Zero Growth of the Population of the United States

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It is sometimes said that there is no population problem in the United States because the U.S. fertility rate is approximately at the replacement level of 2.1 children per woman. However the population of the United States increased in 1992 by approximately three million people. There are two major causes of continued population growth even when fertility is approximately at the replacement level. One is population momentum; the other is immigration. This paper examines what must be done if we want to achieve zero growth of the population of the United States immediately, without the long delays caused by population momentum.

INTRODUCTION

This paper begins with the assumption that the United States should stop its population growth immediately so as to have and maintain a population that is unchanging in size. Our purpose is to examine the options that would allow us to achieve this goal.

Any discussion of adjusting the rate of growth of the population of the United States from its value in early 1994 of over 1% per year to zero (or any other value) can focus only on four factors; birth and death rates,

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which we will refer to as "natural" causes of population change, and rates of immigration and emigration which we will call "artificial" causes of population change. Currently a third to a half of the population growth in the United States involves what has become the subject of an increasingly emotional debate—immigration. This paper is intended to increase understanding of the immigration issue by exploring the simple mathematical relationships between immigration and the other three factors which all act together to determine the growth rate of a population.

THE REASONS FOR WANTING ZERO GROWTH IMMEDIATELY

The immediate achievement of zero growth of the U.S. population would help to:

A) Reduce the rate of destruction of the environment;
B) Reduce shortages of vital resources such as water; while increasing our margins of safety in times of shortage;
C) Preserve resources for the use of future generations of Americans;
D) Slow the rise in the many taxes that are necessary to pay the enormous costs of population growth;
E) Slow the rise in the cost of housing;
F) Save our society from the large expenditures that are now used to support the increases in population, and allow these resources to be used instead;
   i) to help achieve better lives for the millions of our citizens (many of whom are from American ethnic minority groups) who now are largely excluded from the mainstream, and
   ii) improve our nation's flexibility in giving aid to the people of developing nations;
G) Reduce the competition for jobs; if this is done, job creation can work for the benefit of Americans by producing a longterm reduction in unemployment in the United States. Population growth produces cruel competition for the poorly educated and unskilled members of the American work force;
H) Allow tax revenues to be used to repair our crumbling national infrastructure; at present much of our tax money is used to build the new infrastructure that is needed to accomodate the increases in our population;
I) Stop the growth in the congestion, pollution, urban violence, and all of the other assaults on the lives and well-being of Americans that are the direct consequences of population growth;
J) Slow the growth of big government, litigation, regulation, and the ever more restrictive social engineering that is required to manage large growing populations (Iklé, 1994);

K) Preserve American representative democracy;
L) Enhance human dignity and the respect for the individual and for the family;
M) Achieve better and more secure lives for all Americans today and for our children and grandchildren . . . in the future;
N) Set an example for those parts of the world that are currently experiencing the devastation of rapid population growth.

The report of the President's Commission on Population Growth and the American Future, (Rockefeller Commission, 1972) concluded that "Neither the health of our economy nor the welfare of individual businesses depends on continued population growth. In fact, the average person will be markedly better off in terms of traditional economic values if population growth slows down than if it resumes the pace of growth experienced in the recent past" (Abernethy, 1993, p. 256).

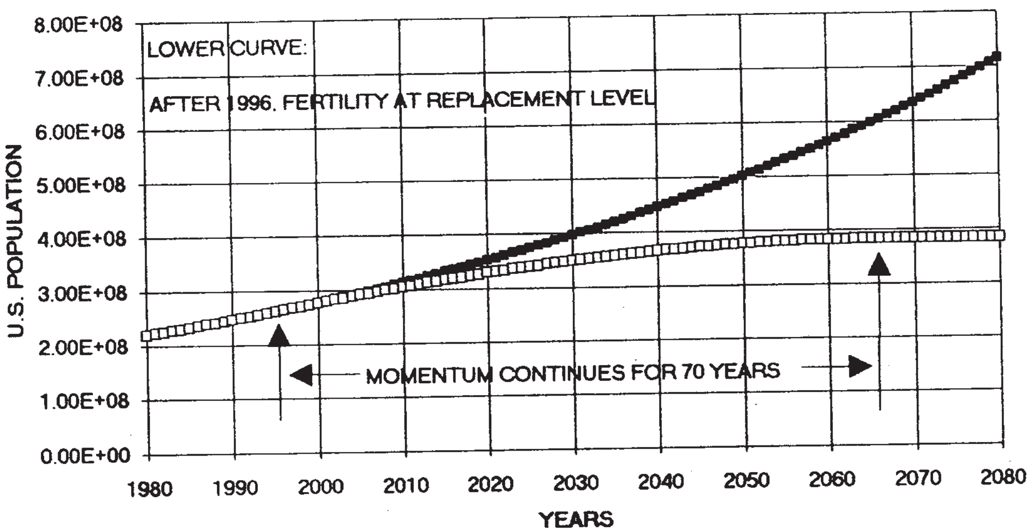
REPLACEMENT LEVEL FERTILITY (RLF) AND POPULATION MOMENTUM

In a society with no artificial change in population (immigration or emigration), one would be very close to having a stable population if, for the preceding 70 years, every woman had just two children to replace herself and the children's father. Not all children survive to reproductive age, so, in the absence of artificial increases, an average of approximately 2.1 children per couple is needed in the United States to ensure a stable, nongrowing population. This is called replacement level fertility (RLF).

In 1993, the population of the United States was growing at approximately 1.18% per year. If, for the moment, we assume no artificial changes in the population, and if we could suddenly achieve replacement level fertility of 2.1 children per woman, would this result immediately in population stabilization? The answer is "No." The RLF would have to be maintained for approximately 70 years before it would result in a population of constant size. *The reason is that the consequences of the sudden imposition of any change in fertility will not be fully realized until all have died who were living at the time the change was achieved.* This long response time of about 70 years is the consequence of what is called population momentum. Even though the RLF (the condition for zero growth of the population) was achieved suddenly, the population of the United States would tend to continue on its 1.18% growth path, changing only slowly from the 1.18% path to the zero growth path over a period of approximately 70 years.

This is illustrated in Figure 1 which is the output of a computer model.

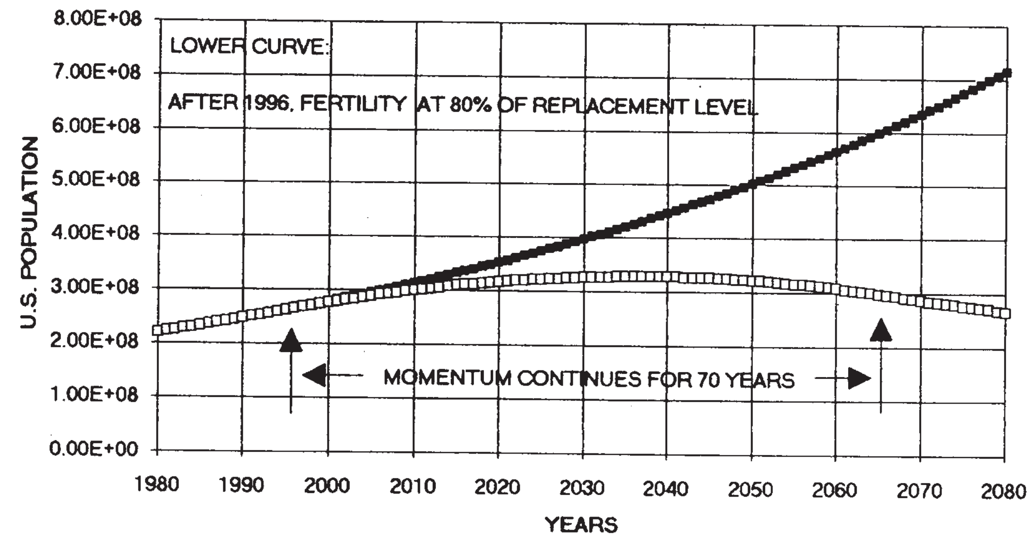
FIGURE 1. This is a plot from a computer model of two paths for a population that is initially growing at a rate of 1.18% per year and that has a size of 256.6 million in 1993. These figures approximately match the figures for the U.S. In this model, the life expectancy is assumed to be 70 years. The line of solid squares traces the size of the population if the growth rate of 1.18% per year continues unchanged throughout the 100 years from 1980 to 2080. The line of open squares traces the path for which the growth rate is 1.18% per year from 1980 to 1995. Then, in 1996 the fertility is suddenly lowered to the replacement level (RLF). Even though replacement level fertility was achieved in 1996 and was maintained thereafter, the population momentum causes the population growth to continue for 70 years, and a constant population is not achieved until the year 2066. At that time the population of the U.S. would be 383 million.



In the model, the life expectancy is assumed to be 70 years and the population is assumed to be growing steadily at 1.18% per year before 1996, so that it reaches 256.6 million in 1993. This approximates the current situation in the United States. Then, in the year 1996, the condition is imposed that the fertility changes suddenly to the replacement fertility. The results are shown in the lower curve where one can see that for 70 years following 1996 the population continues to grow, but at a slowly decreasing rate, until zero growth is reached in the year 2066, at which time the population has increased from 256.6 million to about 383 million people. The upper curve of Figure 1 shows the size of the U.S. population if the 1.18% per year continued unchanged throughout the period from 1980 to 2080.

The same presentation is given in Figure 2 except that in 1996 the fertility is lowered suddenly to 80% of the replacement level. Because of

FIGURE 2. This plot is similar to Fig.1. The upper curve is the same as the upper curve in Fig.1. However, for the lower curve the fertility rate is changed in 1996 to 80% of the replacement level. This fertility rate will ultimately produce a population that declines at a rate of 0.74% per year. However, the population momentum continues for 70 years after 1996. During that 70 years the population of the U.S. would continue to grow to a maximum of 328 million in 2038 and then the size of the population begins its slow decline and finally reaches the expected rate of decline of 0.74% per year after the year 2066.



its momentum, the population continues to grow until it reaches a maximum of 328 million in the year 2038, and after 70 years the change finally (in the year 2066) results in a steady decline of 0.74% per year that is the consequence of this new fertility level.

ZERO GROWTH OF POPULATION

The question we wish to address is this. If we do not want to have the 70-year period of continued population growth as determined by population momentum, what conditions would have to be imposed in order to have zero growth of the population of the United States immediately? In other words, what could we do now to get around the 70-year period of continued population growth illustrated in Figure 1? An examination of population momentum shows that the full consequences of achieving replacement fertility now will not be realized until all people living today (including the children who are living today) have died. If we want our children to enjoy the immediate benefits of zero growth of the U.S. population, then it is not sufficient just to achieve and maintain fertility at the replacement level. The fertility must initially be well below the replacement level, gradually approaching the replacement level in 70 years.

LET'S LOOK AT NUMBERS

Here are the annual figures for the U.S. for the year 1992. In the discussions we will use M to mean "million" and y to mean "year." We will use only two significant figures because these are rough estimates.

Natural Increase

Births		4.1 M/y
Deaths	(−)	2.2 M/y
Annual "Natural" Increase		1.9 M/y

Artificial Increase

Immigration (people arriving)		1.3 M/y
Emigration (people leaving)	(−)	0.2 M/y
Annual "Artificial" Increase		1.1 M/y

Total Increase

Natural		1.9 M/y
Artificial	(+)	1.1 M/y
Total Annual Increase		3.0 M/y

This is close to the recorded increase in the population of the U.S. as given by the U.S. Census Bureau.

Jan.1, 1993	256.6 M
Jan.1, 1992	253.6 M
U.S. Population Increase in 1992	3.0 M

These numbers give an annual rate of increase of 1.18% (Bartlett, 1993).

CONDITIONS FOR ZERO GROWTH OF THE U.S. POPULATION

There are only four variables one can manipulate in order to adjust the population growth rate. They are

a) the annual number of births
b) the annual number of deaths
c) the annual number of immigrants entering the United States
d) the annual number of emigrants leaving the United States

The condition for zero growth of the population of the United States can be represented by the equation which states that the annual additions to the population (births and immigration) must equal the annual subtractions from the population (deaths and emigration). The condition for zero growth of a population is

Equation 1) Births/y + Immigration/y = Deaths/y + Emigration/y

When we insert the numbers given above for the United States on the right side of Equation 1, we have

Equation 2) Births/y + Immigration/y = 2.2 M/y + 0.2 M/y

Equation 3) Births/y + Immigration/y = 2.4 M/y

We can interpret Equation 3) as follows: In order to achieve zero growth of the U.S. population immediately, the annual numbers of births plus immigrants entering the United States must not exceed 2.4 M/y. If these numbers add up to more than 2.4 M/y there will be population growth. If they add up to less than 2.4 M/y there will be a decrease in the size of the population.

It is within the power of any nation to regulate immigration into its territory. Therefore we will regard the Immigration/y (I/y) as the independent variable and examine the consequences (indicated by Eq.3) of various values of (I/y) on the Births/y (B/y) needed for the immediate achievement of zero growth of the population of the United States.

FIVE SCENARIOS FOR ZERO GROWTH NOW

We can examine five scenarios to see the results given by Eq.3.

A) If one had zero immigration, but with the emigration unchanged from its 1992 level of 0.2 M/y, the United States could immediately achieve zero growth of its population by reducing births from the 1992 value of 4.1 M/y to 2.4 M/y. This is a reduction of births to about 59% of the 1992 value. For this scenario, Eq.2 becomes

2-A) 2.4 M/y + Zero = 2.2 M/y + 0.2 M/y

B) If one had immigration of 0.2 M/y which is equal to the 1992 emigration of 0.2 M/y, there would be no net artificial change in the size of the population. To achieve zero growth under this condition, births would have to decline from the 1992 value of 4.1 M/y to 2.2 M/y, which is about 54% of the 1992 value. In this case, Eq.2 becomes

2-B) 2.2 M/y + 0.2 M/y = 2.2 M/y + 0.2 M/y

C) If one wanted the new population in the United States in 1992 to be half "natural" and half "artificial," the births would have to decline to 1.2 M/y or to about 29% of the 1992 value. In this case, Eq.2 becomes

2-C) 1.2 M/y + 1.2 M/y = 2.2 M/y + 0.2 M/y

D) If one wanted to continue the 1992 level of immigration of 1.3 M/y, then births have to decline from the 1992 value of 4.1 M/y to 1.1 M/y, or to 27% of the 1992 value. Equation 2 now reads

2-D) 1.1 M/y + 1.3 M/y = 2.2 M/y + 0.2 M/y

E) If one wanted all new population to come from immigration, i.e., *no births*, then the immigration could rise to the total of deaths and emigration, or to 2.4 M/y, and Eq.2 becomes

2-E) Zero + 2.4 M/y = 2.2 M/y + 0.2 M/y

GRAPHICAL REPRESENTATION

One can subtract the (I/y) from both sides of Eq.3 to show the functional relationship between (B/y) and (I/y) that is necessary to satisfy the condition of zero growth of the population of the United States.

Equation 4) Births/y = 2.4 M/y − Immigration/y

Equation 4) shows that there is a simple linear relation between (B/y) and (I/y). This means that a graph of (B/y) vs. (I/y) is a straight line as shown in

FIGURE 3. The vertical coordinate of the upper square dot represents the 4.1 M/y births in the U.S. recorded in 1992, while the horizontal coordinate of the dot represents the 1.4 M/y immigration recorded in 1992. Points on the sloping straight line give combinations of the annual level of immigration and the corresponding number of births each year that combine to give zero growth of the U.S. population, based on the 1992 data. The coordinates of any point on the straight line represent a pair of values of (I/y) and (B/y) that will produce the immediate condition of zero growth of the population of the U.S. The square dots on the sloping straight line represent scenarios A through E that are discussed in the text.

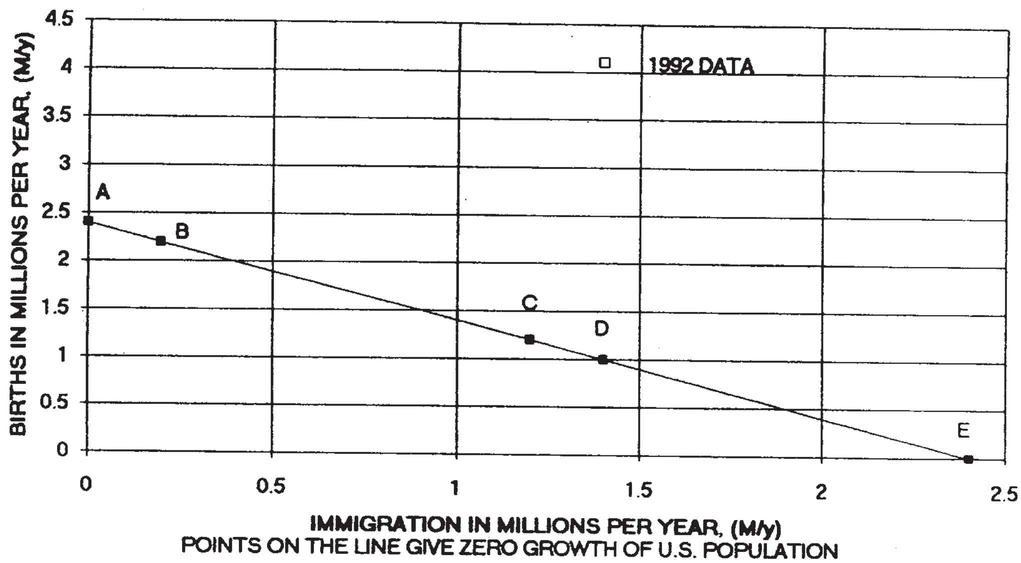


Figure 3. The two coordinates of any point on the line represent a combination of the values of (B/y) and (I/y) that will immediately give zero growth of the population of the United States, based on 1992 data. The individual points shown on the straight line correspond, from left to right, to the scenarios A through E. The isolated point at the top of Figure 3 represents the 1992 data. This shows how far the 1992 conditions are from those necessary for zero growth of the population of the United States.

TRANSLATE THESE NUMBERS TO CHILDREN PER COUPLE

There were approximately 2.5 million marriages in the United States in 1992. For Scenario A, this means that the children per marriage necessary to achieve zero growth of the population of the United States would be

$$\frac{2.4 \text{ M births/y}}{2.5 \text{ M marriages/y}} = 0.96 \text{ births per marriage}$$

This is approximately the same as the "one child per family" policy of the Peoples' Republic of China. The other scenarios give the following numbers of births per marriage in order to achieve immediately zero growth of the population of the United States.

Scenario B	0.88 births/marriage
Scenario C	0.48 births/marriage
Scenario D	0.44 births/marriage
Scenario E	Zero births/marriage

These numbers indicate the enormous difficulty the United States faces in order to achieve zero growth of its population now.

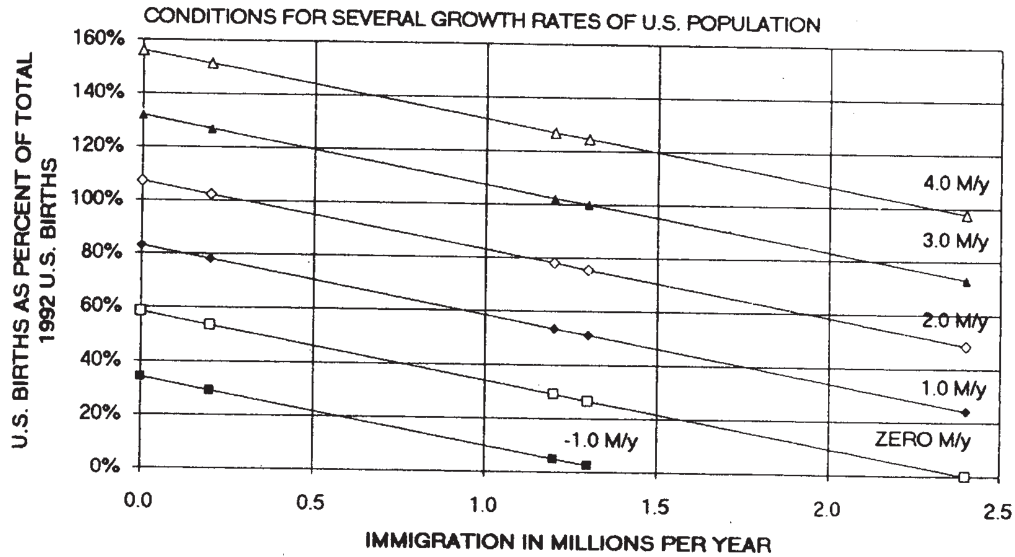
POPULATION STABILIZATION AND FERTILITY RATES

All of these scenarios call for a fertility rate much lower than the replacement fertility necessary to maintain a population of constant size. The greater the amount of immigration, the lower is the corresponding fertility rate that is necessary to stabilize population immediately. If we initiate conditions that correspond to a point on the straight line of Figure 3 and then maintain those conditions throughout the 70-year period of the population momentum, the number of births per year and the number of immigrants per year will remain constant, so the population will remain constant provided there are no changes in the death and emigration rates. Over the 70-year period the fraction of the population that is in the child-bearing age range will decrease gradually from the value that characterizes a growing population to that which characterizes a population of constant size. To maintain a constant birth rate with this declining population of child-bearing people will require a gradual increase in fertility until it reaches the replacement level of approximately 2.1 by the end of the period of 70 years.

BIRTHS, IMMIGRATION AND POPULATION GROWTH

The coordinates of points on the straight line of Figure 3 are matching values of (B/y) and (I/y) that will give zero annual increase of the U.S. population. Similar lines could be drawn for any value other than zero of the annual increase in the size of the population of the United States. Some of these other lines, based on the 1992 data, are shown in Figure 4.

FIGURE 4. This graph is similar to Fig.3 except that the numbers on the vertical axis have all been divided by 4.1 million, which is the number of births in the U.S. in 1992. Thus the vertical axis is the number of births expressed as a percent of the total births in the U.S. in 1992, and the line labeled 100% corresponds to total births of 4.1 million recorded in 1992. The line of this figure marked "Zero M/y" is the same line as was shown in Fig.3. Points on any of the lines above the "Zero M/y" line identify pairs of values of (B/y in percent) and (I/y) that would give the annual population *increase* of 1.0, 2.0, 3.0, and 4.0 million per year. Points on the line below the "Zero M/y" line give values of (B/y in percent) and (I/y) for an annual *decrease* of U.S. population of 1.0 million per year.



REVIEW QUESTION

If the fertility rate in the United States is approximately 2.1 (the value that will give a stable population), why does this arithmetic show that even with zero immigration, the United States would have to decrease the births down to approximately one child per marriage in order to achieve immediately a stable population?

Answer: The answer lies in population momentum and in the fact that the fraction of the population that is in the child-bearing age range is larger in a growing population than it is in a nongrowing population. This is the condition in the United States today. The women in this "bulge" of young people would each have to have their 2.1 children and then pass from the scene before a fertility rate of 2.1 will result in a constant population.

The effect of this population momentum is that we have to think about the population problem approximately 70 years in advance. Most people, especially political leaders, find it difficult to think about things 70 years in the future.

THE IMMIGRATION DEBATE

Continued large-scale immigration into the United States is often defended in historic and humanitarian terms. This perspective on immigration lacks quantitative substance and often leads to debate characterized more by emotion than by reason. If we are to understand the problem, we need numbers and thoughtful evaluations. Examine these observations.

Overpopulation in underdeveloped nations generates conditions that can result in the political repression and terror which often lead to an ever increasing number of people who want to come to the United States as immigrants or refugees. Yet the United States today faces severe and growing social, resource, environmental, and fiscal problems at every level of our society. *We know that the rapid population growth of the United States in the past century has not solved these problems: Instead, the problems have just gotten worse*. There is every reason to expect that the situation will deteriorate even further as population continues to grow. Stopping the population growth in the United States will provide us the best opportunity to solve these problems humanely.

People are quite right when they point out that we are a nation of immigrants: "We have always had immigration, so we should always have immigration." This is an example of the free-fall illusion. If one leaps from the top of the Empire State Building, the first five or six seconds of free-fall are so wonderfully exhilarating that one might be led to think, "I have been falling for some time, I can enjoy this fall forever!" But after about eight seconds the free-fall is interrupted by the street pavement which makes all of the future very different from the past. In mathematical terms, the pavement is a boundary condition which determines that the equations describing the free-fall cannot describe it forever. The finite resources upon which we depend for survival are the boundary condition that limits the population which can be sustained. Some studies have indicated that the population of the United States already exceeds the carrying capacity of our land (Pimentel & Pimentel, 1991). This increases the urgency of stopping population growth now.

Hall and his colleagues have made a quantitative assessment of the environmental consequences of having a baby in the United States (Hall et al., 1994). When the per capita resource consumption and waste production are added up over the life-expectancy of a child born in the United

States today, the numbers are staggering. One small but stunning example; "nearly four liters of oil [approximately one gallon] is used each day to feed an American." The increased national petroleum requirements needed just to feed the 3 million people that are added each year to the U.S. population is then about 3 million gallons of oil per day or about a billion gallons per year. Hall and his colleagues make a good case for requiring that an environmental impact statement be filed before a child is conceived in the United States.

Lowering of the fertility rate in the United States, and stopping or reducing immigration should be seen as the two essential elements of a comprehensive national survival strategy.

CONCLUSION

In closing, it is important to note that in order to have the benefits of zero growth of population for ourselves and for our children, grandchildren, etc., we have three choices. We can,

1) Voluntarily limit both the natural population increase (births) and artificial population increase (immigration) to a combination of values that is shown here to give zero growth of the population of the United States.

2) Continue on our present path, and wait until the population of the United States is so large that limits on births will have to be imposed by our government, as has been done in China by that country's government.

3) Continue on our present path, have no governmental restrictions, and let the population grow until nature cuts down the population by increasing the death rate. The tools that nature uses to increase the death rate are disease, starvation, war, pestilence, etc.

If humans fail to achieve the balance of Eq.1, nature will do it for us.

Population momentum determines that many consequences of today's reproductive choices and immigration policies will be borne by future generations. Perhaps this is one of the reasons why the United States has such a reluctance to recognize and address the problem of population growth. The present generation still has the luxury of voluntary choice to restrict population growth. In a world that may already have exceeded its limits, the resource in shortest supply could well be time.

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