prior to contact, the Aleuts were matrilineal and had avunculocal residence. Early sources (Jochelson 1925; Veniaminov 1984; Sarytchev 1792) indicate that the Aleuts may have also had a matrilineal system during the late 18th century and the early 19th century.

The evidence for matrilineality comes mainly from reports about the importance of maternal uncles in Aleut society. The assumption that the traditional Aleut society may have been matrilineal is strictly based on written records which indicate the relative importance of various kin and preferential marriage practices.

Aleut societies, like the Athapaskan societies (Krech 1978, 1980), had their animal resources drastically reduced by European fur hunters and the demand for furs from trading companies. These new pressures altered traditional Aleut economic strategies and also affected Aleut food and material resources. In addition, the size and location of villages were altered by epidemics and relocations by Russian officials. Although the Aleuts experienced many of the same effects from European contact as did the Athapaskans, there is no indication that the Aleut kinship system changed from a matrilineal system to a bilateral system as was the case in the Athapaskan societies after contact with the Europeans. But the evidence of possible erosion of the Aleut clan system does suggest that structural changes were occurring within Aleut society and that these changes were probably caused by Russian contact.

Chapter IV

DEMOGRAPHIC COMPUTER SIMULATIONS

This thesis uses computer simulation methodology (Dyke and MacCluer 1973) and ethnographic analogy to examine the changes in demographic and kinship changes under two mortality regimes. Through the use of a microsimulation program, demographic and kinship changes at the population level, the household level and the kinship level can be discussed. Computer simulations fulfill many different functions in terms of anthropological research, for the purposes of this thesis a computer model is being used to examine the range of possible outcomes based on a set of demographic parameters.

Researchers who use computer simulations are not attempting to replace historical or ethnographic research, nor do they claim to be duplicating the exact events that occured in a population during a certain period. Simulations allow researchers to investigate what processes may have occured and what outcomes are feasible given certain initial assumptions. Through the use of computer simulation programs which simplify complex processes, we can possibly gain some insight into how various processes work and how different processes interrelate.

4.1 STABLE POPULATION MODELS

This thesis utilizes stable population theory (Lotka 1956) which requires the researcher to make several assumptions. The first assumption of stable population theory is that the population is infinitely large. The theory's second assumption is that it is a closed population with no in or out migration and the last assumption is that the mortality and fertility rates remain constant. A population that fits these assumptions produces a stable age distribution. The population will approach the stable form in less than 100 years after the rates become fixed (Weiss 1973:6). Once a population reaches the stable form, the age distribution does not change as long as the mortality and fertility rates remain constant. Additional information about stable population theory can be found in articles by Keyfitz (1968), Coale (1972), Shryock and Siegel (1971) and Weiss (1973).

A stationary population is a particular type of stable population. Stationary populations are of interest to anthropologists studying stable populations or human populations using an evolutionary perspective (Weiss 1973:8). A stationary population is a population that is not growing. The annual population growth rate (r) is equal to 0. In this type of population, the vital rates are constant, the relative age distributions are constant and the census counts are constant.

4.2 SIMULATION MODELS IN ANTHROPOLOGY

Over the last two decades, researchers in the fields of anthropology, demography and population genetics have used computer simulation models of human populations in their studies. Chapman (1980) and Howell (1982) used computer simulation models for their studies of hunter-gatherer populations. Howell (1982) and Weiss (1973) used simulation models to analyze skeletal populations. Wobst (1974, 1976) used computer simulations to study Palaeolithic populations. Archaeologists (Wobst 1975), socio-cultural anthropologists (Hammel 1980) and sociologists (Howell 1979) have also successfully used computer simulation as an analytical tool.

Simulation models allow researchers to analyze the interaction of demographic and social parameters within a population. Computer simulation programs aid in the exploration of the long term implications of demographic parameters. Also, by using computer models researchers can observe stochastic fluctuation of vital statistics for whole populations.

Computer simulation models are useful anthropological research aids. Anthropologists often work with populations that are too small to enable us to make generalizations. In addition, data are often incomplete or poorly recorded for anthropological populations. Thus, the simulation approach enables researchers to overcome obstacles characteristic of small populations. Such obstacles include: small data bases, incomplete vital statistics and stochastic noise (Howell 1979; Weiss 1973, Hammel 1980). Computer simulations provide study populations which enable measurement of the effects different mortality regimes have on kinship structures while ethnographies, historical records, skeletal remains and general demographic information can provide the initial computer variables.

Several computer simulation programs are currently available for use in anthropological research. One of the earliest simulation models is called POPSIM (Giesbrecht and Ranney 1968; Lachenbruch, Klepfer and Rhode 1968). Two versions of POPSIM were written, an open and a closed model. In the open model, when a woman became eligible for marriage a husband of appropriate age was entered into the simulated population. In the closed model, at the appropriate time a woman would marry a man chosen from the simulated population. Only the open model of POPSIM was fully developed as it was best suited to the current research purposes.

Shorter (1974) developed a deterministic macrosimulation program called FIVFIV. FIVFIV is capable of producing a simulation of 35 years in duration, longer projections must be obtained over successive runs. Algebraic equations determine the simulation's demographic decisions for the entire population. The deterministic nature of FIVFIV results in identical outputs when identical input parameters are used.

Unlike many other programs, FIVFIV includes migration as part of it's input parameters. For each five year period, net migration is included in the input parameters prior to running the program. Net migration is represented by the absolute number of people who have entered of left the population and this net number is then added to or subtracted from the population census.

Another available computer program is SOCSIM. Developed in 1976 by Hammel, Hutchinson, Wachter, Lundy and Deuel, SOCSIM is a general microsimulation program. The creators of SOCSIM needed a closed model in order to study genealogies (Hammel et al. 1976). SOCSIM's authors studied POPSIM in order to determine the programming characteristics they would like to retain from POPSIM and the programming changes that could be made in order to improve the programme's speed and storage capabilities.

SOCSIM can be used to investigate a number of general questions as opposed to earlier programs which were designed to answer a specific question (Kunstadter et al. 1963). SOCSIM is a dynamic model that allows researchers to programme changes in vital rates over time. SOCSIM assumes a closed population to allow for the tracing of kinship ties.

A detailed review of other demographic simulation programs can be found in Dyke and MacCluer (1973), Gilbert and Hammel (1966), Kunstadter et al. (1963) and MacCluer (1973). Dyke (1981) provides a more recent overview of the literature concerning the use of computer simulation in anthropology.

4.3 AMBUSH

One of the limitations of stable population models is that they do not account for variations present in small populations. Some computer simulation programs rely on the principles of stable population models throughout the simulation. AMBUSH does not rely totally on the input parameters. AMBUSH combines stable population theory and stochastic fluctuation. The program randomly generates events from initial age-sex probability distributions (Howell and Lehotay 1977). Researchers use model life tables (Coale and Demeny 1966) to determine the initial probability distributions. The model life tables are based on stable population theory. The input parameters for AMBUSH individualize the simulation population. AMBUSH determines future statistical events that produce vital data through a Monte-Carlo process (Howell 1979; Howell and Lehotay 1977, 1978).

The computer program AMBUSH (Howell 1979; Howell and Lehotay 1977, 1978) was developed to simulate a hunter-gatherer population. Like SOCSIM, AMBUSH is a general program that can be applied to a number of different areas of study. AMBUSH is a stochastic microsimulation program which simulates the effects of different mortality schedules on kinship within a closed population. The simulations combine the effects of random variation with aspects of stable population models.

In this study, stable population theory (Lotka 1907; Sharpe and Lotka 1911; Coale 1972) acts as "a framework for determining the age-sex composition and the growth rate that would be produced by the long-term continuation of a particular mortality schedule and fertility schedule of a closed population" (Howell 1979:20). However, unlike stable population models, AMBUSH simulations are not determinant (Howell 1979). AMBUSH is a stochastic model and the cumulations of random variation affect the program's output.

In terms of social structure, AMBUSH provides three measures: egocentric based relative counts, egocentric based group counts and household and kinship groupings. This thesis uses the egocentric relative counts to determine if there were any changes in the number of kin in terms of parent, grandparents and maternal uncles between the two simulations (Howell and Lehotay

1978:916-19).

The egocentric relative counts determine the percentage of living people who have 0, 1, 2, ... ≥ 9 living relatives in each category. The relative counts are given for ten year age groups and are broken down by sex. For example, the output will give the percentage of living males, between the ages of 0 and 9 years, who do not have a living father and the percentage within this age category who do have a living father. These percentages are also calculated for males in the age categories of 10-19, 20-29, 30-39 and so on. The percentages of females with zero and one living father for these age ranges is given in the next row (Howell and Lehotay 1978).

A count of the basic types of kin was used in this study, these types include: father, mother, spouse, son, daughter, grandparents, grandchildren, cousin, uncle, aunt, nephew and niece. AMBUSH does not distinguish between maternal and paternal kin or between cross or parallel kin. AMBUSH input parameters include: start population size, year of births, sex ratios, fertility schedules and mortality schedules. Probability schedules determine births, marriages, numbers of offspring and deaths that occur within the simulation population. The output provides crude birth rates, crude death rates, dependency ratios and total fertility rates (Howell and Lehotay 1978).

In addition, AMBUSH provides information on the variability expected within small populations. Researchers calculate population ranges and averages from several runs for each simulation. These averages are comparable to figures from stable population models that have similar probability schedules.

This thesis uses two different epidemiological approaches. The first simulation is a batch of twenty runs that show the effects of high infant mortality. The introduction of childhood diseases, such as measles, causes this increase in mortality levels. My hypothesis is that by raising infant mortality levels, family patterns change significantly.

The second simulation uses a mortality level that reflects the level found in the actual precontact aboriginal population. This second simulation represents the control group for this study. Comparisons between the two simulations show how a change in mortality affects the total population, household compositions and the numbers of kin within the society.

The selection of AMBUSH, as the computer simulation program used for this thesis, was based on several factors. Since AMBUSH is a microsimulation program, demographic events are generated at the individual level rather than at the population level.

Also, being a stochastic simulation, AMBUSH calculates demographic events based on several input probabilities. The stochastic feature of AMBUSH results in a range of demographic measures and it is this variance that will illustrate the amounts of stochastic noise that may occur given a set of demographic parameters. Since stochastic programs produce a different set of demographic results for each computer run, each set of results is analogous to a sample drawn from a universe of all possible outcomes.

The combination of stochastic processes (mortality, marriage, divorce and age-specific fertility) and deterministic processes (individual and group total fertility rates, length of simulation) used by AMBUSH is one of the program's strongest characteristics. The other strength of the program in terms of this study is that AMBUSH produces a count of relatives. The egocentric relative counts that AMBUSH provides was essential in order to analyze variations in the numbers of kin between the two simulations.

AMBUSH has several limitations that should be identified by the researcher. Initially, AMBUSH was developed for the study of the !Kung. AMBUSH was designed to observe long-term changes in the parameters characteristic of hunter-gatherer societies and therefore, the program is a stationary model that does not permit changes in vital rates during the simulation process. Therefore, the initial demographic parameters remain the same throughout the length of the simulation process.

Other limitations imposed by AMBUSH include the assumption of a closed population. Like SOCSIM, in order to calculate kinship links, AMBUSH must maintain a closed population where no migration occurs.

Despite the limitations of AMBUSH, the availability of the program along with the attributes of the program outlined earlier resulted in the selection of AMBUSH for this study.

Chapter V

METHODS AND MATERIALS

5.1 Simulations

This study uses the stochastic microsimulation program AMBUSH (Howell and Lehotay 1979, Howell 1979). The input variables that power the program are the start population, fertility parameters and mortality parameters. The accuracy and utility of the simulations depend on the chosen input variables. The defensibility of the selected variables is particularly important in this study because I am modelling a prehistoric population. Thus, most of this chapter discusses and defends the demographic variables chosen for the simulations.

5.2 Input Parameters

There are nine compulsory parameter values that control the operation of AMBUSH. The first of these compulsory parameters is the input type. For the simulations used in this thesis, the input type specifies the start year of the simulation.

This particular study's start year is 1839 A.D. It was after 1839 that European epidemics had a major impact on Aleut populations. During the Russian period in Aleutian regions, life expectancies decreased when the European traders introduced diseases to the area. Between the periods 1830 to 1839 A.D. and 1840 to 1849 A.D., life expectancies decreased by five to ten years. For males aged zero to nine, life expectancies decreased between these periods from 34.81 to 24.81 years; for females between the same ages, figures decreased from 35.78 to 29.95 years (Harper 1979:320). The year 1839 was chosen as the initial year for this study's simulations as this year is part of a historical period in which epidemics affected Aleut populations. AMBUSH begins the two hundred year simulations with the input year coded as ninety-nine.

The next parameter value is the final year. This number identifies the final year of the computer run. Thus, the final year for this study's simulations is three hundred. When the computer reaches the final year at the end of the run it produces various outputs. These show up at the end of the printout under the heading of final statistics. Some of the statistics AMBUSH produces at the end of the run are: the population mean, total fertility rate, age at marriage, age at death and crude birth and death rates.

The largest expected population size is also part of the initial specifications. This figure is the highest number of live individuals that the population should reach during the simulation. The expected population size allows the program to calculate the amount of map space needed for the simulation.

The next parameter specified in the input information is the birth rate. This figure represents the average number of births per woman over the fertility period. The birth rate or the total fertility rate "represents the number of children that would be born per 1,000 females (or males) if they experienced no mortality and were subject to the age-specific fertility rates of a specified fertility table" (United Nations 1958:41). The total fertility rate represents the summation of all the age-specific fertility rates per year.

Another input parameter for AMBUSH is the fertility schedule. A set of age-specific fertility rates provides the basis for the study of patterns of the fertility schedule. Demographers usually provide age-specific fertility figures for five year periods. There are seven of these five year age ranges. Age-specific fertility rates represents the number of live births per one thousand women per year within one of the age groups (Kpedekpo 1982:61). These age-specific fertility rates are used to calculate the fertility scheduals which are part of the initial input parameters for the AMBUSH simulations. There is a discussion of the actual numbers used in this study's fertility schedule at the end of this chapter.

The next input parameter is the eligibility schedule for men and women. The values given by this parameter represent the likelihood of entry into the marriage pool. The eligibility schedule lists the values in yearly intervals for both men and women. For this study's simulations, the schedule for women was a thirty-three percent possibility of women aged fifteen, sixteen and seventeen entering the marriage pool. For men, the schedule specified a fifteen percent likelihood of men aged fifteen through twenty entering the marriage pool and a five percent probability of men aged twenty-one and twenty-two entering the marriage pool.

This eligibility schedule is based on the ages men and women became available for marriage in an Athapaskan population (Roth 1981). These figures simulate an early entrance into marriage for both males and females. The upper age limit for eligibility for women is forty-five years and for men sixty years of age. After reaching these upper age limits, the person is no longer replaced in the marriage pool.

The final compulsory parameter values are the mortality schedules for males and females. The mortality schedules give the relative probability of death for each age group beginning at age interval 0 and 1-4 and continuing in five year age intervals: 5-9, 10-14, 15-19 to the last age cohort of age 80 and above. The mortality values are in thousandth percents. The values are obtained from the D(x) column of the life table representing the proportion dying in each age interval. The mortality section later in this chapter provides a detailed description of the selection of the values for the mortality schedules.

5.2.1 The Population

All simulations use a start or base population of 538 people. The total female population figures cited by Harper (1979) provided the basis for the total population figures used in the simulations. During the period 1830-1839 the total number of female Aleuts is

268 and the total number of male Aleuts is 270 (see Harper 1979:318-9).

Harper (1979:318-9) provides Aleut population figures for three periods: the precontact period (8700 B.P. to 1741 A.D.), the Russian period (1741 to 1867), and the American period (1867 to present). Harper uses skeletal data for the precontact period population figures. These skeletal remains were well preserved in middens and mummy caves (Harper 1979:318). The population information for the Russian period came from parish records kept by the Russian Orthodox Church. Bishop Veniaminov began to collect mortality data in the 1820's on Unalaska. The American government collected population information for the third period. Government censuses provided data on the numbers of living Aleuts from the American period whereas the information from the first two periods provided the numbers of deaths.

5.2.2 Mortality

I use Harper's (1979) Aleut data for the period 1830-39 to calculate the life expectancy rates for this study. During this period Aleutian males had a life expectancy level of 34.52 for ages zero to nine. The rate for Aleut females during this time span was 35.78

(Eo-9). E(x) represents the expectation of life or the average number of years remaining to be lived at age x (Coale and Demeny 1966:38). The first set of computer simulations uses these figures for the life expectancy rates.

Coale and Demeny (1966) life tables were used to calculate the mortality schedule for the simulations. Life tables describe mortality regimes. Specifically they show the chances of dying for each age interval. Coale and Demeny (1966) provide four families of life tables, each represent different patterns of mortality rates by age. The four age patterns of mortality correspond to geographic regions. I use Coale and Demeny's "west" series of life tables throughout this study. The west model life tables are based on the largest data collection of empirical populations (Howell 1979:78). The populations used to construct the west series of life tables also had levels of mortality comparable to the Aleut.

The mortality schedule uses the values from the D(x) column of a life table. D(x) is the number of deaths between age x and x+n per 100,000 people (Coale and Demeny 1966:38). The male life expectancy rate of 34.52 fell between the E(x) values for males from level seven and level eight of the Coale and Demeny (1966) Model West life table. The E(x) value for level seven is 32.484 and for level eight it is 34.892. Thus, the two figures from levels seven and eight were used to interpolate the corresponding D(x) value for the E(x) value of 34.52. The interpolation was done via the United Nations (1983) methodology as shown in Table 1.

The interpolation first requires the calculation of the theta value. Theta is equal to the central E(x) value (34.52) minus the smallest E(x) value (32.484), divided by the largest E(x) value (34.892) minus the smallest E(x) value (32.484). The theta value for this calculation is 0.846. This theta value remains constant for the next set of calculations.

The Y-value is then calculated. The Y-value is equivalent to the D(x) value in the life table. The formula for "Y" is theta (0.846) multiplied by the largest D(x) value (22706) plus 1.0 minus theta (0.846) multiplied by the smallest D(x) value (24817). The Y-value is 23031 for this example. These formulas are represented symbolically in Table 1.

I increased the mortality levels for children during the second set of computer runs. This reflects increases in childhood diseases following European contact. This increase in disease is due to contact with outside populations. The second computer simulation represents the study group for this thesis. The second series of

Table 1: Interpolation

Largest	Central	Smallest	Theta	Y-Value (Dx)
34.892	34.520	32.484	0.846	23031
22706	?	24817		

θ=[central E(x)-smallest E(x)]/[largest E(x)-smallest E(x)]
= [34.520 - 32.484]/[34.892 - 32.484]
= 2.036/2.408
= 0.846

Y = θ [largest D(x)] + [1.0 - θ][smallest D(x)]
= 0.846 [22706] + [1.0 - 0.846][24817]
= 0.846 [22706] + 0.154 [24817]
= 19209.276 + 3821.818
= 23031

simulations based on most of the same input parameters are analogous to samples drawn from a larger universe. A comparison of the two batches of computer simulations will determine the impact of childhood diseases on Aleut kinship, households and populations.

The second simulation uses a lower life expectancy of 25.26 for men and 30 for women. I selected these values directly from the Coale and Demeny (1966) Model West life tables, levels 4 and 5 respectively, because they corresponded closely with Harper's figures of 24.81 for men and 29.95 for women (Harper 1979). These life expectancy figures correspond to the 1840 to 1849 period. It was during this period that the life expectancy figures began to decline.

This decline represented increased contact with the Europeans. Europeans brought disease such as smallpox to the Aleutian Islands. The small pox epidemic occurred in 1838 (Harper 1979) and had its greatest effect during the 1840's. A second epidemic struck the Aleutian Islanders in 1848 and 1849. These smallpox epidemics strongly affected the children. During the one hundred years of Russian contact "the Aleut adaptive level had dropped nearly 10 years of life, or approximately 30 percent" (Harper 1979:322).

5.2.3 Fertility

The total fertility rate used for these simulations is 5.45. This rate remains constant throughout all computer trials. This rate is the average of thirteen non-contraceptive populations as derived by Weiss (1973:33).

These populations represented: the Bushmen data from Howell and Lee (1971), Cocos-Keeling from Smith (1960), Tiwi and Australian aborigines from Jones (1963), Fiji, Samoa and French Polynesia from McArthur (1967) and Moejoe, Fak-Fak, Nimbooran, Beneden-Waropen, Schonten-Eilandenm, Noemfoor from Groenewegen and van de Kaa (1964). The resulting fertility rates from Hassan (1981), which have been used extensively in anthropological studies (Hassan 1975, 1981) are listed in Table 2.

Table 2: Age-specific Rate (per 1,000 females)

	Age Intervals						
	15-19	20-24	25-29	30-34	35-39	40-44	45-49
Average of 13 Pop.	104	275	275	226	150	52	8

I calculated the total fertility rate of 5.45 based on these age specific fertility rates. The total fertility rate estimates the number of live births per adult women who survived through her reproductive period (ages 15 to 49). This estimate assumes that the woman will bear children at a constant age-specific rate. The mathematical formula for the total fertility rate is:

$$\text{TFR} = n \sum_{x=15}^{49} {}_nf_x \tag{5.1}$$

where n=5 if the data are grouped into five year age intervals and f is the total of the age-specific fertility rates per 1,000 females.

The fertility rate of 5.45 used in this study is also comparable to Hassan's (1975) fertility rate of 5.7 for an adult female with a longevity rate of thirty-seven years.
This rate is also comparable to fertility rates of other hunter-gatherer populations (Weiss 1973, Hassan 1975, Howell 1979, Chapman 1980).

The age specific rates listed above also determined the fertility schedule used in this study's simulations. The relative amounts of fertility in yearly intervals is calculated by first determining what percentage each age specific fertility rate is of the combined age specific fertility rates. This figure is then broken down into one-fifths, representing each year of the five year interval. These calculations are mathematically shown in Table 3.

Table 3: Calculations for Fertility Schedule

AGE	ASF			
15-19	0.104			
20-24	0.275	(ASF/Cumulative ASF)/5		
25-29	0.275			
30-34	0.226	i.e.	1)	0.104/1.09 = 10%
35-39	0.150		2)	10%/5 = 2%
40-44	0.052			
45-49	0.008			
	1.090			

The results are then used to construct a table representing percentages in tenths of fertility by yearly intervals (Tables 4 and 5).

AMBUSH uses this fertility level of 5.45, the fertility schedual and initial start population (n=538) to simulate two hundred years of population history.

Table 4: Age-specific Fertility Rates for an Average of Thirteen Anthropological Populations

Age	A.S.F.
15-19	0.104
20-24	0.275
25-29	0.275
30-34	0.226
35-39	0.150
40-44	0.052
45-49	0.008
	1.090

(Weiss 1973)

Table 5: Fertility Schedule

Age	F*	Calculations 1) (ASF/Sum ASF)=x 2) x%/5=y
15	020	1) 0.104/1.09=10%
16	020	2) 10%/5=2%
17	020	
18	020	
19	020	
20	050	1) 0.275/1.09=25%
21	050	2) 25%/5=5%
22	050	
23	050	
24	050	
25	050	1) 0.275/1.09=25%
26	050	2) 25%/5=5%
27	050	
28	050	
29	050	
30	040	1) 0.226/1.09=21%
31	040	2) 21%/5=4%
32	040	
33	040	
34	040	
35	030	1) 0.150/1.090=14%
36	030	2) 14%/5=3%
37	030	
38	030	
39	030	
40	010	1) 0.052/1.090=5%
41	010	2) 5%/5=1%
42	010	
43	010	
44	010	
45	002	1) 0.008/1.090=1%
46	002	2) 1%/5=0.2%
47	002	
48	002	
49	002	

* Fertility in yearly intervals by 10ths

The length of the simulations was chosen to ensure demographic stability and time for the program to produce sufficient genealogical data. For each mortality level, Eo = 30 and 37.78, twenty runs were conducted. Holding fertility constant while varying the mortality levels allows for the assessment of the effects of lowered mortality regimes on population household structures and kinship composition.

Chapter VI

RESULTS

The demographic analysis of the artificial populations was based on the data stored for the population during each simulation. The results are presented in three parts. The first section presents the general demographic data. The second section presents the household results, followed by the kinship results.

6.1 General Demographic Data

The random number generation feature of AMBUSH enables researchers to conduct several runs with identical parameters without producing duplicating results. Multiple runs with the same parameters are treated as samples of the universe of possible outcomes produced by runs with those parameters. The central tendency and variation of demographic parameters can therefore be studied by running AMBUSH several times with the same parameters.

Tables 10 and 11 show a striking difference between the final population sizes of the first and second simulations. The first simulation's mean final population size is 1065.4, more than twice the mean final population size of the second simulation (410.83). This reflects the impact of the increase in mortality levels during the second simulation. Put simply, the introduction of an epidemic in the second simulation resulted in a severe reduction in the end population sizes observed during that simulation.

In addition, when comparing the final population sizes to the initial population sizes, the second simulated population, after a period of two hundred years, was smaller than its initial population size. In contrast, the population which did not undergo an epidemic almost doubled its population after two hundred years. The population sizes for the first twenty runs each began with 538 people and varied between 888 and 1195 at the end of 200 years. Thus, there is less than a two-fold difference between the minimum and maximum population sizes for the first simulation. For the second simulation, the twenty runs also began with 538 individuals and the population sizes ranged between 289 and 503 after 200 years. This also represents less than double the difference between the minimum and maximum population sizes for this simulation. The annual growth rates for the artificial populations from the two

Table 6: Distribution Variation of Vital Rates for Simulated Aleut Populations

Simulation #1					
Vital Rates	Mean	Range	Variance	S.D.	Coeff. of Variat.
Initial Pop. Size	538.00	-	-	-	-
Final Pop. Size	1065.40	888.34-1195.16	8520.4750	92.31	0.09
Total Fert. Rate	4.83	4.75-4.89	0.0015	0.04	0.01
Crude Birth Rate	30.19	25.21-34.48	5.4351	2.33	0.08
Crude Death Rate	28.25	21.98-37.34	18.1440	4.26	0.15
Growth Rate (%)	65.79	-	-	-	-
Depend. Ratio	62.98	58.24-69.49	9.7176	3.12	0.05
Length of Sim. (Years)	200.00	-	-	-	-

Table 7: Distribution Variation of Vital Rates for Simulated Aleut Populations

Simulation #2					
Vital Rates	Mean	Range	Variance	S.D.	Coeff. of Variat.
Initial Pop. Size	538.00	-	-	-	-
Final Pop. Size	410.83	288.63-502.96	3004.1361	54.81	0.13
Total Fert. Rate	4.81	4.67-4.91	0.0049	0.07	0.01
Crude Birth Rate	31.83	18.98-42.98	32.9476	5.74	0.18
Crude Death Rate	38.07	30.92-46.71	22.09	4.70	0.12
Growth Rate (%)	-0.13	-	-	-	-
Depend. Ratio	56.75	50.31-67.88	22.8856	4.78	0.08
Length of Sim. (Years)	200.00	-	-	-	-

simulations were computed using the following formula derived from Kpedekpo (1982:29):

$$(6.1) \qquad r = \frac{2(P_{t+n} - P_t)}{n(P_{t+n} + P_t)}$$

where P_{t+n} is the size of the population at time (t+n), P_t is the size of the population at time t and n is the length of time. The average growth rate for the populations from the first simulation is approximately 66 percent. For the second simulation, the average growth rate is -0.13 percent. These growth rates further illustrate the decline in population size experienced by the populations in the second simulation, and the large increase in population size and the final population size observed during the first simulation.

The input population for the two simulations is 538 individuals. During the input year (99) the program prepares the population. At the end of this year, twenty of the initial individuals were removed from the population as they had reached the removal age of 81 (default value). The simulation then begins in the year 100 which is the starting year. Thus, each of the forty runs begins with a population size of 518.

The coefficient of variation (Lutz 1983:132-136) in column 5 of the tables shows the variation in the vital rates as measured by the standard deviation in relation to the mean. The formula for the coefficient of variation from Lutz (1983) is:

$$\text{C.V.} = \frac{S}{\bar{X}} \qquad (6.2)$$

The coefficients of variation show that the variation in the first simulation's runs for the final population size (CV = .09) was less than the variation in the second simulation's final population size (CV = .13). However, the differences between these variations is minor.

In fact, there is relatively little variation in the simulations for any of the vital rates listed in Tables 6 and 7. This suggests that the values generated by the computer were similar for the twenty runs within each simulation. Runs using identical input parameters yielded relatively uniform output results.

I have used the student's t-test to determine whether differences in vital rates, final population sizes and dependency ratios between the two simulations are significantly different. The student's t distribution tests the hypothesis of no difference between the means of small samples. The ratio is:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{n_1 s_1^2 + n_2 s_2^2}{n_1 + n_2 - 2}} \sqrt{\frac{n_1 + n_2}{n_1 n_2}}} \quad (6.3)$$

(from Mueller, Schuessler and Costner 1977:430)

where $\bar{X}$ is the mean, n is the sample size and s is the standard deviation.

The student's t distribution is really many distributions. They are all based on Formula 6.3, but they differ according to the degrees of freedom determined by the sample size. Degrees of freedom are calculated as follows:

$$df = n_1 + n_2 - 2 \quad (6.4)$$

Although the student's t-test formula is designed for small samples, as the degrees of freedom are increased, the t distribution takes on a more bell-shaped curve. The t distribution becomes more like a normal distribution or z distribution the larger the sample size; "even with degrees of freedom as small as 30, the critical values of t are only slightly larger than those of z" (Mueller, Schuessler and Costner

1977:435). Since this study used two sets of simulations of twenty runs each, the degrees of freedom for all the t-tests performed on the output data is equal to 38. Thus, the t-values used in this study should closely approximate the z distribution.

For the final population size, vital rates and dependency ratio t-values were calculated from Tables 6 and 7. Table 8 lists these t-values and the corresponding degrees of freedom. For the first variable listed, I anticipated that the final population size would be largest for the first simulation since the mortality level was lower than the level for the second simulation. Thus, I formulated the hypothesis that the difference between the means will be less than 0.0. The substantive hypothesis can be symbolically stated as:

H_1: $u_1 - u_2 > 0$

and the rival null hypothesis of no difference between means is:

H_0: $u_1 - u_2 = 0$.

Table 8: T-values and Degrees of Freedom for Aleut Vital Rates

Vital Rates	T-values	Degrees of Freedom	Critical Value of t*
Final Pop. Size	26.577 ($p<.05$)	38	1.686
Total Fert. Rate	1.081 N.S. ($p>.05$)	38	1.686
Crude Birth Rate	-1.154 N.S. ($p>.05$)	38	-1.686
Crude Death Rate	-6.748 ($p<.05$)	38	-1.686
Depend. Ratio	4.757 ($p<.05$)	38	1.686

* 0.05 level of significance for a one-tailed test

The directional nature of the alternative hypothesis, H_1, determines that this will be a one-tailed test.

The critical value of t, given the degrees of freedom equal to 38, for a one-tailed test at the level of significance of 0.05 is 1.686. All remaining t-tests will also be one-tailed or directional tests and they will all be at the significance level of 0.05 and will therefore all have 1.686 as the critical value of t. The 0.05 probability level was chosen to conform with the standards of most statistical studies within the social sciences.

The test statistic shown in Table 8 (26.577) compared to the tabular statistic (1.686) shows that the test statistic is in the rejection region that begins to the right side of +1.686. For this reason, I reject the null hypothesis. The sample result would not occur with more than 0.05 probability assuming the null hypothesis to be true.

Given the rejection of the null hypothesis, the assumption that the population of the first simulation would be larger than the population of the second simulation is supported. The simulated epidemic greatly decreased the population size and after two hundred years the population was less than half the size it would have been had the European diseases not been introduced to the population.

Analysis of the other variables in Tables 6 to 8 yielded similar results. For example, the crude death rate and the dependency ratio also differed significantly between the two simulations. The crude death rate for the first simulation (28.25) was significantly lower than the crude death rate for the second simulation (38.07). Again, this was an expected result given the increase in the mortality regime for the second simulated population.

The dependency ratio for simulation number one (62.98) is significantly higher than the ratio for simulation number two (56.75). The dependency ratio is the relative number of dependents in relation to the number of productive people in the population. The dependency ratio is the ratio of children under 15 years of age plus persons aged 65 and over to persons aged 15-64 years. The dependency ratio is expressed as:

$$(6.5)\ \text{Dep.Ratio} = \frac{(\text{child.} < 15 \text{ years}) + (\text{persons} \geq 65)}{\text{persons aged } (15\text{-}64)\text{years}} \times 100$$

(from Kpedekpo 1982:15)

The dependency ratio was calculated for each of the twenty runs per simulation (see Tables 19 and 20 in Appendix). These ratios were then summarized and the variations were calculated (Tables 6 and 7). For the first simulation, the dependency ratio was approximately 63 dependents per 100 productive persons. This ratio is close to the upper range for developed countries. In most of the developed countries, the dependency ratio is between 50 and 70 dependents per 100 in the 15-64 age group (Kpedekpo 1982:16).

The dependency ratio for the second simulation is significantly lower at about 57 dependents per 100 productive persons. These rates illustrate that the simulated epidemics had a stronger effect on the dependent age-groups within the population than on the productive persons. These diseases especially affected the children between the ages of 0 and 14.

The total fertility rate and the crude birth rate (Tables 6 to 8) did not differ significantly between the two simulations. For these two variables the test statistic did not fall into the rejection regions, therefore I was not able to reject the null hypothesis. The increase in the mortality level did not significantly alter the total fertility rate and the crude birth rate for the simulated population.

6.2 Kinship Ties

AMBUSH uses demographic processes to generate kinship ties. The simulation produces a basic kinship inventory, allowing researchers to count kin ties and compare kinship relationships between males and females and various age groups. AMBUSH counts the following basic types of relatives: fathers, mothers, spouse, sons, daughters, grandfathers, grandmothers, grandsons, granddaughters, cousins, uncles, aunts, nephews and nieces.

For this study I will focus on the following kin: mothers, fathers, grandmothers and grandfathers and maternal uncles. I have limited my analysis to these kin because AMBUSH is based on the bilateral kinship system of the !Kung whereas some references claim that prior to contact, Aleuts probably had a matrilineal kinship system. This assumption regarding the Aleut kinship system is based on the central role maternal uncles had in Aleut society. Maternal uncles were responsible for training their nephews and supervising the training of their nieces (Lantis 1970:228; Jones 1976:17).

Other sources suggest that traditional Aleut society may have been matrilineal but a bilateral system developed by the 20th century (Shade 1949). By 1839, the first year of the simulations for this study, I believe that the Aleuts' kinship system already showed signs of bilaterality and by the end of the 200 year simulation the Aleuts had a totally bilateral system.

Regardless of the simulated kinship system, these basic kin would be counted in the same manner.

I begin with the percentage of males without fathers. The percentage of males without fathers from each of the twenty runs for the two simulations is provided in Tables 21 and 22 (see Appendix). The second simulation has a higher percentage of males without fathers than the first simulation for all of the age intervals (Table 31 in the Appendix and Table 9). These differences are significant at the 0.05 probability level for the first four age intervals. The t-value for ages 50-59 is not large enough to reject the null hypothesis, therefore there is not a significant difference between the two simulations for the percentage of males without fathers in the age group 50-59.

Tables 23 and 24 (see Appendix) show the parallel percentages of females without mothers for all forty computer runs. These percentages are summarized in Table 10 (also see Table 32 in Appendix). There is a systematic difference between the two simulations for the percentages of females who do not have a surviving mother. The differences between the simulations are significant at the 0.05 level of significance for all of the age intervals (Table 13).

Table 9: Means and Standard Deviation of Percentage of Males Without Fathers

	Simulation number					
	1			2		
Age	Mean	S.D.	n	Mean	S.D.	n
0-9	15.4	1.68	20	33.9	3.40	20
10-19	25.4	2.57	20	40.5	4.03	20
20-29	44.7	5.40	20	61.0	4.83	20
30-39	63.7	3.77	20	76.8	4.62	20
40-49	86.7	2.77	20	93.7	2.25	20
50 +	97.7	21.89	20	98.5	50.29	20

Table 10: Means and Standard Deviation of Percentage of Females Without Mothers

	Simulation number					
	1			2		
Age	Mean	S.D.	n	Mean	S.D.	n
0-9	14.5	1.8	20	32.6	4.7	20
10-19	22.7	1.9	20	33.0	5.2	20
20-29	37.3	2.5	20	52.7	4.6	20
30-39	52.9	2.3	20	64.1	3.8	20
40-49	74.5	2.5	20	83.6	3.3	20
50-59	94.4	1.7	20	97.4	1.2	20
60 +	99.0	0.4	20	-	-	-

The probability of males not having a living father is higher than that of females not having a living mother. Part of this difference is that fathers are at risk of death for nine months longer than mothers. The fathers only have to be alive at conception whereas mothers must by alive at the birth of their child (Howell 1979:310). A more important source of the difference is that fathers are usually older than mothers, therefore they are at a greater risk of dying during each interval.

Grandparent ties are determined before birth, so the probability of death of the grandparent determines the number of grandparents in each age group. Tables 25 to 28; Tables 33 and 34 (in Appendix) and Tables 11 and 12 list the distributions and summarize the percentages

Table 11: Means and Standard Deviation of Percentage of Males Without Grandfathers

	Simulation number					
	1			2		
Age	Mean	S.D.	n	Mean	S.D.	n
0-9	39.2	4.6	20	59.0	6.2	20
10-19	63.4	4.2	20	78.4	4.8	20
20-29	88.8	2.1	20	94.7	2.2	20
30-39	98.5	1.2	20	98.2	1.0	20
40-49	99.7	0.0	20	-		20

Table 12: Means and Standard Deviation of Percentage of Females Without Grandmothers

	Simulation number					
	1			2		
Age	Mean	S.D.	n	Mean	S.D.	n
0-9	28.4	1.9	20	46.4	4.6	20
10-19	47.0	3.2	20	59.8	5.9	20
20-29	76.7	3.0	20	86.3	3.3	20
30-39	95.6	1.3	20	97.8	1.2	20
40-49	99.5	0.1	20	99.3	0.1	20

Table 13: T-values and Degrees of Freedom for Simulated Aleut Populations

Age	T-values	Degrees of Freedom
Percentage of Males Without Fathers		
0-9	- 2.126	38
10-19	- 13.771	38
20-29	- 9.807	38
30-39	- 9.576	38
40-49	- 8.550	38
50-59	- 0.064 N.S.	38
Percentage of Females Without Mothers		
0-9	- 15.676	38
10-19	- 8.110	38
20-29	- 12.822	38
30-39	- 10.991	38
40-49	- 9.581	38
50-59	- 6.284	38
Percentage of Males Without Grandfathers		
0-9	- 11.179	38
10-19	- 10.251	38
20-29	- 5.218	38
30-39	0.837 N.S.	38
Percentage of Females Without Grandmothers		
0-9	- 15.765	38
10-19	- 8.313	38
20-29	- 9.481	38
30-39	- 5.420	38

of males without grandfathers and the percentages of females without grandmothers. The percentage of males without grandfathers and females without grandmothers are higher for the second simulation for all age groups except 30-39 years for males without grandfathers and 40-49 years for females without grandmothers. Likewise, all of the differences between the two simulations for percentages without grandparents are significant at the 0.05 level with the exceptions of the respective aforementioned age intervals (Table 13). These exceptions are probably due to stochasic noise as the numbers only differ by 0.2% for males and 0.3% for females. There is a higher percentage of grandmothers alive at each age interval than grandfathers and the grandmothers also live longer than grandfathers.

Lastly, due to the emphasis placed on maternal uncles by the Aleuts, I looked at changes in the proportion of mother's brother for males between the two simulations (see Tables 14 and 15; and Tables 29, 30 and 35 in Appendix). The percentage of males without maternal uncles is significantly higher in the second simulation for all age ranges except ages 60 to 69. AMBUSH only records the total number of uncles (maternal and paternal), but the figures are given as a percentage of both males and females who have no uncles, one uncle, two uncles etc. Therefore, since I am only interested in the percent of males without maternal uncles there was no need to divide the proportion of uncles in half to specify maternal uncles. The percentage of males without maternal uncles would be the same as the percentage of males without any uncles. All kinship ties reveal the effects that increased mortality levels have on a population. In simulation number two, the higher mortality levels reduced the numbers of kin in the older generations (fathers, mothers, grandfathers and grandmothers and uncles). The reduction in the percentage of older kin would effect the household compositions. Household sizes would become smaller as a result of the earlier loss of fathers and mothers. Also the economic knowledge the older generations hold would be reduced and in some cases lost.

This would make it more difficult for the population to adapt to environmental changes and may even negatively effect the population's chances of survival.

Table 14: Means and Standard Deviation of Percentage of Males Without Maternal Uncles

	Simulation number					
	1			2		
Age	Mean	S.D.	n	Mean	S.D.	n
0-9	11.0	0.7	20	32.2	2.5	20
10-19	9.0	0.7	20	28.4	2.8	20
20-29	23.0	0.9	20	52.4	3.4	20
30-39	37.8	1.7	20	67.8	2.9	20
40-49	62.4	2.4	20	85.8	2.1	20
50-59	86.0	1.7	20	95.0	1.2	20
60-69	97.2	0.8	20	96.6	0.6	20
70 +	98.0		20			

Table 15: T-values and degrees of freedom for simulated Aleut Populations

	Percentage of Males Without Maternal Uncles	
Age	T-values	Degrees of Freedom
0-9	-17.797	38
10-19	-14.650	38
20-29	-18.218	38
30-39	-19.450	38
40-49	-15.992	38
50-59	-9.426	38
60-69	1.308 N.S.	38

6.3 Households

The household mean sizes produced by AMBUSH are summarized in Tables 16 and 17. From these tables, we can see that the mean household sizes are smaller for each fifty year simulation interval in the second simulation than in the first simulation. This difference in household size is significant at the 0.05 level for a one-tailed test for each of the four simulation years (Table 18). It would therefore appear that the decrease in mortality levels in the second simulation caused a decrease in household size. This discrepancy in household size increased as the simulations progressed, with the greatest difference in mean household size between the two simulations occurring at the end of the two hundred year simulation period.

As a result of differences in the definition of a household, these AMBUSH measures regarding household sizes may not accurately reflect Aleut household sizes. AMBUSH's definition of a household is more western in nature, with married couples and their children under 15 years of age forming a household. The allocation rule

Table 16: Distribution Variation of Households by Mean Size

Simulation #1						
Sim. Year	n	Mean	Range	Variance	S.D.	Coeff. of Variat.
150	20	2.98	2.83-3.21	0.0087	0.093	0.031
200	20	3.05	2.85-3.24	0.0082	0.090	0.030
250	20	3.08	2.88-3.23	0.0076	0.087	0.028
300	20	3.10	2.83-3.21	0.0081	0.090	0.029

Table 17: Distribution Variation of Households by Mean Size

Simulation #2						
Sim. Year	n	Mean	Range	Variance	Standard Deviation	Coeff. of Variat.
150	20	2.78	2.55-2.98	0.0167	0.125	0.045
200	20	2.78	2.53-3.04	0.0211	0.145	0.052
250	20	2.73	2.50-2.96	0.0166	0.129	0.047
300	20	2.74	2.55-2.96	0.0119	0.109	0.040

Table 18: T-values and Degrees of Freedom for Aleut Household by Size

	Household Size	
Simulation Year	T-values	Degrees of Freedom
150	5.596	38
200	6.896	38
250	9.805	38
300	11.101	38

for household composition was originally based on !Kung households. The !Kung appear to have had smaller household sizes than the Aleuts.

During the simulated time period, the Aleuts practised polygamy and often resided in a shared dwelling with several other families. This household composition is not analogous to the households simulated by AMBUSH. Thus, the household results may be unrealistic for an Aleut society. The simulated households produce far more households with one or two members than would have been the case in an Aleut society during the mid-1800's.

For the Aleuts, family composition was not necessarily the same as that of the household. The family may consist of a man, his wife or wives and his offspring whereas the household may also include nephews, married sons and their families and younger brothers and their families (Lantis 1970:272).

Chapter VII

SUMMARY AND DISCUSSION

7.1 Summary

The aim of this study was to examine the effects of epidemics on Aleut populations, households and families. European epidemics have had a tremendous impact on indigenous populations throughout the New World. Most researchers now agree that disease caused massive reductions in native populations at the time of contact. Several analytical methods have been used to estimate pre-historic and proto-historic native population figures. Historical, archaeological, ethnohistorical and ethnoarchaeological methods have yielded important information about pre-contact and post-contact populations. These techniques have also been used to gather epidemiological information and to describe population changes resulting from relocation, immigration and the merging of populations.

Historical and archaeological techniques are generally used to answer larger questions about native populations. Other methods must be employed to answer questions about smaller scale changes that occur within populations. Computer simulations are a useful way to link studies that focus on the macro issues of aboriginal population changes with the resulting micro-level changes that occur within populations.

As we have seen in this study, a simulation approach can also be used to examine the effects of changing demographic rates on kinship ties. AMBUSH allowed me to analyze the range of population changes that could have resulted from the introduction of European epidemics to the Aleutian region.

The analysis is limited to the changes that could occur given a particular increase in mortality levels. The simulation results are not intended to be interpreted as a projection of population trends until the year 2039 A.D. The purpose of this study is to examine how changes in one demographic variable (mortality) can effect other aspects of the population (demographic variables, household composition and kin relationships). As responces to the epidemic are not included in the simulation, the results of this study are not to be viewed as a simulation of actual historical demographic events during the period 1839 - 2039 A.D.

This study examines the specific changes in demographic parameters, in household composition and in kinship structures which could result from increases in mortality levels.

7.2 Discussion

7.2.1 Historical Data

Historical records describing Aleut society provide a broad outline of the society but they do not provide detailed information about specific aspects of family composition or kinship ties. Existing historical records approximate aboriginal population sizes during the early contact period although these figures are sometimes contradictory and not always comprehensive. Historical records provide some estimates of total population figures but they often do not provide more detailed demographic information. In the absence of detailed demographic information, traditional demographic techniques cannot be used to analyze the specific changes which occur in a society as a result of epidemics.

Although some historical information is available about Aleut household and kinship structures, the reports of Aleut household composition are quite general and the data concerning kinship structures are limited.

Based on the earlier reports from the Aleutian region (Jochelson 1925; Sarytchev 1792) the Aleuts had a lineal kinship system. References from Veniaminov (1984) indicate that maternal uncles played an important role in Aleut society. It is probable that prior to contact the Aleuts had a matrilineal system. Some changes to the traditional Aleut kinship system may have taken place during the post-contact period mainly as a result of village relocation by the Russian officials.

7.2.2 Simulations

The inspiration for this study was derived from questions about the impact of depopulation on household composition and kinship structures. A computer simulation was used to assess these changes within Aleut populations because existing records are incomplete and lack the detail needed for an accurate assessment of the effects of depopulation on household and family structures. Simulations not only allow researchers to examine possible changes in a population at both the macro and micro levels, they also illustrate the processes. The process of depopulation can be examined in detail through the use of a computer simulation such as AMBUSH.

The purpose of computer simulations is not to reproduce a real population. Simulations can be used to examine the impact of specific demographic changes on other aspects of a population. Simulation results have been shown to yield similar demographic measures to those of reconstructed populations (Roth 1980).

Simulations can also provide approximate values for demographic parameters which could not be recorded for prehistoric populations or for parameters which are difficult to determine for historic populations. Researchers have also used simulations to gain insights about a population under study (MacCluer, Neel and Chagnon 1971). Discrepancies between variable frequencies in the artificial population and frequencies in the real population can reveal additional information about features of the society previously overlooked.

7.3 Conclusions

The kinship counts provided by AMBUSH have been used to analyze the effects of disease on the relationships between kin. Changes in the number and types of kin within the family unit have social and economic implications for the entire population. Several scenarios are possible: the emotional and financial ties between parents and children or between grandparents and grandchildren may be strengthened or non-relatives may assume some of the parenting responsibilities usually allocated to relatives (Goldman 1986). Child care responsibilities may indeed need to be dispersed among other members of the community as the simulations indicated that the numbers of orphans rose sharply due to the population reductions caused by epidemics. A third possibility is that a decrease in the number of elderly will make it difficult for the population to successfully adapt to environmental and social changes. Changes in mortality directly determine the number of kin in a family. Both the number of kin who are born under a particular mortality regime and the number of kin who die at each age interval are effected by changes in mortality. This thesis studied the numbers of living kin for a fixed fertility schedule and two levels of life expectancy: e_0 = 30 and 37.78 years. The level of fertility (GRR = 3) is similar to gross reproductive rates of developing countries where there is little fertility control (Goldman 1986:82).

The differences between the low and high life expectancy populations were considerable. In a society with e_0 = 37.78 the odds of an individual knowing older kin were much lower than for an individual in a population with $e_0 = 30$. Other studies have noted the effects of increased life expectancies on the survival of older kin (Preston 1974, Martin and Culter 1983, Goldman 1986). In populations with lower death rates, such as the populations from the first simulation in this study, children spend more years with kin from other generations such as parents and grandparents.

The reduction in the number of old people in Aleut populations is reflected in the lower numbers of grandparents in the second simulations and also in the reduction of the dependency ratios in the simulations reflecting the impact of epidemics. Although in many societies a drop in the dependency ratio would be advantageous for the community, the Aleuts depended strongly upon their elderly to help educate and care for their children. The elderly also had specialized knowledge about certain traditional medical practices.

The lower dependency ratio in the second simulation illustrate some of the changes associated with an increase in the mortality schedule. The second simulation's dependency ratio more closely reflects the dependency ratio of a developed country than the ratio observed during the first simulation.

Although a reduction in the dependency ratio may be economically favourable for populations within developed nations, a slightly higher dependency ratio may be economically advantageous for small hunter-gatherer or pastoral groups. "Having large numbers of kin may actually increase the probability of survival and reproduction for some individuals, perhaps through improvements in the diet of those who are central in the kinship system compared to those who are marginal" (Howell 1979:331). This can be the case in a population where children make significant economic contributions to the society or, in the case of the Aleuts, where the elders retain much of the knowledge regarding religious and subsistence activities.

The Aleuts have higher average life expectancies than other populations within similar northern regions (Laughlin and Wolf 1979:10). These higher rates have been attributed to the Aleuts' ecological-cultural adaptations (Harper 1979). These adaptations have been achieved in part through the economic contributions of the elderly within the society. Such economic contributions would be severely altered by changes in mortality levels.

Although Harper argues correctly that the elderly in Aleut societies significantly contributed to their successful environmental adaptations, he does not integrate fluctuations in the sizes of populations or in the percentages of older Aleuts. Despite the fact that he points out the reductions in Aleut populations during the contact periods, his argument regarding the successful adaptation of the Aleuts seems to assume a fairly stable environment and population.

I believe that the Aleuts were able to survive several epidemics due to kinship adaptations, not environmental adaptations. The increased number of orphans and the decreases in numbers of parents and grandparents may have produced an increased need for adoptions within the society. One of the methods the Aleuts may have adopted as a result of the increase in orphans is to create more kinship relationships with consanguine kin. This would be one explanation for the shift from a matrilineal to a more flexible bilateral kinship system.

Another family level adaptation that the Aleuts may have used is adoption. There is some evidence in the literature that suggests adoption was practised by the Aleuts (Veniaminov 1984; Shade 1949). Both family members and strangers may have adopted children either to aid children who were orphaned or to replace their own children who died from disease. The less structured bilateral kinship system may also have been better suited to these increases in the number of adoptions.

The importance of this study is that it focuses on the micro-level of changes that occur at the family level rather than remaining at the macro-level looking only at depopulation in terms of changes in total population figures. Population stresses create fluctuations in kinship and family formation and it is important to study these smaller scale changes in tandem with the larger scale population changes. It is hoped that this study will add to the present body of knowledge of changes that take place at the household and family levels.

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APPENDIX:

SIMULATION RESULTS

Table 19: Dependency Ratio

Simulation #1									
				Run Number					
1	2	3	4	5	6	7	8	9	10
60.10	61.00	60.71	62.82	68.05	61.36	63.80	65.60	63.74	64.26
				Run Number					
11	12	13	14	15	16	17	18	19	20
58.62	59.70	66.23	59.68	58.24	63.65	65.89	69.49	61.96	64.75

Table 20: Dependency Ratio

Simulation #2									
				Run Number					
1	2	3	4	5	6	7	8	9	10
54.66	57.14	59.70	54.87	55.60	63.22	58.39	53.92	51.88	50.33
				Run Number					
11	12	13	14	15	16	17	18	19	20
58.64	53.11	67.88	55.09	52.04	53.31	50.31	59.51	63.46	62.01

Table 21: Percentage of Males Without Fathers (from Simulation 1)

	Age					
Run	0-9	10-19	20-29	30-39	40-49	50+
1	15.9	21.9	46.1	66.1	86.1	97.8
2	13.6	23.4	46.2	68.6	91.8	98.4
3	14.6	28.4	43.0	63.3	84.7	98.3
4	16.1	27.7	44.2	69.6	88.2	98.1
5	16.9	25.9	43.8	64.4	85.9	97.9
6	18.8	27.0	46.4	63.0	86.9	96.2
7	12.6	22.4	46.8	66.2	84.6	98.8
8	14.7	28.5	42.6	60.6	87.6	98.4
9	18.2	29.0	51.5	60.0	89.3	98.8
10	15.2	25.0	35.2	66.3	85.9	98.4
11	15.8	20.4	43.5	60.9	89.8	96.6
12	12.7	22.5	43.9	60.3	88.4	97.3
13	16.1	24.0	42.4	63.6	85.0	97.2
14	17.3	26.1	50.8	71.6	88.6	–
15	15.5	25.3	45.6	64.3	83.6	95.1
16	15.2	25.3	48.2	65.0	84.9	96.2
17	15.3	23.3	45.2	60.0	88.7	99.6
18	14.4	27.4	43.8	64.6	84.8	98.3
19	13.5	26.0	41.4	66.0	87.5	97.0
20	15.9	29.4	42.4	59.6	80.8	98.8

Table 22: Percentage of Males Without Fathers (from Simulation 2)

	Age					
Run	0-9	10-19	20-29	30-39	40-49	50+
1	38.3	37.8	62.5	73.2	93.0	98.9
2	36.7	41.6	70.8	82.6	95.4	-
3	33.0	40.4	65.9	74.8	74.8	91.0
4	34.6	38.1	66.0	76.8	93.7	99.1
5	37.9	43.5	63.0	73.3	90.3	98.0
6	33.3	39.5	55.3	76.6	90.0	-
7	31.3	38.3	62.5	78.0	92.2	-
8	31.8	34.6	59.5	78.6	92.2	-
9	42.1	47.8	70.7	90.2	94.6	-
10	33.9	40.2	59.0	78.3	95.1	-
11	29.6	38.3	60.1	79.3	98.4	-
12	31.8	40.0	63.8	72.4	94.4	99.0
13	33.2	42.9	59.5	83.0	95.9	-
14	33.4	43.1	61.4	76.0	90.0	97.1
15	37.8	46.0	58.3	73.6	94.6	-
16	29.6	37.5	63.2	71.7	95.3	-
17	32.1	41.9	58.2	71.2	93.9	98.3
18	30.0	36.8	66.2	74.1	94.8	98.4
19	30.7	33.3	68.0	73.3	91.2	-
20	37.1	48.8	65.8	78.9	96.1	98.9

Table 23: Percentage of Females Without Mothers (from Simulation 1)

	Age						
Run	0-9	10-19	20-29	30-39	40-49	50-59	60+
1	15.2	26.7	33.2	54.5	79.8	95.2	99.1
2	12.1	20.6	34.7	45.6	74.7	91.1	99.3
3	14.8	24.7	37.7	53.0	77.4	97.2	-
4	14.9	26.2	40.6	52.9	74.4	93.0	-
5	14.0	22.8	35.0	53.7	72.1	95.0	99.2
6	16.9	23.0	38.3	53.9	70.1	96.1	-
7	13.3	19.0	33.9	51.7	72.5	93.5	-
8	12.2	21.1	40.2	52.6	73.4	97.3	-
9	15.6	22.2	36.3	52.2	75.1	94.5	-
10	16.0	22.8	36.5	57.2	74.6	93.1	-
11	16.1	22.2	35.2	53.0	73.9	96.7	98.3
12	12.9	24.0	40.8	53.4	70.3	93.1	99.3
13	14.6	22.1	34.6	54.3	74.1	91.8	-
14	17.5	20.7	35.8	50.6	77.0	94.6	-
15	14.9	22.1	38.4	53.6	73.4	94.7	-
16	15.3	22.6	36.8	54.8	76.0	93.0	-
17	16.9	20.8	39.5	51.2	72.7	96.4	99.3
18	11.2	23.6	40.1	52.8	74.1	92.9	99.2
19	12.6	21.8	37.0	55.7	76.9	94.7	-
20	13.5	25.1	41.1	51.6	78.3	94.8	98.6

Table 24: Percentage of Females Without Mothers (from Simulation 2)

	Age					
Run	0-9	10-19	20-29	30-39	40-49	50+
1	29.7	28.1	52.6	60.3	80.8	97.7
2	37.8	35.7	48.5	62.2	81.8	98.0
3	33.3	32.4	56.9	65.9	82.3	95.1
4	29.5	27.5	48.3	55.4	80.9	98.5
5	31.7	24.6	50.0	60.0	84.0	96.5
6	33.7	41.2	55.7	69.2	80.3	96.5
7	34.5	29.7	49.1	61.2	90.1	97.4
8	28.7	36.7	48.8	68.0	83.8	97.5
9	46.7	38.3	57.4	62.1	87.0	99.0
10	30.8	27.2	54.2	62.6	85.4	99.1
11	32.8	32.9	50.8	61.8	77.2	96.5
12	27.9	29.1	50.4	65.0	83.0	99.2
13	31.6	28.8	54.3	66.8	84.0	95.5
14	37.6	35.1	52.6	59.6	86.0	96.3
15	35.2	36.2	48.7	67.2	83.3	96.2
16	27.0	32.1	46.2	65.5	84.8	97.3
17	26.2	33.7	54.6	63.4	85.6	97.9
18	29.8	34.8	57.4	68.2	81.9	98.2
19	30.6	30.6	50.9	68.8	80.0	96.4
20	36.4	45.9	65.8	68.8	90.5	99.0

Table 25: Percentage of Males Without Grandfathers (from Simulation 1)

	Age				
Run	0-9	10-19	20-29	30-39	40-49
1	42.7	71.6	89.2	99.4	-
2	43.7	68.6	90.8	98.6	-
3	37.7	64.8	87.0	97.9	-
4	44.2	68.6	90.5	99.5	-
5	31.7	62.8	88.8	98.4	-
6	42.9	68.4	87.0	98.6	-
7	36.6	64.2	91.7	99.5	-
8	42.3	61.9	90.1	98.3	-
9	38.6	61.4	89.3	98.5	-
10	29.7	55.6	87.3	97.8	-
11	41.4	64.4	87.1	99.4	-
12	39.9	67.4	89.9	99.5	-
13	37.8	60.4	88.2	98.7	-
14	50.0	70.7	89.6	98.8	-
15	37.4	61.8	85.0	94.8	99.7
16	37.1	60.8	85.2	97.7	-
17	39.8	63.8	93.2	99.7	-
18	38.0	57.7	87.2	96.7	-
19	39.0	63.3	89.9	97.8	-
20	33.8	59.3	88.1	99.7	-

Table 26: Percentage of Males Without Grandfathers (from Simulation 2)

	Age				
Run	0-9	10-19	20-29	30-39	40-49
1	52.9	76.6	92.1	-	-
2	67.3	83.8	92.1	-	-
3	61.5	74.3	92.1	96.3	-
4	55.7	79.8	94.8	94.5	-
5	54.4	73.0	94.5	-	-
6	57.2	78.4	96.0	-	-
7	63.4	80.2	94.9	-	-
8	55.0	76.3	95.5	-	-
9	76.8	84.0	96.4	-	-
10	63.5	80.4	92.7	-	-
11	60.0	84.1	96.5	99.2	-
12	57.0	74.4	95.5	99.3	-
13	62.0	78.3	98.2	-	-
14	57.3	71.2	90.6	97.5	-
15	55.3	70.3	93.2	-	-
16	57.0	80.7	96.5	99.3	-
17	52.0	74.7	94.1	97.6	-
18	50.0	79.4	90.9	96.5	-
19	56.0	76.9	96.1	98.5	-
20	65.2	89.6	94.5	98.2	-

Table 27: Percentage of Females Without Grandmothers (from Simulation 1)

	Age				
Run	0-9	10-19	20-29	30-39	40-49
1	31.2	54.5	79.8	96.9	-
2	24.5	40.4	75.4	95.1	-
3	28.2	51.3	79.4	97.6	-
4	28.6	47.3	72.1	95.1	99.6
5	27.0	48.0	79.3	94.0	99.8
6	32.7	49.3	72.0	94.7	-
7	27.3	49.2	73.8	96.1	-
8	26.3	44.7	80.3	95.4	-
9	27.8	46.1	79.4	96.5	-
10	26.5	43.6	74.7	97.7	-
11	27.5	49.6	75.8	94.5	99.6
12	30.0	44.4	72.2	96.0	-
13	29.1	44.2	76.1	94.5	-
14	31.3	47.6	80.7	97.9	-
15	28.7	45.6	77.5	95.2	-
16	27.0	50.0	75.1	94.1	99.3
17	29.1	45.2	74.7	96.1	99.6
18	26.5	46.8	74.0	93.1	-
19	29.0	47.6	80.8	95.6	-
20	29.6	44.5	73.8	95.3	-

Table 28: Percentage of Females Without Grandmothers (from Simulation 2)

	Age				
Run	0-9	10-19	20-29	30-39	40-49
1	39.4	50.8	79.2	-	-
2	45.4	69.1	84.7	96.8	-
3	48.6	61.7	88.5	98.5	99.3
4	37.2	55.1	80.9	89.4	99.2
5	43.0	60.2	87.2	97.2	-
6	50.4	60.0	85.6	98.4	-
7	44.1	60.0	90.8	98.5	-
8	53.6	58.3	89.8	98.8	-
9	56.1	63.3	88.0	89.0	-
10	44.4	65.3	90.9	96.2	-
11	48.4	56.9	81.2	97.8	-
12	46.5	62.9	85.7	97.5	-
13	48.0	63.2	86.1	96.6	-
14	44.6	63.5	87.6	97.5	-
15	50.0	51.9	85.9	97.4	-
16	43.0	61.0	87.7	99.3	-
17	40.3	61.1	89.3	98.4	-
18	49.1	54.6	83.4	95.2	-
19	48.0	57.3	84.6	99.3	-
20	48.8	72.2	89.0	97.2	-

Table 29: Percentage of Males Without Maternal Uncles (from Simulation 1)

	Age							
Run	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70+
1	12.0	8.2	26.2	42.6	68.4	86.8	96.8	98.0
2	10.2	9.4	22.4	40.0	70.4	86.0	97.6	-
3	11.8	9.0	22.2	37.8	67.0	84.2	96.6	-
4	10.6	11.4	25.6	41.0	58.8	86.8	92.8	-
5	9.6	8.8	23.0	35.0	56.4	80.6	96.4	-
6	12.8	9.2	23.8	41.0	65.8	87.2	97.6	-
7	9.6	8.0	24.6	42.0	61.2	86.8	98.4	-
8	9.6	8.4	24.4	35.4	61.8	83.2	95.4	-
9	11.6	8.8	23.2	34.8	71.4	93.0	99.2	-
10	10.8	9.2	21.6	30.8	64.8	89.4	96.2	-
11	11.2	8.8	21.0	39.8	62.4	90.8	98.2	-
12	10.4	8.0	20.2	34.8	59.6	81.8	95.8	-
13	9.6	7.6	22.2	36.4	59.6	86.4	96.4	-
14	14.8	12.8	25.2	44.2	64.8	87.0	98.2	-
15	11.6	7.4	22.8	39.0	54.4	80.8	97.6	-
16	10.8	11.0	24.6	37.4	61.0	82.4	97.4	-
17	11.8	10.4	25.8	38.6	63.0	90.8	99.2	-
18	11.6	9.2	21.0	32.6	54.0	87.2	98.4	-
19	9.6	6.8	20.6	34.8	59.8	84.4	99.2	-
20	9.8	8.2	22.4	39.0	61.8	84.8	96.8	-

Table 30: Percentage of Males Without Maternal Uncles (from Simulation 2)

	Age						
Run	0-9	10-19	20-29	30-39	40-49	50-59	60+
1	37.0	22.2	47.4	60.6	80.8	98.0	-
2	37.4	32.2	59.8	70.2	84.4	97.0	-
3	29.6	27.4	51.4	69.2	83.0	96.4	-
4	27.4	21.6	49.2	61.8	83.6	95.6	-
5	38.0	24.6	51.0	64.8	90.8	91.2	96.0
6	33.4	28.8	51.4	68.4	79.2	92.8	-
7	28.6	37.6	25.4	72.4	86.8	97.4	-
8	30.4	20.6	44.6	62.6	89.2	96.2	-
9	45.6	35.2	71.6	80.4	94.6	95.0	-
10	32.2	20.6	47.6	75.0	88.8	93.8	98.0
11	28.8	30.6	56.6	60.4	86.8	97.4	-
12	28.4	23.2	56.0	59.6	78.4	92.6	-
13	28.0	32.2	59.0	67.6	86.8	92.2	-
14	33.4	28.8	50.2	72.0	84.6	88.6	96.0
15	39.8	35.2	55.8	69.4	81.0	95.8	-
16	28.8	28.6	48.0	62.0	85.2	92.8	-
17	29.2	30.6	41.2	68.8	86.0	94.2	-
18	27.2	21.0	45.4	65.8	88.0	98.8	-
19	28.6	29.0	52.4	66.0	83.8	95.4	-
20	34.2	37.0	59.8	78.0	91.4	94.6	-

Table 31: Percentage of Males Without Fathers in Two Simulated Populations

	Simulation Number			
	1		2	
Age	Mean	Range	Mean	Range
0-9	15.4	12.6-18.8	33.9	29.6-42.1
10-19	25.4	20.4-29.4	40.5	33.3-48.8
20-29	44.7	35.2-51.5	61.0	52.5-70.8
30-39	63.7	56.8-71.5	76.8	71.2-90.2
40-49	86.7	80.8-91.8	93.7	90.0-98.4
50 +	97.7	95.1-99.5	98.5	97.1-99.1

Table 32: Percentage of Females Without Mothers in Two Simulated Populations

	Simulation Number			
	1		2	
Age	Mean	Range	Mean	Range
0-9	14.5	11.2-17.5	32.6	26.2-46.7
10-19	22.7	19.0-26.7	33.0	24.6-45.9
20-29	37.3	33.2-41.1	52.7	46.2-65.8
30-39	52.9	45.6-57.2	64.1	55.4-69.2
40-49	74.5	70.1-79.8	83.6	77.2-90.5
50-59	94.4	91.1-97.3	97.1	95.1-99.2
60 +	99.0	98.3-99.3		

Table 33: Percentage of Males Without Grandfathers in Two Simulated Populations

	Simulation Number			
	1		2	
Age	Mean	Range	Mean	Range
0-9	39.2	29.7-50.0	59.0	50.0-76.8
10-19	63.4	56.6-71.5	78.4	70.3-89.6
20-29	88.8	85.0-93.2	94.7	90.6-98.4
30-39	98.5	94.8-99.7	98.2	96.5-99.3
40-49	99.7	99.7-99.7		

Table 34: Percentage of Females Without Grandmothers in Two Simulated Populations

	Simulation Number			
	1		2	
Age	Mean	Range	Mean	Range
0-9	28.4	24.5-32.7	46.4	37.2-56.1
10-19	47.0	40.4-54.5	59.8	50.0-72.2
20-29	76.6	72.0-80.8	86.3	79.2-90.9
30-39	95.6	93.1-97.9	97.8	95.2-99.4
40-49	99.5	99.3-99.6	99.3	99.2-99.3

Table 35: Percentage of Males Without Maternal Uncles in Two Simulated Populations

	Simulation Number			
	1		2	
Age	Mean	Range	Mean	Range
0-9	11.0	9.6-14.8	32.2	27.2-45.6
10-19	9.0	6.8-12.8	28.4	20.6-37.6
20-29	23.0	22.2-26.2	52.4	41.2-71.6
30-39	37.8	30.8-44.2	67.8	59.8-80.4
40-49	62.4	54.0-71.4	86.8	78.4-94.2
50-59	86.0	80.6-93.0	95.0	88.6-98.2
60-69	97.2	92.8-99.2	96.6	96.0-98.0
70 +	98.0	98.0-98.0		

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