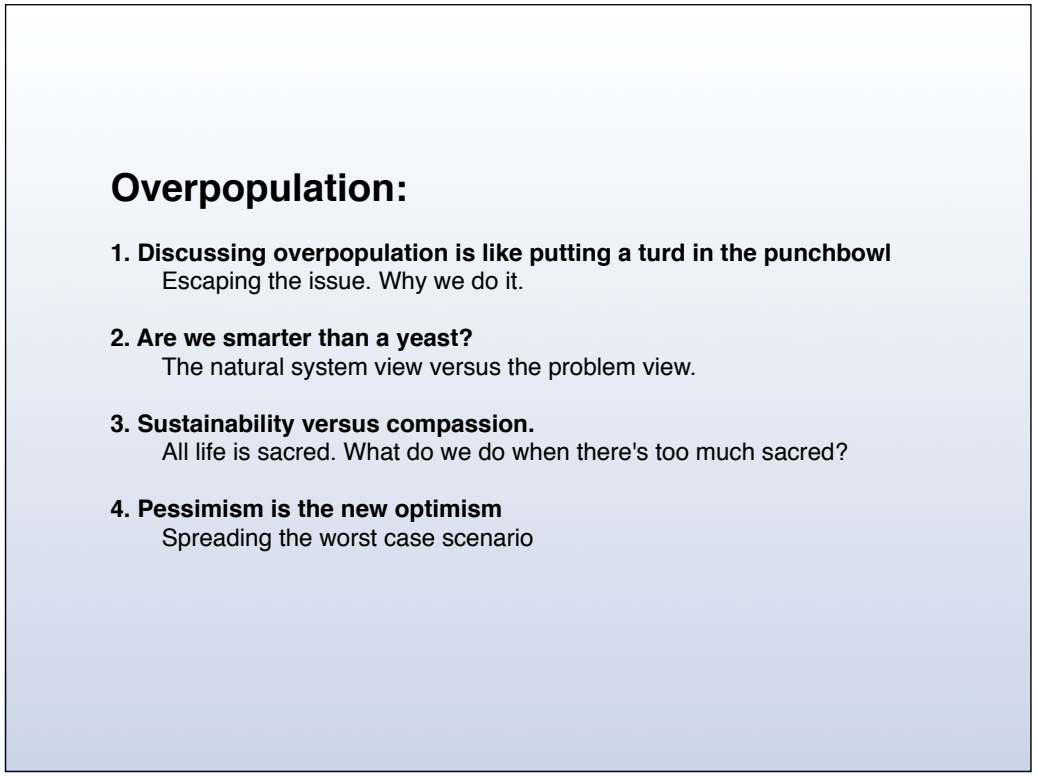


My short talk is divided into four parts

1. Discussing overpopulation is like putting a turd in the punchbowl
   Escaping the issue. Why we do it.

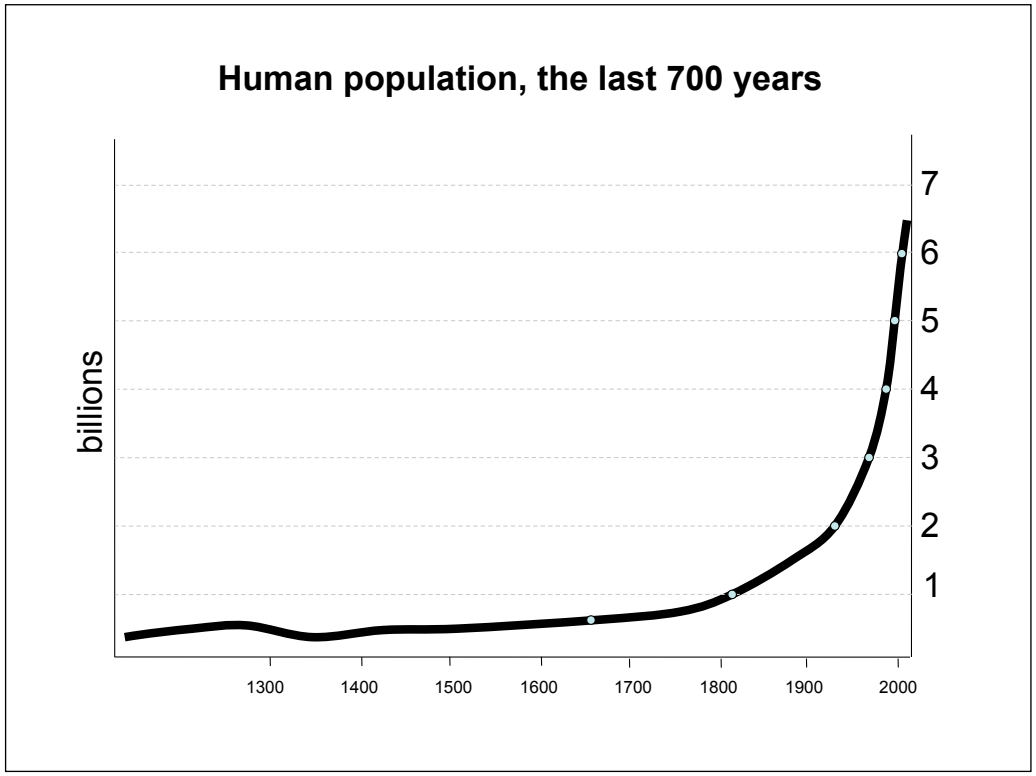
2. Are we smarter than a yeast?
   The natural system view versus the problem view.

3. Sustainability versus compassion.
   All life is sacred. What do we do when there's too much sacred?

4. Pessimism is the new optimism
   Spreading the worst case scenario

1. Discussing overpopulation is like putting a turd in the punchbowl

Escaping the issue. Why we do it.



First let me show you what we are discussing today. For the next sixty seconds allow yourself or force yourself to pay attention to the subject as I present a quick overview, even if your gut reaction is to daydream, write a perl script in your head or contemplate your entries on the IDEA form for this course. After the overview, I will ask you to register how you feel about it. This is a psychology experiment.

OK. Look at this graph.

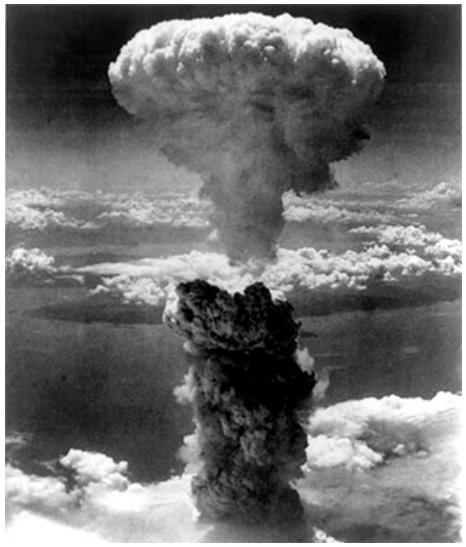
On this graph is plotted the global population over the last 700 years. Note that we first reached 1 billion in 1830, after a hundreds of thousands of years hovering in the low millions. In 1930 we reached 2 billion, a doubling time of 100 years. 3 billion was reached in 1960, 4 billion in 1976, 5 billion in 1988, and six billion in 1999, a doubling time of 39 years. The opinion of many experts is that it cannot double again.

Overpopulation is the root cause of many if not all of the man-made environmental disasters we are experiencing today, including but not limited to global warming, mass extinctions of species, destruction of coral reefs, forests, and wetlands, loss of biodiversity, degradation of arable land, and the proliferation of invasive species. The consequences of continued overpopulation are coming in the next fifty years and they will be one or more of the following

Disease!

Epidemics as our natural predators find an increasingly abundant and reliable source of hosts.

War!



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Social unrest of the worst kind as humans fight against humans for the diminishing natural resources.

Famine!

6

Hunger as the world's farmland fails to grow at the rate we are growing.

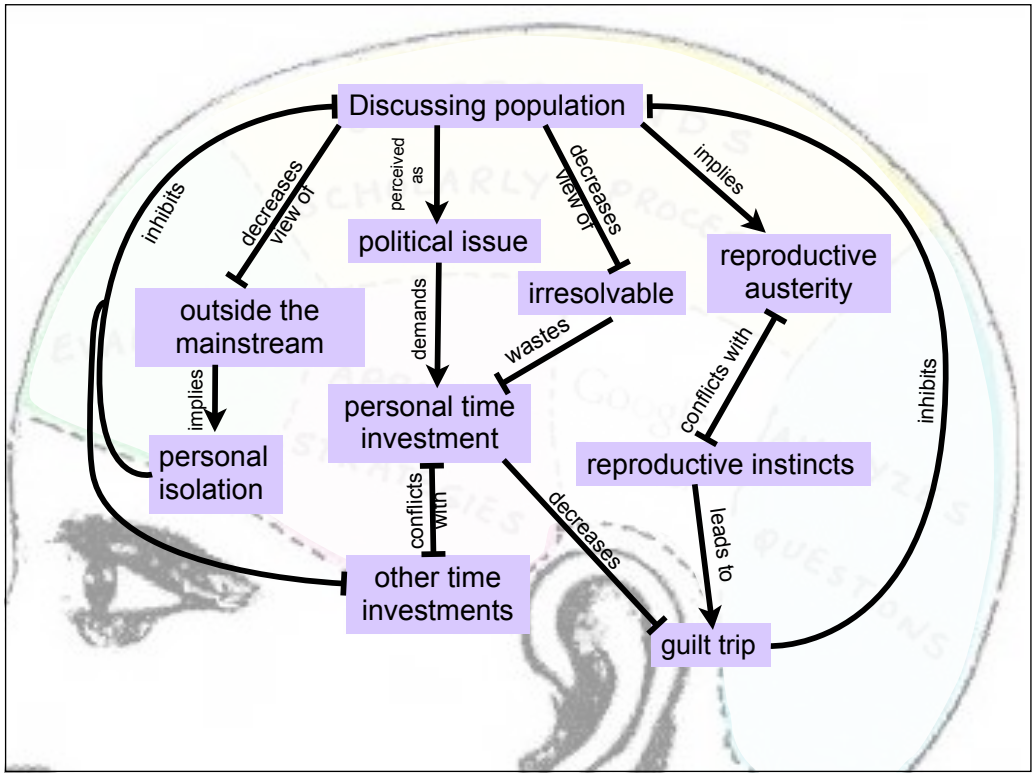
Now that you have been forced to hear the ugly truth, you can register how you feel about this topic. Your choice are (1) I like this topic and would like to be exposed to it more often and to discuss it in depth, or (2) I do not like this topic and would pay you handsomely to change the subject right now before going any further.

Or better (1) like, (2) dislike. [vote]

If you are the average person then you reacted **negatively** (like the guy in the picture) to the broaching of this subject and would react to it, if you could, by either walking away, changing the subject, or if all else fails by denying that a problem exists.

Now this is interesting, because I could present other difficult and unpleasant problems, such as cancer, HIV, drug-resistant bacteria, or bioterrorism, and I am guessing that most students of biology or biotechnology would been keenly interested in the discussion. So what is the essential different between these topics?

So I'll start the discussion of population by discussing why discussing population is a non-starter .

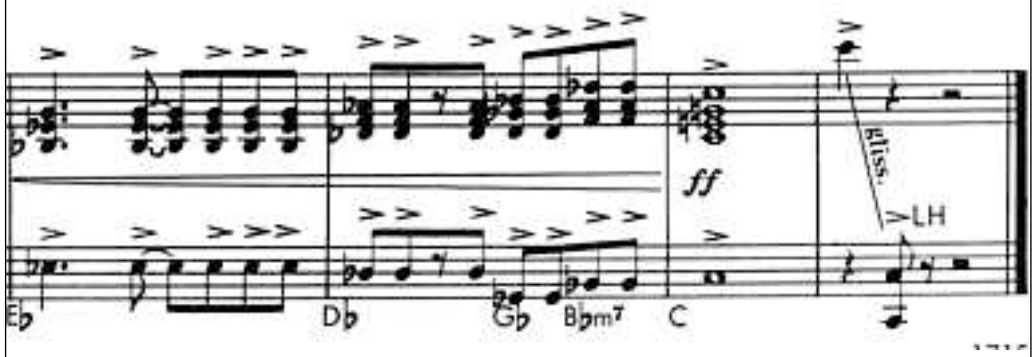


The brain is a neural net that automatically and instantly converts input data into feelings. Feeling convert back into actions. When I brought up the subject of population, your neural net may have been stimulated along one of three potential pathways. You may have immediately perceived it as outside the mainstream, implying social isolation if you bring it up in polite company (the turd in the punchbowl effect). Or you may have perceived it as a political issue, demanding a time investment on your part, which would take time away from, say, farmville, which you can't afford. Or you might have perceived it as an irresolvable problem, which would make any time investment on your part a waste of time. Because of your age, and your knowledge of the subject, you might take it as a personal attack on your reproductive plans. Or if you are my age you might take it as repudiation for past reproductive acts . In any case, the loop back is inhibitory. Note that cancer and bioterrorism don't stimulate the same pathways.

Note too that reading about the subject has no such feedback loops, except perhaps taking time away from Farmville. How many of you have read about the issue?

vote

Cognitive dissonance



Cognitive Dissonance -- uncomfortable feeling caused by holding conflicting ideas simultaneously.

The proper term for a guilt trip is cognitive dissonance.

The population problem is a source of cognitive dissonance in most people, for reasons that are deep in our brains. That is, people naturally try to resolve conflicting ideas, and they get pleasure from it, much like resolving dissonance in music. Resolving dissonance is the process where one takes conflicting data and comes up with the new model or theory to explain it away. It is what drives science. Resolving dissonance both in music and in science feels good, and not resolving it feels bad. This we know from personal experience.

How we react to dissonance

Level of Dissonance	Music	Science	Human reaction
low	twinkle twinkle little star	basic arithmetic	boring
medium	J.S. Bach	physics or biology	interesting!
high	Anton Schönberg	overpopulation	flee!!!

10

But there are different levels of dissonance, some easy to resolve some hard, and some impossibly hard. Only a moderate level of dissonance captures our attention. Trivial music like happy birthday or twinkle twinkle little star does not hold our interest unless we are small children just learning how to recognize rhythm and tonality. As adults we don't listen to it for fun. Likewise we don't do research into basic arithmetic. Bach provides a challenging level of dissonance, with some fugues and preludes that inaccessible to a child but endlessly fascinating to one who has studied it. Bach goes to the far corners of tonality and still manages to resolve dissonance in a logical way. The analogy is college level science to a college student. Kids can't handle it, but to you it is (hopefully) very engaging. Schonberg on the other hand frustrates even the most experienced student of music, (driving music majors like me forcibly back to chemistry, which is much more logical). Overpopulation is like Schonberg. We can't resolve it, so it feels like noise, illogical sound. Our pre-programmed response to noise and impossible problems is to take our personal time elsewhere -- Farmville for instance -- and forcibly avoid the dissonant subject matter.

And because of the perceived dissonance, most will not give it a listen and will never study it. And because they will not study it they will not find the solutions. And because no one is talking about it, and no one is voting about it, and because the solutions to overpopulation **are political**, and because politics greases only the squeaky wheels, the solutions to the population problem will not be acted upon if nothing changes.

How will overpopulation be resolved?

Choose one.

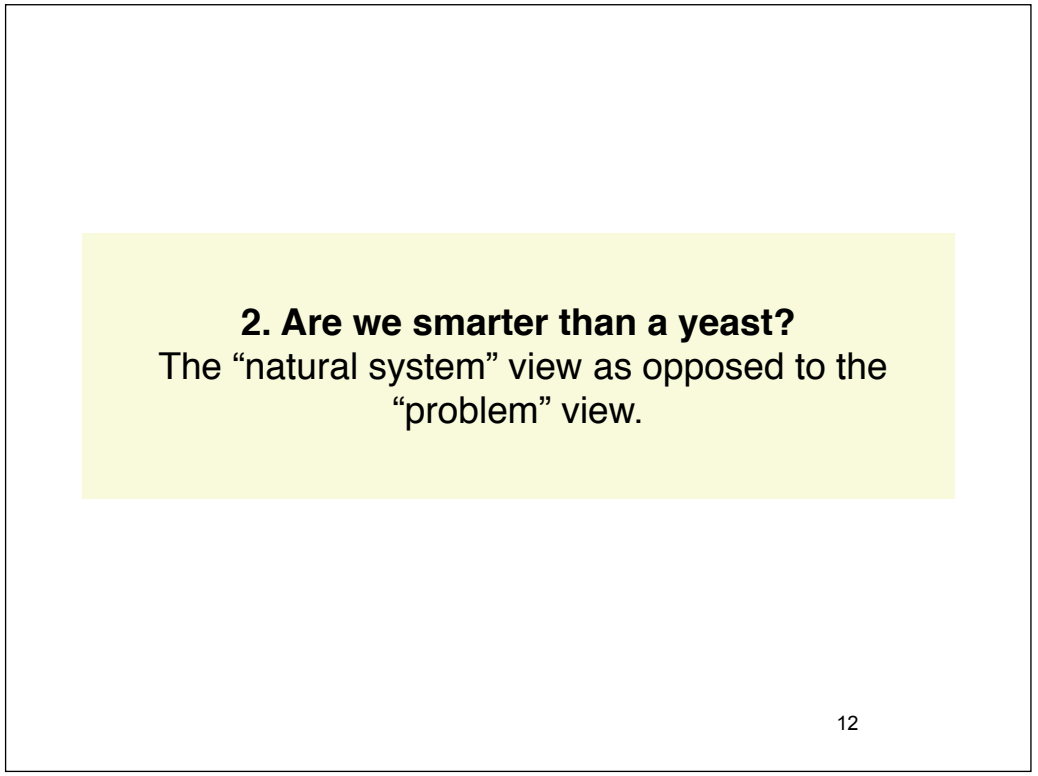
(A) War.

(B) Disease.

(C) Famine.

(D) All of the above.

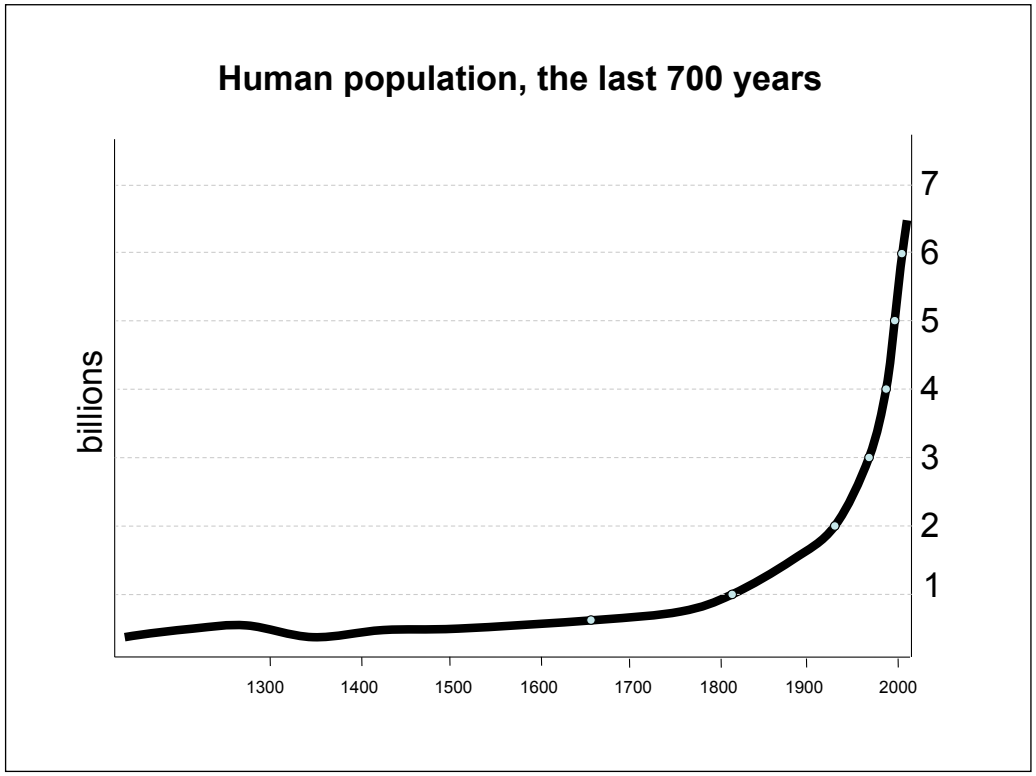
And if we do not (as a species) resolve this particularly extreme dissonance, we will be left with this multiple choice question on the final exam of humanity. That is, if we don't resolve it, **Nature will**.



2. Are we smarter than a yeast?

The natural system view as opposed to the problem view.

It is human nature to try to ***solve*** problems, whether or not we actually **understand** them first. But I think **understanding** the science of overpopulation is the key to **solving** it.



Here's that curve again. It looks exponential, and it is.

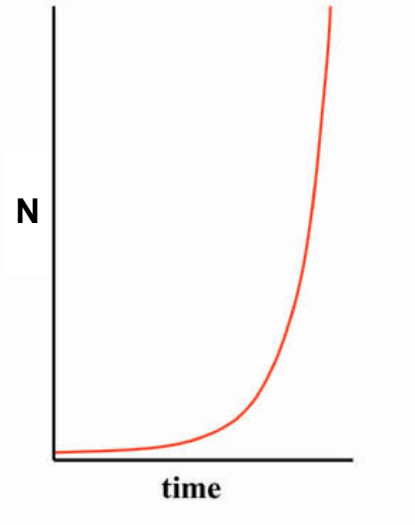
Population growth is exponential given constant conditions

$$N = N_0 e^{rt}$$

r = birth rate - death rate

$t_{1/2} = \ln(2)/r$

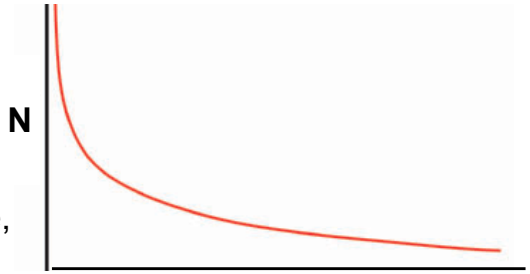
$t_{1/2}$ = 70 years / %pop. incr.



Here's the equation for exponential growth. This says the population next year will be a certain fraction of the current population, and that fraction depends on the difference between the yearly birth rate and the death rate. If the birth rate is greater than the death rate, then the population climbs ever more steeply. This is the natural order of things for a species as long as it has enough food and no predators... like humans.

Population *decline* is exponential given constant conditions

$$N = N_0 e^{rt}$$

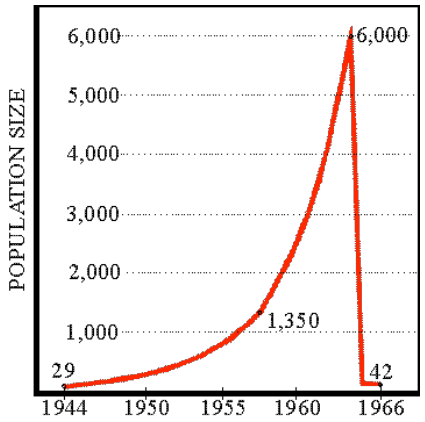


If birth rate < death rate,
$r < 0$
so $e^{rt} < 1$.

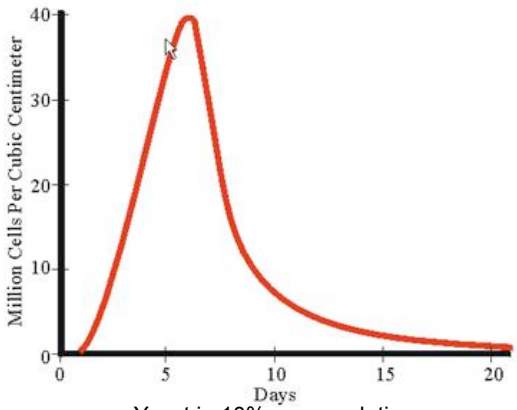
15

When the death rate exceeds the birth rate, population drops and this decline is also exponential. Both exponential growth and exponential decline assume constant, unchanging birth and death rates and both represent the Natural Order of Things for an isolated species.

boom/bust of isolated species



Assumed population of the St. Matthew Island reindeer Herd. Actual counts are indicated on the population curve.



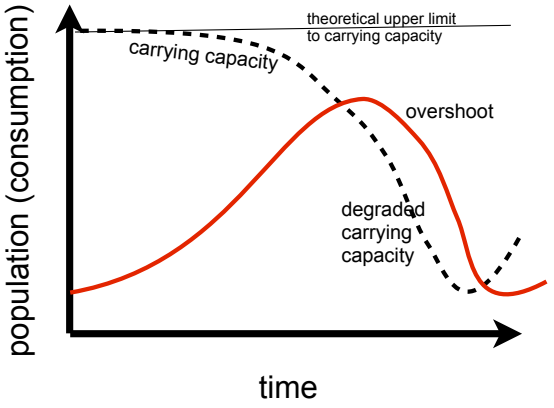
Yeast in 10% sugar solution

16

Michael Mills, Dept of Psychology, LMU

Here are two examples of exponential growth followed by exponential decline. The first is an island where a herd of reindeer had no predators and only a finite amount of vegetation. They grew at a constant rate until the food ran out, **whereupon** they declined just as steeply. The second example is brewer's yeast in a sugar solution. The yeast eat and grow until the food is gone, then they die off. Yeast don't plan ahead. They don't save for a rainy day.

Overshooting the carrying capacity degrades the carrying capacity

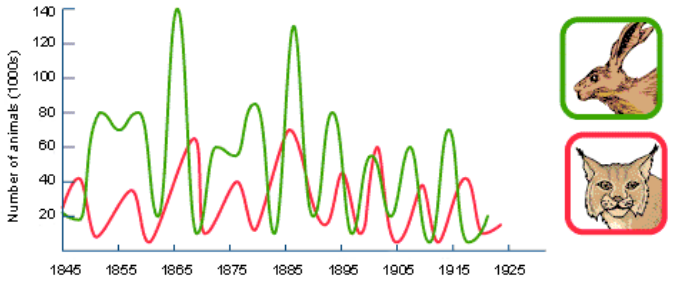


Carrying capacity is the amount of food (and other resources) available to support human life sustainably. If resources (such as wild fish) are overused, they do not recover as quckly, degrading the carrying capacity.

17

To explain why this happens, ecologists have introduced a concept called the Carrying Capacity, which is the ability of the system to sustain a species. If we do things that degrade the growth rate of our prey species, that we use for food, either directly by harvesting those species, or indirectly by degrading their habitat or displacing them, we decrease our carrying capacity. When our population overshoots the carrying capacity, two thing happen. Our population begins to drop due to starvation, and the carrying capacity decreases more rapidly due to overharvesting. Eventually the population drops enough that it drops below the carrying capacity and both recover.

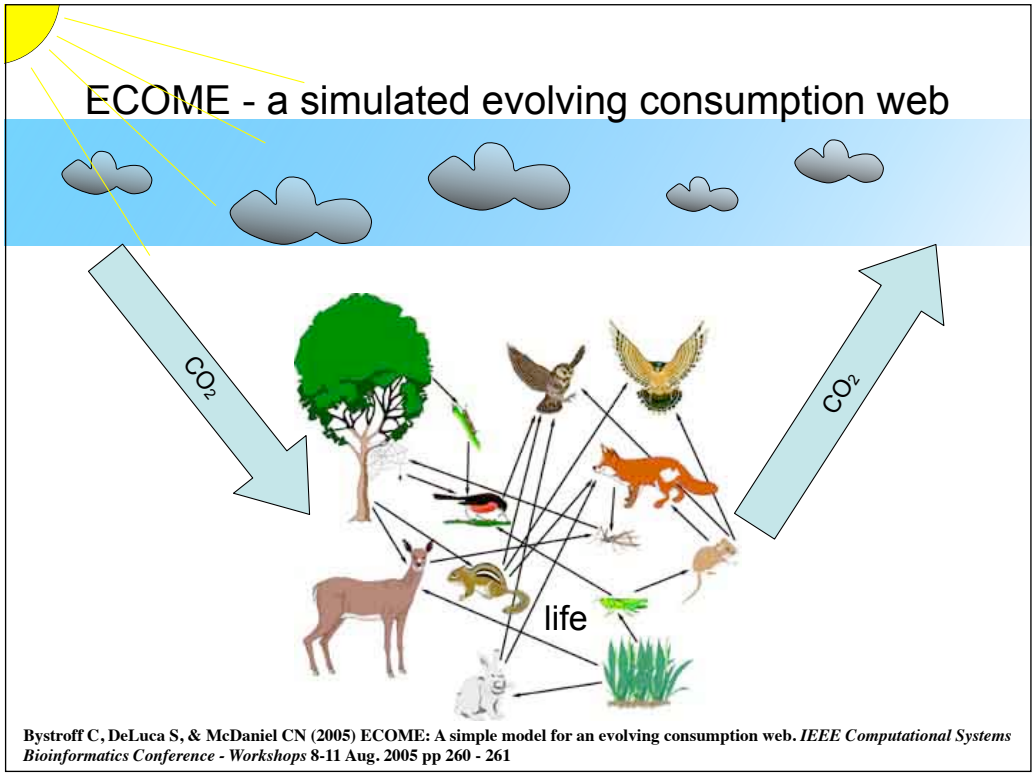
Boom/bust oscillation



18

http://io.uwinnipeg.ca/~simmons/16cm05/1116/16popbio.htm

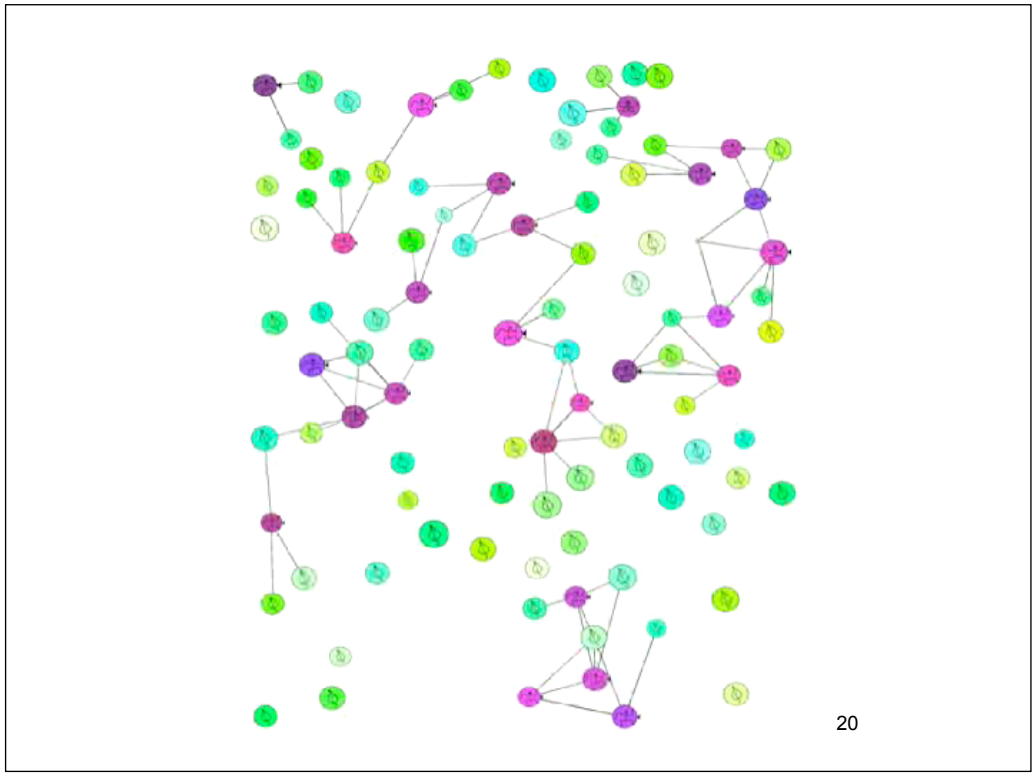
In a very simple ecosystem where a predator such as a lynx, eats predominantly one prey species, the hare, then we see boom and bust population dynamics. When the lynx exceeds the carrying capacity, it means they are eating more hares per year than are born. This naturally happens because the lynx doesn't plan ahead and doesn't institute rationing of hare supplies. Nor do they engage in abstinence or other such contraception. One or both of those two behaviors would slow the oscilation rate, but unless the lynx population was matched exactly to the carrying capacity, the curves would never flatten out.



Bystroff C, DeLuca S, & McDaniel CN (2005) ECOME: A simple model for an evolving consumption web. *IEEE Computational Systems Bioinformatics Conference - Workshops* 8-11 Aug. 2005 pp 260 - 261

The behavior of a more complex food web can be simulated as something like a Markov chain, where biomass changes hands instead of probability. Biomass goes from the atmosphere to plants as CO2, then from plants to herbivores, herbivores to carnivores, etc and from all species back to the atmosphere through respiration and decomposition.

So you can see I have been thinking about such a model. In fact, **I coded it in**.



This is a ECOME food web simulation where all species were allowed to speciate and gain new predator and prey edges. PLant species are green. Animal species are purplish colors. What you can see is that animal populations are naturably unstable. They go up slowly, then collapse quickly, usually as a tightly connected group. Over all, if I added enough species, the whole system was dynamically stable, but no one animal species stuck around for very long.

Just for fun, I allowed an animal species to control its own population. That led in some cases to animals that survived longer. But not always. The animal species with triangles are the ones that have evolved to control their own population.

Letters to Nature

Nature **412**, 543-545 (2 August 2001) | doi:10.1038/35087589; Received 30 April 2001; Accepted 22 May 2001

The end of world population growth

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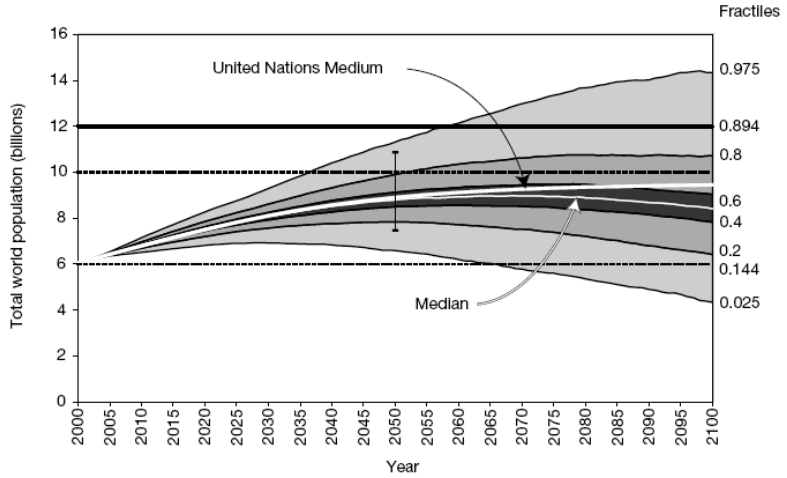


Having come to the conclusion that populations naturally boom and bust, I looked up published predictions for the human species and found this UN reprt, sating basically that population is expected to level out within 50 to 100 years. Here I noticed two things. One was that the authors were economists, not biologists. The other was that the projections were based on curve fitting. That is, they ignored the carrying capacity entirely and only considered birth rates and death rates, extrapolating in a naive way.

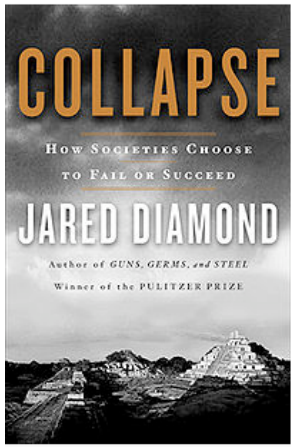
Types of science

Who we are.	What we do first.	What we then do.
Natural Scientists	Devise a hypothesis.	Test it against real data.
Social scientists	Devise a hypothesis.	Publish it.

22

This leads me to conclude that there are really two very different types of scientist. There are natural science people, and there are social science people (economists are social scientists). Scientists will use data to build a hypothesis, then test it. Social scientists will use data to build a hypothesis, then just go ahead and publish it.

Collapses in past human societies



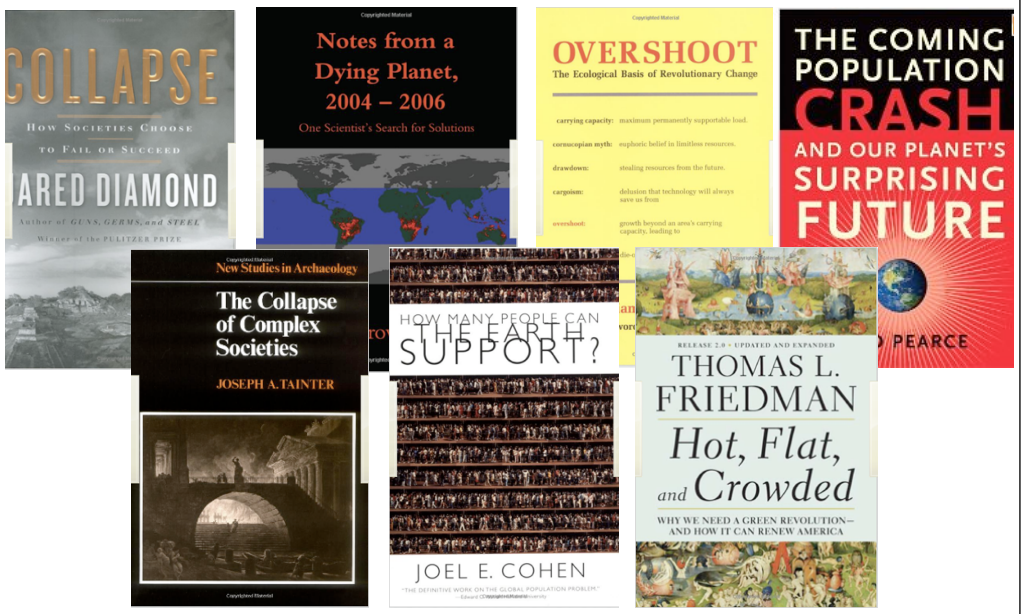
A short list

Mashkan-shapir	2300 BCE
Rome	400
Maya	800
Angkor	1220
Anasazi	1300
Ghana/Mali/Songhai	1300-1500
Europe	1348
Greenland Norse	1450
Easter Island	1860
Rwanda	1994

23

Looking more carefully, I found Jared Diamond has published a book “Collapse” that chronicles how populations have grown, outgrown their environments, and collapsed, sometimes dramatically. Population collapses date back to prehistory. For example, carbon dating of human bones in Africa shows that populations peaked at various times, correlated with technological advances, such as farming or smelting metal. Recent collapses include the Maya, who eroded away their farmland, the Anasazi, who deforested northern Mexico. The people of Easter Island who cut every tree and lost 97% of its population in 10 years, and the Greenland Norse, who refused to eat fish and died off completely when the climate shifted.
Diamond suggests that the Rwanda genocide in 1994 was caused by food shortage.
And recent events suggest that North Korea may be headed for a period of starvation and unrest.

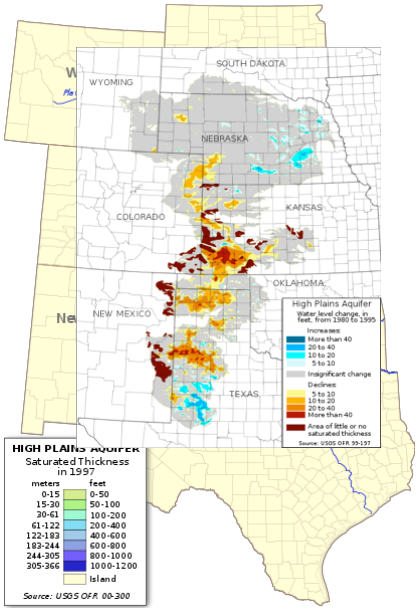
books that predict the future of population



Here's a few books on the subject, some historical, some theoretical, and some attempting to predict the future.

Overshooting carrying capacity by using non-renewable water

NASA ASTER image of an approx. 557 mi² area of fields (1443 km²) in Kansas which are watered from the Ogallala aquifer with center pivot irrigation systems.



The Ogallala aquifer is being depleted due to irrigation.

Will we suffer a collapse in the US?

In the US, our large amount of arable land has allowed both dramatic populationgrowth and consumption per person over the last century, but there are signs that food production will soon reach a peak. If you have flown over the midwest in recent years you have seen these circles of crops. These are center-pivot irrigation systems, drawing water from the Ogallala aquifer, a massive underground basin that stretches from Texas to South Dakota. Sustaining production means drawing water at an unsustainable rate and in many places, the water levels in the aquifer are down by more the 40 feet.

Wheat farmers in Saudi Arabia and Nevada also use “fossil” water to turn their deserts green. Fossil water is water from ancient aquifers no longer in circulation. Saudi Arabia will be forced to end wheat production by 2016 when aquifers are projected to run dry.

'STEADY AS SHE GOES'

There's another way we are like yeast and that's the Free Market Economy. The Economy is a system created by humans for the benefit of humans. As such it is designed to promote growth. If you are not sure about that, ask yourself if you were an investor and I were a company that is planning on **just breaking even**, or maybe **shrinking** over the next 5-10 years, would you invest in me? Likewise would you save your money in a bank that offers **negative** interest? The Free Market stimulates businesses that grow, and businesses grow when spending increases, and spending increases when there are more people spending. And more people are spending when the population is going up. In that sense, the Free Market works only if the population is constantly growing, or constantly consuming more per person.

Environmental impact

Impact = Population * Affluence * Technology

I = PAT

Barry Commoner, Paul Ehrlich & John Holdren

27

At the same time, the impact on the environment is also proportional to population and spending.

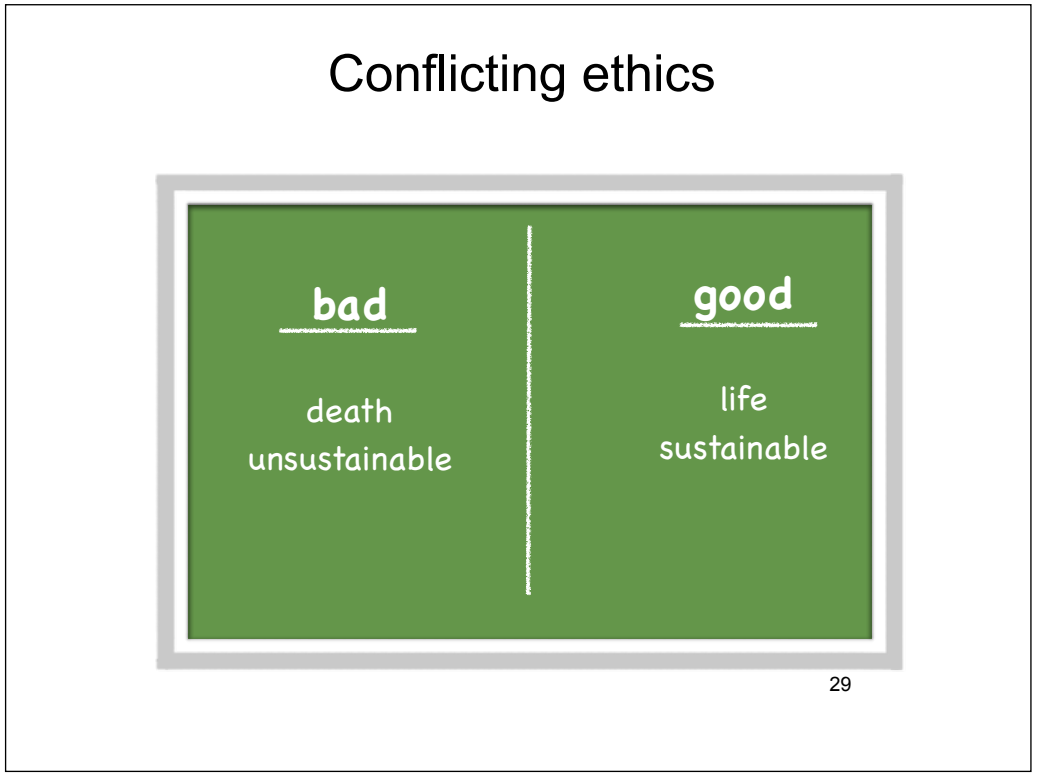
This simple equation, **Impact = population * affluence * technology**, is the product of a debate in the 1970's between three forward thinkers who took the time to study this dissonant issue. Make sense? If we put these two ideas together, (1) that the economy is designed for growth, and (2) that environmental impact is proportional to the size of the economy, then you must conclude that the economy is designed to destroy the environment, and perhaps us with it. If you doubt my calculations, ask an ecological economics major.

This is unintential, I hope. And there is one mitigating factor, **Technology**, which is calculated as the impact on the environment per unit consumed. But it is not likely that we can get that factor down to zero and still continue to grow.

3. Sustainability versus compassion.
All life is sacred. What do we do when there's too much sacred?

28

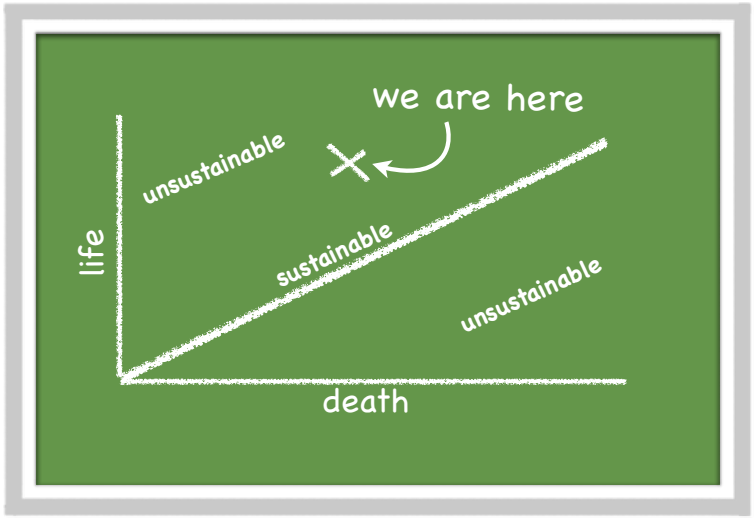
From psychology, to ecology, to ethics.



If you had a chalkboard with a line down the middle and you were asked to put bad things on one side and good things on the other, most people would put **life** (especially new life) on the good side, and **death** on the bad side. If you doubt this, ask yourself how many times you have offered **condolences** to a new mother, or **congratulations** to a new widow.

Most people surveyed would also put sustainability on the Good side and unsustainability on the Bad side. Does anyone really favor using up the last of the fish in the ocean? And yet,

bad is good, good is bad



30

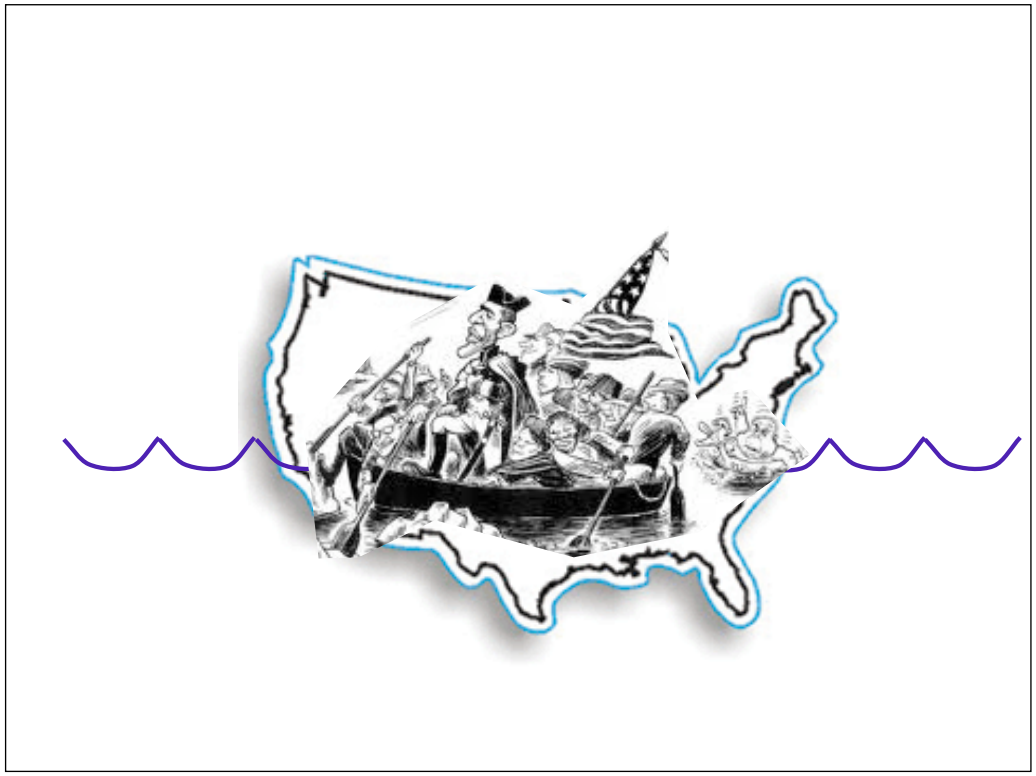
Now plot life versus death. That's the birth rate versus the death rate. A sustainable population is one where the birth rate equals the death rate. Worldwide, there are about 140 million births each year while the death rate is 57 million per year. So we are somewhere up and to the left of the sustainable zone. The direction of "good" is further up and further to the left. The way back to sustainability, an acknowledged "**good thing**", is down and to the right, either **less birth** or **more death**. Unless we can envision congratulating people on not having children, or dying earlier, then we have an ethical paradox. Too much good is definitely a bad thing.

Lifeboat Ethics

It was pointed out by a philosopher Garrett Hardin that our ethical situation is like the situation of survivors on a lifeboat that safely holds 50 people, while swimmers in the water are trying to board and save themselves. The lifeboat has a captain and the captain has to decide whether to load more people than is safe, and possibly sink the boat, or leave the swimmers to their doom.

It is rarely so black and white, but Lifeboat Ethics is in play when we consider the ethics of **immigration versus sustainability**. Inside the US border is the lifeboat, where life is good and jobs are plentiful, while outside are the swimmers trying to board by immigration. If they get in, we are in danger of overwhelming our resources and eventually collapsing like an overloaded lifeboat. If they don't get in, they may be forced to live out their lives in poverty.

A rich country life ours is a lifeboat in one sense. The **whole Earth is a lifeboat** in another sense, where unborn children are trying to get in. But too many people will sink the ship by overshooting the carrying capacity, leading to a worldwide collapse.



The important difference is that the USA lifeboat has a captain, who has the ability (at least in theory) to make decisions on behalf of the whole country, to secure the borders and to limit (somehow) the birth rate. But on the global scale, we have no leader. Without a leader, we can only expect to behave like yeast.

Table 1. Immigrant Birth Rates Higher in U.S. Than Home Countries

Country	TFR* in Home Country	TFR* of Immigrants in the U.S.
Mexico	2.40	3.51
Philippines	3.22	2.30
China	1.70	2.26
India	3.07	2.23
Vietnam	2.32	1.70
Korea	1.23	1.57
Cuba	1.61	1.79
El Salvador	2.88	2.97
Canada	1.51	1.86
United Kingdom	1.66	2.84
TFR for Top Sending Countries	2.32	2.86

*Total Fertility Rate (TFR) is the number of children a woman can be expected to have during her reproductive years. See Data and Methodology section of report for more detail.
Source: Fertility for Immigrants based on Center for Immigration Studies analysis of 2002 American Community Survey. Fertility for foreign countries comes from the United Nations Population Division, Department of Economic and Social Affairs.

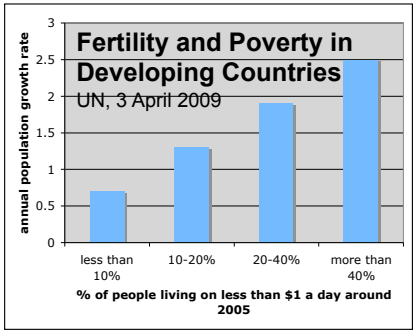


Table 3. Less-Educated Immigrants Have Significantly More Children than Less-Educated Natives

Mother's Education	Native TFR	Immigrant TFR
< High School	2.27	3.30
High School Only	2.32	3.37
Some College	1.81	2.04
College or More	1.79	1.91

Source: Center for Immigration Studies analysis of 2002 American Community Survey.

Is immigration a simple shift of population from one side of a border to the other? Not really. Both consumption and fertility rate increase on average when a person moves to the US. All except asian immigrants have more children here than they would have if they stayed in their home counties. It is well known that fertility is correlated with poverty(upper right graph) and that fertility is inversely correlated with education (lower right).

The data (if they are correct) create an ethical paradox.

Compassion (an item generally placed on the “good” side of the chalkboard) says Immigrants have just as much right to be here as we do. Sustainability on the other hand urges us to take an anti-immigration stance To overcome the cognitive dissonance we have to choose which “good” is more “good”. It’s not for me to make this decision for anyone else but me. But as far as I’m concerned, as much as it pains me to quote Bill Gates, **life really isn't fair. Perhaps it's not within our power to make it so.**

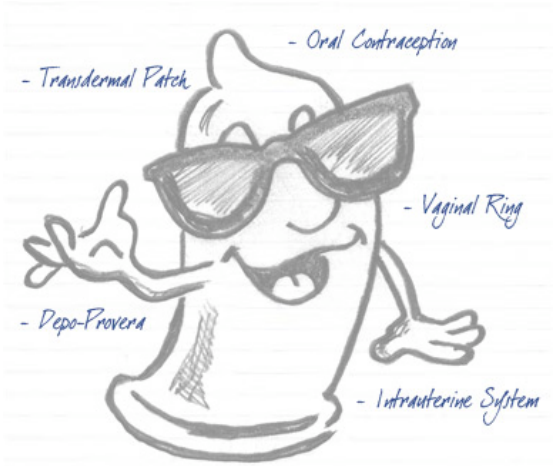
4. Pessimism is the new optimism
Spreading the worst case scenario

35

4 Pessimism is the new optimism

Spreading the worst case scenario

decrease the birth rate!



36

The good news is that there is an ethical solution to overpopulation. Simply **decrease the birth rate**. And the technology for doing has always existed. But willpower has been lacking until this last half century.

Unintended pregnancy in the US

In 1994,

- 49% of pregnancies were unintended
- 54% of these ended in abortion
- 48% of women have had ≥1 unplanned pregnancy
- 28% of women have had ≥1 unplanned birth

Highest unintended pregnancy rate among women 18-24, unmarried, low-income, minority.

Stanley K. Henshaw. Unintended Pregnancy in the United States. *Family Planning Perspectives* 30(1), January/February 1998

37

In the US, most of the population growth can be explained by unintended pregnancies, especially among young women. A better contraceptive technology or social strategy could correct this with little or no negative social repercussions.

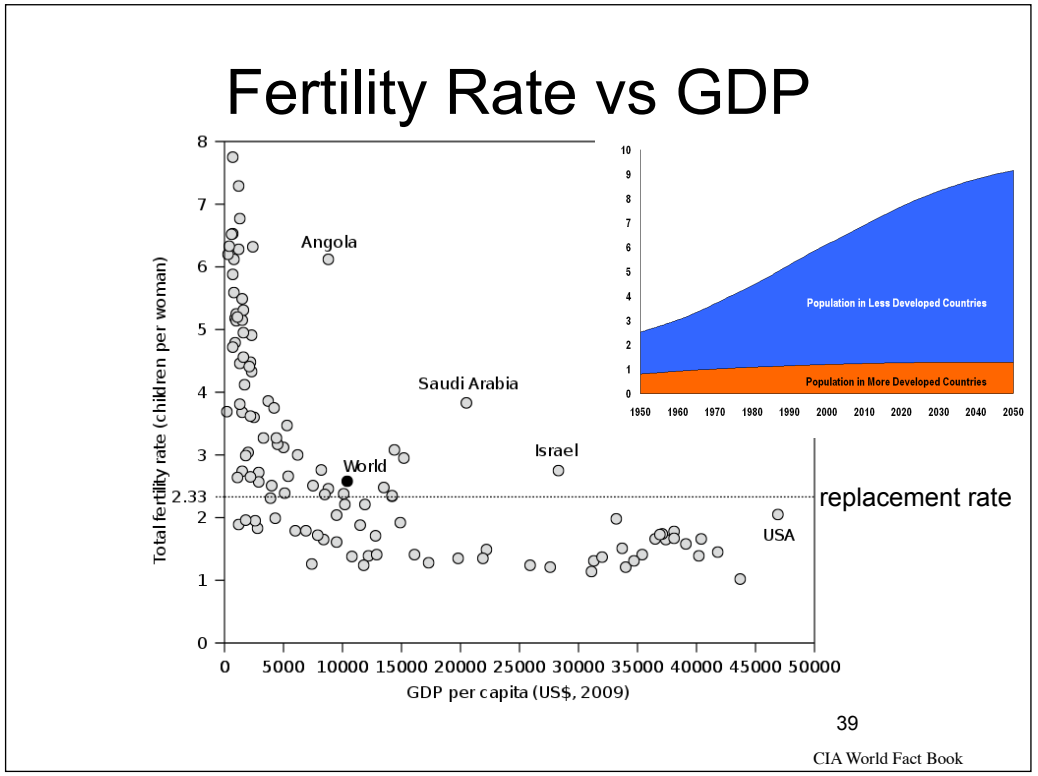
Dropping TFR

World historical and predicted total fertility rates (1950–2050)

UN, medium variant, 2008 rev.[2]

Years	TFR	Years	TFR
1950–1955	4.92	2000–2005	2.67
1955–1960	4.81	2005–2010	2.56
1960–1965	4.91	2010–2015	2.49
1965–1970	4.78	2015–2020	2.40
1970–1975	4.32	2020–2025	2.30
1975–1980	3.83	2025–2030	2.21
1980–1985	3.61	2030–2035	2.15
1985–1990	3.43	2035–2040	2.1
1990–1995	3.08	2040–2045	2.15
1995–2000	2.82	2045–2050	2.02

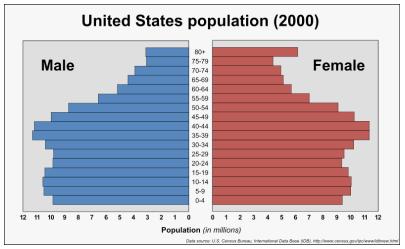
Looking at trends, we see the **Total fertility rate** worldwide was almost 5 children per woman in 1960 but is now 2.5 children per woman, and is projected to reach the 2.2 replacement level by 2025.



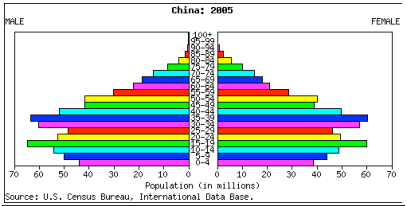
Broken down by country, population growth is now almost entirely confined to the poorest countries of the world as this graph of **Total Fertility versus GDP** shows. These countries have a long way to go to reach sustainability, but these are the countries **most susceptible** to improvements in education and healthcare, so there's clearly hope that they will join the developed countries at replacement level fertility within a few decades.

On the other hand, developed countries are either at equilibrium or shrinking when one factors out immigration, with fertility rates below 2.2 children per woman, and in the case of many parts of the globe, well below 2.0. China's fertility rate is below 2, as are most countries in Europe, especially eastern Europe.

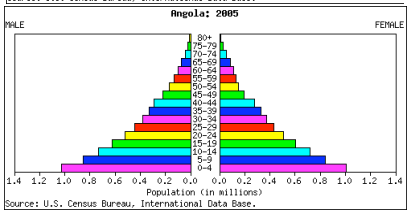
Population lag effect.



USA: Baby boom followed by birth dearth.



China: one child policy, followed by birth dearth.



Angola: no boom. High fertility. Low life expectancy.

40

http://environmentalet.org/env1100/demoframes.htm

Baby booms in the US and China were followed by birth dearths in both countries. China currently has some of the lowest fertility rates in the world, and their continued population growth is entirely the result of the "**population lag effect**" . In twenty years the baby boom generation will begin dying off in large numbers and the death rate will finally catch up with the birth rate, and population will decline. Poor countries like Angola continue to have high fertility rates.

Education and healthcare

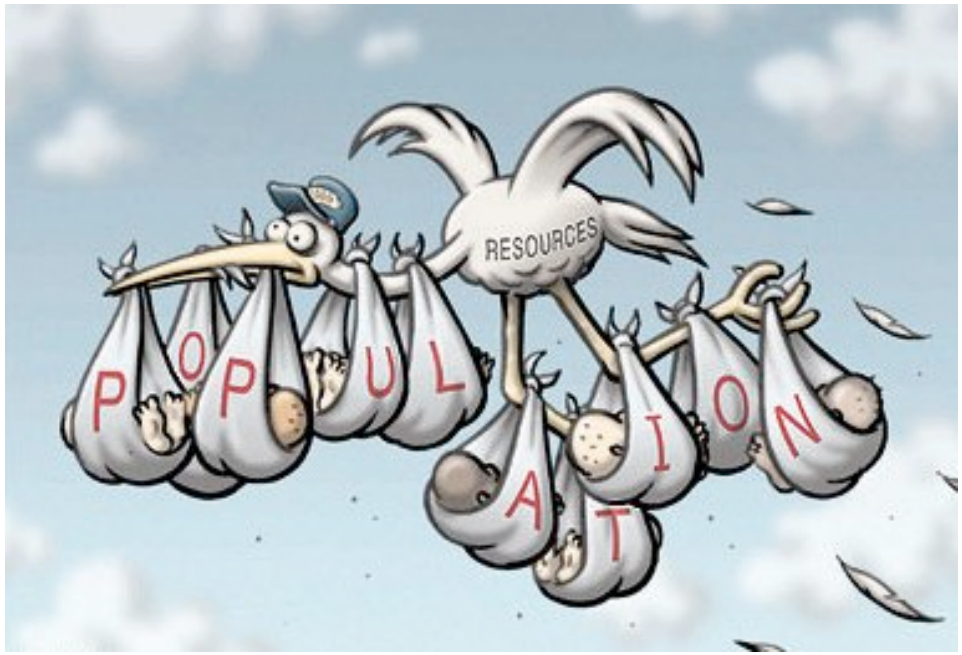
= lower fertility

41

The birth rate depend mostly on women and their choices. Women choose to have larger families if they perceive the likelihood of any child's survival to be lower.

With the improvements in healthcare and sanitation, women in developing countries are seeing that more of their children are surviving to adulthood, and are having fewer children by choice. Education has made them aware of their rights, their career opportunities, and of contraceptive technology to control their family sizes. Because more women are chosing careers over families, the total fertility rates are falling. But are they falling fast enough?


IMAGINE HOW MUCH SMALLER THIS CROWD WOULD BE IF WE DIDN'T OPPOSE CONTRACEPTION.



43

I believe THE ONLY way to solve overpopulation is to be extremely pessimistic about the future. Not faith, not polyanna optimism, but doom-and-gloom possimism is our only hope. A growing chorus of hopeful pessimism can be found in these books. They raise the alarm. They cry out "danger!!" They paint an ugly picture of the outcome if we ignore the current trends, and they spur people to take on the tasks of better sex education, improving healthcare for children and fighting against denial for the benefit of future generations. I'm convinced that in a world where Bad is Good and Good is Bad, that Pessimism is the new Optimism. Our only hope for survival is to prepare for the worst.