Human Population Growth: Is Our Future "Gloom" or " Boom"?

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Introduction

I am a science teacher at Hodgson High School of the New Castle County Vocational Technical School District. I teach two different classes, Integrated Science, which is an 11th grade course, and Physical Science, which is a freshman course. My course load is three classes, two Integrated Science and one Physical Science. Our school is on a block schedule and the classes are eighty-five minutes long. The demographics of the school for the 2013-2014 school year were a student body consisting of 1,048 students, of which, 37% were African-American, 49% were Caucasian and about 11% Hispanic. Any student in New Castle County can apply for admission into any of the four high schools that comprise the school district. Each school focuses on training in the trades ranging from Dental Assisting to Electrical Trades. The strengths of the student body are good attendance and a strong desire to receive good grades. A weakness in the student body is the desire to socialize at inappropriate times but this is a common complaint about high school teenagers.

State Standards

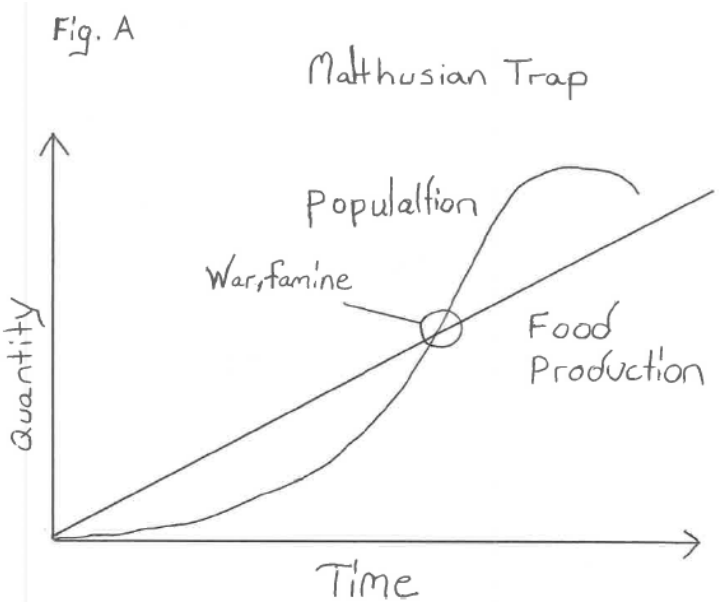
The unit of focus is population. The state standard, which the population unit focuses on, is standard number eight. This standard analyzes principles of ecology, specifically the flow of energy and the cycling of matter that link organisms to one another in an ecosystem. Human beings are an integral part the global ecosystem and human activities can alter the stability of individual ecosystems and the whole earth's environmental stability. Some of the essential questions this population unit wishes to answer are: How do humans have an impact on the diversity and stability of ecosystems? How do populations change over time, initially when resources are plentiful and then as resources become limited? What factors affect human population growth? How do humans impact the diversity and stability of ecosystems?

Rationale

Is human population growth's pressure on the environment truly an urgent matter? Authors have written books on our ever-growing human population with such titles as: *The End of Food, State of the World 2013: Is Sustainability Still Possible,* and *Battling Drought: The Science of Water Management*. With such alarming titles it is clear that concerns over human population growth, and environmental sustainability are

increasingly important topics for analysis. An increase in global population has put pressure on the sustainability of the food and water supplies[1] Can our earth's ecosystem continue to supply the food demands of our growing human population? Claims about the fate of the human population have cycled historically from a feeling of doom, to boom and back again. These two camps of thought can be termed "Doomsters" and "Boomsters". We will talk about these two perspectives on population growth and its effect on the environment.

First, we will begin with the original Doomster, Thomas Malthus. "In his 'Essay on the Principle of Population,' Thomas Malthus insisted that human populations would always be 'checked' (a polite word for mass starvation) by the failure of food supplies to keep pace with population growth."[2] Malthus believed that agricultural productivity could not increase, so that food production could only grow in a linear fashion: each year the amount of food produced could only be increased by expanding cultivated land. [For example: 1, 2, 3, and 4.] In contrast, Malthus argued that population increased exponentially, for example: 2, 4, 8, 16. A simple example of this would be a farmer who increases his crops by ten acres every year would produce a linear line growth chart. The farmer's crops land is increasing every year but at a steady and consistent rate. On the other hand, if a farmer and his wife have four children and each offspring has four children. This would increase the human population for two people to twenty in just three generations. This is what is meant by exponential growth, it is not slow and steady but rather fast and accelerating. Using this argument he concluded that human population growth would soon outpace food supply and famine would ensue. He also observed that it was not the well-to-do class that was putting pressure on population growth but the poor. He believed that if the poor people's growth rate could be bought under control then a catastrophe might be averted. In order to influence the poor to have fewer babies he advocated the government repeal the "poor laws" which gave aid to needy families. Malthus said that helping the poor would only encourage them to have more children. Thoughts such as these made Malthus a controversial character. As time went on and the apocalypse predicted by Malthus did not come to pass, the fear of his population collapse eased and waned, but his thoughts would surface again.



Now that we have talked about the original Doomster, Thomas Malthus, let's now proceed from a Boomster perspective. Today we know that human's population growth does not behave in the same manner as other animals in nature. In nature, resources like food and water will limit population growth. Populations will grow indefinitely until the supply of resources limits them. Humans on the other hand have been shown to grow their population through a process called Demographic Transition. This model was developed by the American demographer, Warren Thompson in 1929. It shows that human population growth goes through four distinct phases based on the development of technology and urbanization.

In the first phase of Demographic Transition there are both high birth rates and death rates. Stage one occurs in pre-industrial societies where families are primarily rural and depend on agriculture for subsistence. In this stage it is beneficial to have a lot of children because the cost vs. benefit ratio is very small. Children provide labor to work on the farm and help with cooking and childcare. The only real cost of having children are feeding them and since they help tend the crops the real cost is minimal. Another reason for having a lot of children in this pre-industrial stage is that adult children in many societies provide social security to their parents. It is the children who are responsible for caring the elderly's needs. Since childhood mortality is high in this phase, women will often have as many children as possible because the number of children who reach adulthood is relatively small. Therefore, it makes sense that parents decide to have large families because the children provide labor capitol as well as insurance for help in old age.

The second stage of the Demographic Transition is marked by a decrease in death rate and corresponding rise in population. The reason for this decrease in death rate has to

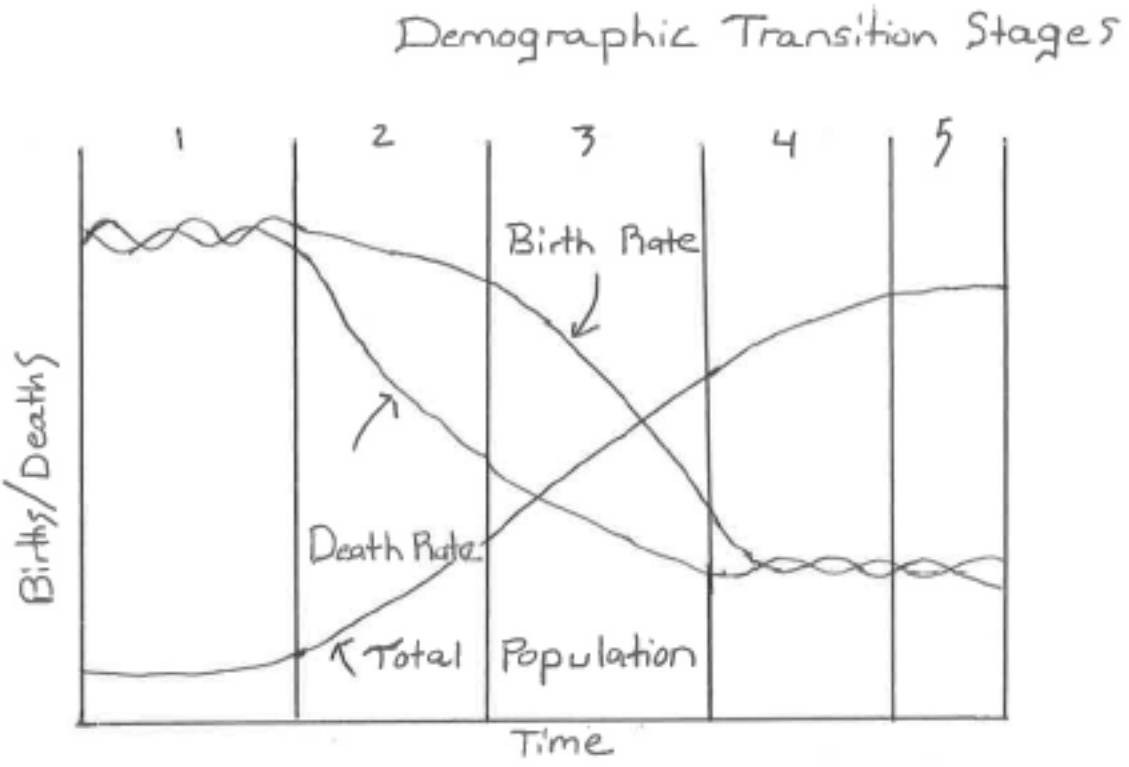
primarily with advances in agricultural technology and improvements in sanitation and public health. The advances in agriculture like crop rotation provide more food and public health improvements like creating a sewage system to protect the water supply significantly decrease the death rate. Families are still having large numbers of children and the population swells. At this time there is a large gap between birth rate and death rate with birthrate being higher. Some nations today are in this stage primarily in the parts of the Middle East and Africa. These are the regions of the world where human population growth is growing fast.

The third stage of the Demographic Transition leads to bringing the birth and death rates closer together, thus stabilizing population growth. A number of factors help to achieve this stabilization. First, parents begin to realize that childhood mortality is going down and that it is not necessary to have a large number of children provide the labor on the farm and help with the elderly. Second, as families move to the cities they realize that to agricultural mindset of having a lot of children does not make sense in the city. Parents realize that children no have a higher cost to benefit ratio. Food, clothes, education and entertainment all take a toll on the urban family budget and whereas having a large number of children on the farm provided income to the family as a whole, big families deplete family resources in the city. So, out of necessity parents have fewer children in the urban society. As a consequence, the rate of population growth begins to fall.

Finally the fourth phase of the Demographic Transition is characterized by both a low birth rate and a low death rate as indicated by today's modern societies. Countries in this stage include the United States, and most of Europe. The low death rates are due in part to increased food production and improvements in medical technology to treat disease. The low birth rate is due to women having the choice to have children. With the wide availability of contraception and opportunities to work, women choose to have fewer children. At this stage the population is stable either growing slowly at slightly above the level replacement level of two 2.1 per couple, or even declining if the birth rate falls below the replacement level.

The Demographic Transition Model has shown that Malthus's original claims were incorrect. Human population has not grown in an exponential manner but rather in a more complex fashion based on the human condition related to agricultural and medical technological advances. Even though Demographic Transition has shown a stabilization of population growth in today's modern society, many still feel cause for alarm by the fact that not all the world is in stage three or four and less developed parts of the world are adding quickly to the global population total and thus putting ecological pressure on the planet.

Fig. B



While seeing a positive spin on population growth through the Demographic Transition Model, let's take a look at another perspective similar to the Doomster camp way of thinking. More recently, in *The End of Food*, Paul Roberts sees humanity increasingly struggling to meet its food needs. He predicts that in the next forty years, as agriculture is threatened by climate change, 'demand for food will rise precipitously,' outstripping supply[3]

Compounding the food shortage problem is the issue of global warming's effect on water supply. This is illustrated in the *US News* article: "Study: Climate Change Could Put Millions More at Risk of Water Scarcity" the author writes: " Although water scarcity is already a problem in many countries today due to factors like population growth, the effects of global warming could put millions more people at risk of absolute water scarcity", according to a new study from the Potsdam Institute for Climate Impact Research.[4]

Expressing concern for the Neo-Malthusian line of thinking, Bidwell in her *US News* article states: "Malthus was a political economist who was concerned about what he saw

as the decline of living conditions in nineteenth century England. He blamed this decline on three elements: the overproduction of young; the inability of resources to keep up with the rising human population; and the irresponsibility of the lower classes. To combat this, Malthus suggested the family size of the lower class ought to be regulated such that poor families do not produce more children than they can support. Does this sound familiar? China has implemented a policy of one child per family (though this applies to all families, not just those of the lower class)."[5]

This political belief that population growth is poor people's fault and that they should bear the burden of corrective measures could easily be seen as unethical and immoral. While concern over population growth causing food and water shortages may be real, I think it is important to look closely at exactly who is making such claims and how scientifically valid those claims are. What changes are being called for? Whom do these changes help and whom do they hurt?

As stated above there are a lot of people out there calling for change in terms of population control and resource management? However there are also other people who are far less concerned. In the Boomster camp, we have what has come to be known as the cornucopian views of Dr. Julian Simon. Simon was an economics professor at University of Maryland. He believed that the key to solving human population growth was ingenuity, that humans have been able to solve life problems using technology and the mind. Rather than subscribing to the belief that human overpopulation will deplete the earth of all its natural resources he predicted that human beings were the ultimate resource that would provide technological advances to solve these problems as they have done in the past and continue to do currently.
Simon, author of the book, *The Ultimate Resource* led the charge against Gloomsters' warnings about population growth and its corresponding problems during the 70's, 80's and 90's. In the late 60's he was actually for population control through birth control etc. but had a revelation in the early 70's that made him possibly the most avid Zero Population Growth foe.

Simon believed that when humans were presented with problems, technology and ingenuity would step in to find solutions. The environmentalists claimed that human population growth would stretch beyond the limits for which the earth could sustain food, energy, water, and other essential natural resources. They claimed that we would simply run out of these necessary commodities and doom would inevitably follow. However, Simon argued that the earth's resources were endless when human ingenuity was added into the equation, so that anything would be possible. He even went so far as to say that copper would be able to be made from other metals and that if resources did run out on earth there was always the Universe to provide for us.

As outrageous as some of Simon's claims were, he proved to be right in many accounts. As an economist, he looked at people as adding to the economy whereas the

environmentalist looks at people as takers from the environment. Where the Neo-Malthusian camp claimed there would be soon not enough food to feed people. Simon claimed that agriculture *innovation* and technology would find ways to increase food production. This has been the case by and large for the world with respect to food supply. The development of fertilizers and pesticides along with other agricultural technology has been more than able to keep up pace with global population increases.

Dr. Paul Ehrlich, author of *The Population Bomb*, and the Club of Rome authors of *Limits to Growth* have led the Doomster camp. This group believes that our survival is intimately tied to human population size. In 1968, Ehrlich published *The Population Bomb* too much fanfare and attention. In fact, the popularity of the book and his warnings pushed forward the environmental agenda of the 70's. Both Richard Nixon and Jimmy Carter made the environment one of their top issues during their presidencies. Ehrlich became so popular that he was on the Johnny Carson *Tonight Show* multiple times during the 70's. The government EPA government agency and the energy conservation movement had had their roots in the national environmental movement that emerged after the publication of *The Population Bomb*.

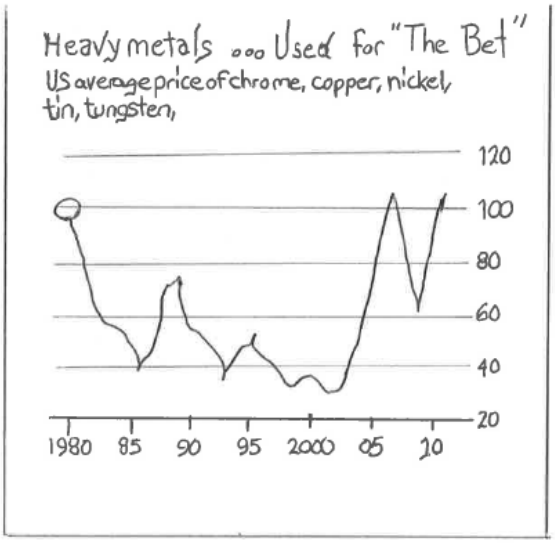
The book in effect reintroduced the basic thesis of Malthus that resource supply could not keep up with the demand of an ever-increasing human population. The book predicted mass starvation in the 70's and 80's. In Ehrlich's view the best solution to the growing population and lack of resource problem was to decrease population growth. He observed that while some affluent countries such as the United States had slow population growth other developing countries such as India and Africa had fast growing populations. Ehrlich had always enjoyed nature and the peace and solitude it affords. He made a trip to India and was overwhelmed by the sheer volume of people and congestion. Being witness to this probably had a lasting effect on him and placed concern in his heart that the same fate would inevitably occur throughout the rest of the world if drastic measures were not taken. He came up with a variety of possible solutions that would help slow down population growth. He advocated mass sterilizations, even adding temporary sterilizers to the drinking water. He believed that countries with a population problem should not be given economic or food aid unless they implemented population reduction measures. Contraception was another tool he believed would help reduce population. The government should levy taxes on people for having children giving them an economic reason not to have more children. Since it was primarily people of color at home and abroad who were the primary targets of population reduction, Ehrlich got his fair share of criticism for being a racist. This accusation hurt Ehrlich deeply and he spent much of the 70's trying to dig himself out of being thought of as a racist.

The Club of Rome was some students at MIT who authored the book *Limits to Growth* in 1972 in many ways supported Ehrlich. These students developed computer models that looked at a variety of factors believed to influence population. The results of their modeling appeared to mirror the kind of outcome Ehrlich proposed in his book. As

human population increased there inevitably came a tipping point where humans were consuming more than they produced and the result was a population crash. The primary reason for the population collapse was that society had run out of resources. The logical solution to the problem then was to use fewer resources. The longer resources last, the longer society can flourish. Since more people use more resources authors of *Limits to Growth* certainly felt that population growth was central to the lack of resources problem.

Simon and Ehrlich became bitter rivals. In the early 80's Simon proposed a bet to Ehrlich. Simon invited Ehrlich to pick any five raw materials for which he expected that after ten years the price of each material would go up rather than down (which would indicate that these resources were becoming scarcer). If the prices actually fell, this would prove Simon's point that resources are not really limited and that humans would find ways to get or make more of the commodity. Ehrlich took the bet and ten years later all of the five material prices that he chose really did go down. This gave credibility to Simon and the Boomsters who believed that growth was good. Even though Ehrlich's loss relied heavily on the economy of the time, the blow had been made on the Ehrlich camp. The history between these two important characters in the human population debate was illustrated in Paul Sabin's book *The Bet.* It was later found that Ehrlich really had bad luck in the timing of his bet with Simon.[6]After further investigation it was discovered that if the bet had been for the last forty years in total, four of the five materials prices would have gone up, thus supporting the claim that resources are decreasing.

Fig. C



Conclusion

The human population debate highlighted by these two professionals illustrates how society can take sides on an issue and find data and statistics to support their claims. Though neither side of the argument was lying per se, each camp focused on different variables to arrive at their conclusion. Each person argued the exact opposite of the other yet each received fame, and political influence. Though each man's argument about population growth is convincing, it is important for the observer to understand the agenda that each man had in order to fully grasp their arguments. Dr. Simon ultimate goal was to show that human population, and correspondingly the economy, can grow ad infinitum thanks to human ingenuity and technology. Dr. Ehrlich on the other hand cautioned against uncontrolled population growth lest it lead to a Malthusian crash of food, water and resources. In short, Simon believed the human condition would improve with increasing population growth and Ehrlich believed humans would be dangerously worse off with increasing population growth.

In addition to increasing population growth putting pressure on resources such as land, it will also force society to use more water. As the population grows, more people will need to be fed. Farmers will need to increase their yield of animals and crops. These new crops and animals will need more water. The question may be, "Is this increase in water use sustainable" into the future. There is enough water on earth to supply these demands, but it is unevenly distributed throughout the world. Generally speaking, the northern hemisphere stands to fare well with respect to water availability while the southern hemisphere struggles because its ability to satisfy future water demand relies heavily on water purification technology. With this technology much more water will be able to be utilized but at a high monetary cost. Therefore, those countries and regions that have the financial capital to invest in these technologies will fare well. Those poor countries will continue to struggle.

In his book *Countdown: Our Last, Best Hope for a Future on Earth?* Alan Weisman counters "The rosy opinion that necessity has always given birth to invention when we need it, and that our knack for technology will surely solve the future," and adds:

> Yet technological leaps have yet to solve anything without causing unforeseen problems. Plus, as the hydrogen community knows, they're hard problems. That includes other forms of hydrogen- based energy, nuclear fusion- basically a controlled H-bomb- whose projected arrival seems perpetually forty years away. So far, our best alternative energy sources are solar and wind. Although there are multiple ways to apply them far more widely than we do, we've barely begun, and the world's biggest business, intent on squeezing the last drop of petroleum out of the earth's crust, isn't helping matters much. Even if we vastly improved our energy efficiency, to ramp up solar and wind up to meet demands of all our transport industries, and the Chinas and Indias, would be far beyond their capacity to deliver.

> And even if we somehow conjured up a truly limitless, emissions free energy source, it wouldn't cure traffic, or sprawl, or noise pollution. However, the one technology that in fact could make a dent in our collective impact is the one we already have: the one that lets us curb the number of consumers.

Even Norman Borlaug, who has been called the father of the Green Revolution, by developing high yield disease resistant wheat varieties, thinks continued human population growth is a serious concern. In his Nobel Peace Prize acceptance speech he concluded not in success, but with a warning:

> We are dealing with two opposing forces, the scientific power of food production and the biological power of human reproduction. Man has made amazing progress recently in his potential mastery of these two contending powers. Science, innovation, and technology have given him materials and methods for increasing his food supplies substantially and sometimes spectacularly… Man also has acquired the means to reduce the rate of human reproduction effectively and humanely. He is using his powers for increasing the rate and the amount of food production. But he is not yet adequately using his potential for decreasing the rate of human reproduction…"[7]

Thus, in effect we have come back to the original Malthusian fear that human population growth may outpace supply in the future to drastic effect.
It is my ultimate purpose in writing this unit to help students be able to look at a variety of issues and be able to make critical decisions on claims people or institutions make.

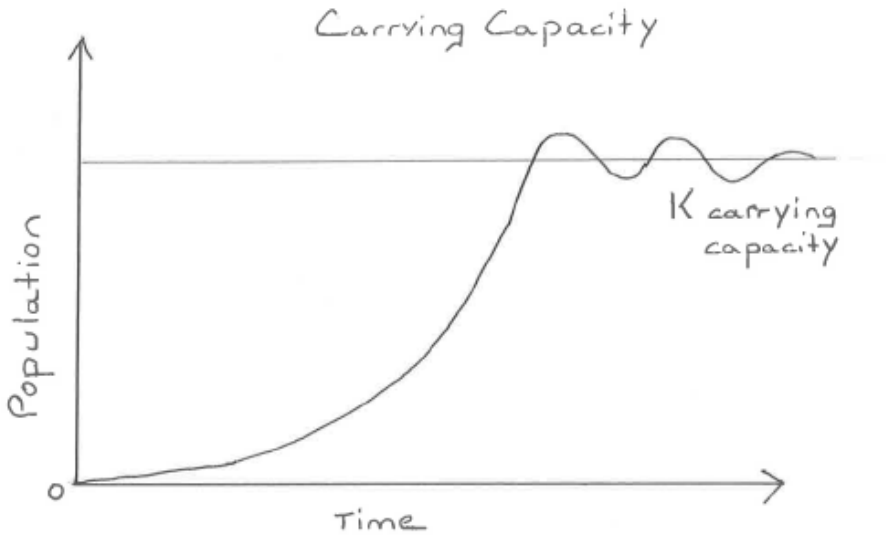
Teaching Strategies/ Activities

The classroom investigation of the aforementioned topics will occur in the Ecology Unit of 11th grade Integrated Science class. Delaware State Science Standard #1 Nature of Science and Technology covers these topics. The standard states: "Science is a human endeavor involving knowledge learned through inquiring about the natural world. The pursuit of scientific knowledge is a continuous process involving diverse people throughout history. The practice of science and the development of technology are critical pursuits of our society." The lessons used to illustrate these topics ask the students to use critical thinking inquiry to answer questions posed classroom activities.
Another standard that this unit focuses on is Science Standard 8 Ecology states that: "Organisms are linked to one another in an ecosystem by the flow of energy and the cycling of nutrients. Humans are an integral part of the natural system and human activities can alter the stability of ecosystems. Essential questions associated with this Population Unit are: How can biotic and abiotic factors affect population size? How do populations change over time, initially when resources are plentiful and then as resources become more limited? And finally, "What factors affect human population growth?"

These topics will be covered in POPULATION UNIT of the Integrated Science class ecology portion of the course. The key concept addressed in ecology is how the living organism interacts with its environment. The section begins with a discussion of the difference between biotic and abiotic factors in the environment. It is emphasized that all biotic living things depend on non-living abiotic factors such as air, soil, and water for survival. We discuss the trophic energy pyramid, which illustrates that energy in an ecosystem begins with primary plant producers providing all of the energy necessary to support the ecosystem. Students are asked to answer the question "Why are big fierce animals rare?" The author and ecologist Paul Colinvaux asked the question of why big fierce animals are rare and he wrote a book with the same title. This book explains how inefficient life is at transferring energy up the food chain. When animals eat plants, 90% of the energy is lost as heat and only 10% is transferred to the animal. This inefficient process continues up the food chain leaving only a small amount of energy for the top predators to live on.

The concept of energy inefficiency is carried over into the discussion of populations. The concept of carrying capacity is introduced and we discuss how an organism's population will only grow to a level that its environment can support. When organisms are introduced into an environment their population will grow exponentially until land or resources limit continued growth. This leads our discussion into human population growth and that humans are the only known organisms on earth that continues to grow exponentially and has not reached its carrying capacity. The question is then asked, can humans continue to grow exponentially forever? The obvious answer is no, the earth does not have an unlimited supply of resources to support an endless number of human beings. It is at this point that we begin to discuss some of the varying opinions on the topic of human population growth ranging from claims that the earth's population is already overpopulated and beyond the earth's carrying capacity to claims that billions of more people can be added to the planets population and the earth will sustain it. Students will be given perspective on these issues by looking at the chronological development of the human population analysis. First we will look at the Malthusian " Doom" perspective. Secondly, Demographic Transition and its positive " Boom" outlook will be analyzed. Finally students will reflect on the debates over human population and available resources.

Fig. D



Activities

Activity #1 Gist

The Common Core standards ask teachers to develop lesson plans that require students to critically read and write material. In the New Castle County Vocational School District (NCCVT) we have had professional development on the topic of summarizing for reading comprehension.

"The 2010 Carnegie Report *Writing to Read*: *Evidence for How Writing Can Improve Reading* confirms what decades of research have shown: the single BEST instructional strategy for improving READING comprehension involves having students WRITE *meaningfully* about what they READ."

One of the strategies we have used to achieve this has been the "GIST" summarizing strategy. This reading strategy has students summarize chunks of reading material into one-sentence pieces. These one sentence pieces are combined repeatedly until this the whole reading is summarized into a ten-word, one-sentence summary. Students will read and summarize two selected articles each from professors on opposite sides of the human population debate. First students will read an article by Dr. Paul Ehrlich relating to the dangers of population growth. Second students will read an article by Dr. Julian Simon down playing the dangers of human population growth. Students will be assessed based on a rubric, which analyzes student's correct use of the GIST summary.

" Gist" Critical Reading/ Writing Score Matrix

2 Points: Student appropriately uses the GIST framework to construct a thoughtful summary of the reading. Summary accurately reflects the author's intent and meaning.
1 Point: Student uses the GIST summary structure appropriately, but summary only partially reflects author's intent.
0 Points: Neither the GIST structure or the summary is used appropriately. Final summary does not reflect author's intent.

Activity #2 Debate

Students will participate in two kinds of debates: a Silent Debate, and a Whole Class Debate. The silent debate will be completed in partners. Each partner will receive an opposing viewpoint article on human population growth. Students will be given fifteen minutes to study their point of view and take notes. After the article has been analyzed, students will flip a coin to see who goes first. The first student has thirty seconds to write down their point of view. The second student then has thirty seconds to reply. This back and fourth continues for five minutes. At the end of the five minutes, students will be asked to make a concluding statement. Students will be assessed based on a rubric critiquing debate papers that are turned in at the end of class.

Finally students will participate in a whole class debate. The class will be organized in two semi- circles. Students will be given the opportunity to choose which side of the human population debate they would like to be on and sit in that group. Groups will flip a coin to decide which team goes first. Students are directed to make short, to-the-point arguments expressing why their position is correct. In order to be called on students need to raise their hands. In order to receive credit for the debate, students need to raise their hand, and present a valid point for the discussion. Groups will take turns alternating from pro human population growth to con human population growth.

Silent debate scoring rubric:

1. Students are silent during the debate and respectful toward their opponent. 5 pts.
2. Use textual evidence to support debate points. 5 pts.
3. Students correctly address arguments for their side of the debate. 5 pts.
4. It is clear which side of the debate students are on. 5 pts.
5. Students respond directly to their opponent's statements. 5 Pts.

Whole class debate scoring rubric:

4 (Superior) Students use many facts to support their arguments and demonstrate a thorough understanding of the information they deliver in a clear, confident and respectful manner.

3 (Proficient) Students use some facts to support their all arguments and communicate points clearly.
2 (Poor) Students use few facts to support their arguments and rarely communicate clearly.
1 (Unsatisfactory) Students do not present facts and fail to communicate clearly.

Activity # 3 National Population Graph Comparison:

Students will be challenged to see how human population has grown in four countries; two modernized and two developing countries. Students will be asked to gather population data from the last fifty years. This data can be found at the worldometers website. Students will make a graph of each of the countries they chose to research and then put all the graphs on poster board. They will then write a one-page report indicating how their four countries either support or refute the Demographic Transition model of population growth.

Population Graph Evaluation Rubric:

4. (Superior)
- Students always use the following:
- Dependent and independent variables labeled on X and Y-axis.
- Each axis is labeled including measurement units for each variable.
- Each data point is indicated with an appropriate marker.
- A descriptive title is printed on an open area of the graph.

3. (Proficient)
- Students most often clearly and correctly utilize the following:
- Dependent independent variables labeled on X and Y-axis.
- Each axis is labeled including measurement units for each variable.
- Each data point is indicated with an appropriate marker.
- A descriptive title is printed on an open area of the graph.

2. (Poor)
- Students seldom clearly and correctly utilize the following:
- Dependent independent variables labeled on X and Y-axis.
- Each axis is labeled including measurement units for each variable.
- Each data point is indicated with an appropriate marker.
- A descriptive title is printed on an open area of the graph.

1. (Unsatisfactory)
- Students never clearly and correctly utilize the following:
- Dependent independent variables labeled on X and Y-axis.
- Each axis is labeled including measurement units for each variable.
- Each data point is indicated with an appropriate marker.

- A descriptive title is printed on an open area of the graph.

Written report evaluation rubric:

4 (Superior) Students use many facts to support their arguments and demonstrate a thorough understanding of the information they deliver in a clear manner.
3 (Proficient) Students use some facts to support their all arguments and communicate points clearly.
2 (Poor) Students use few facts to support their arguments and rarely communicate clearly.
1 (Unsatisfactory) Students do not present facts and fail to communicate clearly.

Appendix A - Resources for teachers/ students:

Students will be provided the opportunity to look up various points of view in the topics covered using the UBLib/SEARCH engine at school. Books and articles on the topics of human population growth, Malthusianism, and Demographic Transition growth will be research and discussed.

Appendix B – Bibliography

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Wilson, Bee. "The Last Bite - The New Yorker." The New Yorker. Accessed August 5, 2014. http://www.newyorker.com/magazine/2008/05/19/the-last-bite.

Notes

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[4] Bidwell, " Climate change."

[5] Bidwell, " Climate change."

[6] Sabin, Paul. *The Bet: Paul Ehrlich, Julian Simon, and Our Gamble over Earth's Future*. Yale University Press, 2013.
This book provides a detailed history of both Julian Simon and Paul Ehrlich's

[7] Weisman, Alan. *Countdown: Our Last, Best Hope for a Future on Earth?* Little, Brown and Company, 2014.This book takes a critical look at the challenges of human population across the world.

Curriculum Unit Title Ecology

Author Paris Crockett

KEY LEARNING, ENDURING UNDERSTANDING, ETC.

- The carrying capacity for a specific population in an ecosystem depends on the resources available.
- Given adequate biotic and abiotic resources and no disease or predators, populations increase at rapid rates.

ESSENTIAL QUESTION for the UNIT

- The flow of energy and the cycling of materials link organisms to one another in an ecosystem. Humans are an integral part of the natural system and human activities can alter the stability of ecosystems.

CONCEPT A	CONCEPT B	CONCEPT C
Population dynamics	Demographic Transition	Sustainability

ESSENTIAL QUESTIONS A	ESSENTIAL QUESTIONS B	ESSENTIAL QUESTIONS C
• How do biotic and abiotic factors affect population size? • Why are big fierce animals rare?	• How do populations change over time, initially when resources are plentiful and then as resources become more limited? • What factors affect human population growth?	• What is the earth's carrying capacity for humans? • How many humans can the earth sustain?

VOCABULARY A	VOCABULARY A	VOCABULARY A
• Biotic • Abiotic	• Demographic Transition • Carrying capacity	• Sustainability • Biodiversity

ADDITIONAL INFORMATION/MATERIAL/TEXT/FILM/RESOURCES

http://www.worldometers.info/world-population/

http://udlibsearch.lib.udel.edu/