

# Learning About Population Dynamics

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During the past few years at Weston (Mass.) High School we have been emphasizing more and more the application of biologic principles to an understanding of the important problems of man. "Man in the Web of Life" is only the final chapter in the BSCS Green Version, on which we base our approach to biology; but we have found that a logical and meaningful focus for the entire year's study can be developed around human ecology. Biologic concepts are fresh in students' minds, and real involvement is more probable when students can relate abstract concepts to current issues of concern.

The dynamics of human population growth and its relation to contemporary world problems is a significant example of a concern of man that can be studied as an extension of basic biology. Within our introductory-biology program the following sequence has been established to develop a meaningful consideration of human population problems from the general principles that apply to all biologic populations:

1. Basic principles of population growth and dynamics.
2. Human population dynamics.
3. Social implications of human growth patterns.

## Basic Principles

This aspect of our program is developed primarily from the BSCS Green Version. A quadrat in a forest is the focus of our introduction to the basic concepts of ecology: we investigate plant and animal populations found there. Using census and sampl-

ing techniques, densities of populations are measured. Simultaneously, in the classroom, students study textbook material on density, density change, and the biotic and abiotic factors affecting population size.

After the forest study is completed we look at other populations. We construct and analyze graphs of a model population (sparrows on an island: constant birth and death rates) and of open real populations (ring-necked pheasants in Washington state and heath hens before their extinction on Martha's Vineyard). The data from a yeast population, representing a real but closed population, are compiled in the laboratory and studied for 10 days, and a comparison is made with other populations. Case studies, based on the work of ecologists and animal behaviorists, of the fates of various natural populations are analyzed.

All these studies provide the students with a general sense of population dynamics and the factors affecting the growth of populations under natural and artificial conditions. Once this basic framework has been established, students can extend the general principles to an understanding of a specific population: their own.

## Human Population Dynamics

Our study of human population dynamics and awareness begins where the BSCS Green Version leaves off. The ideas of Thomas Malthus are presented, and we speculate about the significance of his views on the future of the human population.

To understand the dynamics of human populations, so that they can be compared with animal-population dynamics, students search out population data and graph this information. They make

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three graphs: of United States population growth, 1800-1960; of the world figures for the same period; and of data for some other country or continent. They also plot the population density of the U.S. during that period.

In class, analyses are made of these graphs and the pattern they present. Students are quick to compare the animal-population graphs with the human-population graphs. They also begin to raise questions about the implications of the patterns observed.

At this point students have an excellent sense of population growth—its general trends and its peculiarities—within animal and human populations. Now an awareness of man's current difficulty—the problem of providing a suitable environment for increasing numbers of people—can be developed from firm biologic principles.

### Social Implications

To raise further questions, to stimulate further thinking, and to form a basis for class discussion, the article "Population Control in Animals," by V. C. Wynne-Edwards (1964: *Scientific American* 211 [2]: 68-74) is assigned. Here the students encounter the hypothesis that animals maintain fairly constant population levels by forms of social behavior that limit reproduction and thus avoid overexploitation of food.

Next, each student selects two readings from a bibliography prepared by the teacher. He is asked to prepare notes on the articles and to refer to them during class discussions. From readings and discussions the student then selects a topic to explore and prepares a two- or three-page report. (References are listed on the assignment sheet, and several copies of each are available in the library.)

During the study a large bulletin board, on which posters, articles, quotations, and questions are displayed, increases awareness and interest. Most of these aids are obtained from social organizations, government agencies, and private persons concerned with the issues.

Student reports vary from summaries of articles to original analyses of the problem. Some of the chosen topics that have been considered are the following: war and its effect on populations in the future; the relationship between the Depression and population growth in the 1930s; how Japan stopped its population explosion; rural *vs.* urban populations; fish-protein concentrate; comparison of population trends in developed countries; and malnutrition and learning.

Class discussion of human populations begins with a review of the assigned graphs and related questions, and this quickly leads to ideas from the required and the selected readings. The overhead projector and the opaque projector are used for displaying graphs. During this time an invaluable reference is the current *World Population Data*

*Sheet* (Population Reference Bureau, Inc., 1755 Massachusetts Ave., N.W., Washington, D.C. 20036).

Student involvement is generally good, and classes engage in enthusiastic argument. Many well-prepared students can support ideas from their research. A most common issue is the pressure placed on the environment by rapid population growth. Questions of food supply, pollution, and land use are debated, and these matters are referred to throughout the year in connection with other biologic topics within ecology.

### Testing

As a means of determining the impact of our study on population dynamics, we test the students both before and after the unit. At the outset, students are informed that the rapid increase in human population, particularly in underdeveloped countries, has been of great concern to many authorities; but, other than this "bias," no formal knowledge or attitudes are presented to them. They are told that the test will not be graded; they are *not* told that the test will be readministered.

All items on the test are multiple-choice, with either four or five alternatives. The test includes items in four categories: (i) basic concepts of population dynamics; (ii) general human population statistics; (iii) population trends throughout the world and their environmental influences; and (iv) general attitudes toward the issue.

We give the test twice because we wish to find out whether the students become better informed on the issue of population and whether their views change. It should be noted that we do not "teach for" the test items. Rather, the test and the curriculum have been written separately, with the common goals of helping students learn the principles of population dynamics and become aware of current rates and trends in the growth of the human population. For sample questions from the test see the accompanying box.

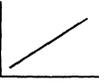
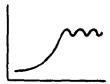
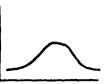
### Conclusions

The general success of this unit has been demonstrated, but revisions are continually being made, with the goal of making the experience more effective without being more extensive. For example, we are creating "Population Explorations"—novel short essays, stories, or quotations, with probing questions. These are designed as invitations to explore certain aspects of population studies, either through library or field-lab research. A problem is to find readings attractive and comprehensible to students of many abilities and interests; but the "Explorations" usually can be tailored to this variability. Some students choose to write their own "Explorations"; in this way, topics they have found exciting can be shared with other students. We are also developing "Pop Studies"—a series of case studies based on research by population biologists and demographers.

**Sample test questions.** Numbers indicate percentage of students selecting a particular alternative when the test was given before ("Pre") and after ("Post") they had completed the unit. Statistical significance was not determined, but our examination of the answers led us to generalizations about the responses, the validity of the questions, and the effects of the unit; these generalizations are presented in brackets.

**Question 1**

The characteristic form of a line graph that represents the growth of a new population in a favorable environment is best shown by:

A.		Pre	Post	C.		Pre	Post
		38	81			33	3
B.		34	15	D.		4	0

[The unit required students to construct the graph of the correct alternative several times, and apparently this concept of population growth was established.]

**Question 2**

The graph that best depicts the growth for animal population where constant birth rate exceeds constant death rate is:

A.		Pre	Post	C.		Pre	Post
		18	7			46	39
B.		19	50	D.		15	4

[The answers indicated that the students generally had not made a distinction between an exponential rate of increase (correct answer) and a simple straight-line increase. However, the question does not specify which kind of graph (semi-log or arithmetic) is being presented.]

**Questions 3 and 4**

The present size of the United States population is:

		Pre	Post
A.	20,000,000	5	5
B.	120,000,000	5	12
C.	200,000,000	56	72
D.	2,000,000,000	32	12

There does not seem to be much significant work, thus far, in developing biology curricula that include population dynamics and awareness. However, in the light of widespread social concern for the environment, surely this side of "applied biology" will not be overlooked. The approach we have described offers a firm beginning—an approach

The present size of the world population is about:

		Pre	Post
A.	350,000,000	6	12
B.	950,000,000	9	8
C.	3,500,000,000	45	70
D.	9,500,000,000	36	8

[Obviously there was a much greater polarization of answers toward the correct alternatives after the unit, which required the students to know these statistics.]

**Questions 5 and 6**

Family planning, providing ways that parents can limit family size to the number they desire, is the main answer to the rapid population growth in underdeveloped countries.

		Pre	Post
A.	Strongly agree	32	34
B.	Slightly agree	38	35
C.	Disagree slightly	7	10
D.	Disagree strongly	19	18
E.	Don't know	3	3

What do you believe is the best way of controlling population growth?

		Pre	Post
A.	Eliminate tax deductions for children	1	0
B.	Natural birth-control methods	26	22
C.	Artificial birth-control methods	46	47
D.	Change in social attitudes	21	26

[These answers show that students consistently had great faith in birth-control methods, artificial or natural. One might have expected "change in social attitudes" to become a more prevalent answer, but this was not the case.]

**Question 7**

An authority on population recently stated that he believes "the world population crisis is a phenomenon of the 20th century and will be largely, if not entirely, a matter of history when humanity moves into the 21st century."

Do you:

		Pre	Post
A.	Strongly agree	2	5
B.	Agree	30	28
C.	Disagree	52	44
D.	Strongly disagree	15	22

[It is interesting that although there was little change in answers, several students became stronger in their disagreement with the statement.]

that, we feel, can be extended to the social sciences and other disciplines.

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