Human Population Growth - Crash Course Ecology #3

Crash Course: Ecology
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===== Introduction (0:00) =====

If being alive on earth was some kind of contest, humans, I think, would win it hands down. As a population of organisms, we're the Michael Phelps of being alive, only we have like 250,000 times more gold medals. Last week, we talked about exponential growth, when a population grows at a rate proportional to the size of the population, even as that size of that population keeps increasing.

Well, since around the year 1650, the human population has been undergoing probably the longest period of exponential growth of any large animal in history ever. In 1650, there were about 500 million people on the planet. By 1850, the population had doubled to 1 billion. And it doubled again just 80 years after that, and doubled again just 45 years after that. We are now well past 7 billion and counting.

So think about this: today, there are 80 year olds who have watched the population of their species on earth triple. So why is this happening? And how? And how long can it go on, because it's kind of uncomfortable?

[Title Sequence]

===== Quantity vs. Quality (1:08) =====
Let's say you're shopping for dinner, and bear with me, we're going to relate it back to ecology in a second, but you've got a lot of choices at your grocery store, you could buy five packs of ramen for a dollar, or you could buy some fancy ravioli made by Italian nuns out of organic pasta for like $20 a pound. They're both noodles, they're both food, but you know, with the ramen, you get more, whereas with the handmade stuff, it tastes better--higher quality. What do you do? It's a perennial problem in nature, and in our lives, satisfying the two competing impulses: do I have more or do I have the best? Quantity or quality? Tough choice.

===== R vs. K Selection Theory (1:41) =====
Although we're not really aware of it, all organisms make a similar choice through how they reproduce. In ecology, we size up who chooses quantity over quality by something called the R vs. K Selection Theory. The R vs. K Selection Theory says that some organisms will reproduce in a way that aims for huge exponential growth, while others are just content to hit the number of individuals that their habitat can support, that is, the carrying capacity, and then stay around that level. Species that reproduce in a way that leads to very fast growth are called R-Selected Species because R is the maximum growth rate of a population when you're talking math-talk, as we learned last week.

The very-strongly R selected animals make a lot of babies in their lifetime and just hope that they make it. If some of the babies get eaten or something, no biggie, there are others where those came from. On the other hand, K-selected species only make a few babies in their lifetime and they invest in them very heavily. K in math language is carrying capacity, since K-selected species usually end up living at population densities closer to their carrying capacity than R-selected ones.

Of course, things aren't so cut and dry in nature as most animals aren't very strongly K-selected or R-selected, it's actually, you know, a spectrum--some organisms, usually small-ish ones, reproducing more on the R side, others, usually larger ones, on the K side. Most species are somewhere in the middle.

===== Humans: K-selected or R-selected? (2:55) =====
So the reason I'm telling you this is to drive home how bananas it is that humans have gotten to the population size we have. Because we tend to reproduce way on the K-selected side of the spectrum, we're pretty big mammals, usually only have a few kids during our lifetimes, and those kids are a total pain in the butt to raise but we put a ton of resources into them anyways.

So even though humans reproduce K-selected-ishly, for the past few centuries, our population growth curve has been looking suspiciously like that of an R-selected species. And exponential growth, even for R-selected species, usually does not go on for 350 years.

Well, how did this all happen? Well, the short answer is that humans figured out how to raise our carrying capacity so far indefinitely, and we did this by eliminating a bunch of obstacles that would have made our numbers level off at a carrying capacity a long, long time ago. These obstacles you will recall are limiting factors, and we managed to blast them to pieces in a few different ways.

===== Causes of Exponential Human Growth (3:48) =====

First, we've upped our ability to feed ourselves. Our crazy rapid population growth started in Europe around the 17th century because that's when agriculture was becoming mechanized and fancy new farming practices like the domestication of animals and crops were increasing food production. From Europe, those agricultural practices and their accompanying population explosion spread to the New World and to much of the rest of the world by the mid-19th century.

Another game changer for the human population came in the form of medical advances. Anton van Leeuwenhoek, father of microbiology, all around really smart guy, was the first modern scientist to propose the germ theory of disease in 1700, and even though it took about a century and a half for people to take it seriously, it revolutionized human health, leading to things like vaccinations. Suddenly, people stopped dying of stupid, avoidable stuff as they had been for thousands of years, which meant that everybody lived longer, childhood survival rates improved, and those kids went on to make their own babies and became very, very old.

And we also increased our carrying capacity by not being so disgusting. We figured that you can't just sit around in your own poop and live to tell the tale, so sewage systems became a thing. In Europe, at least, it started around the 1500s, but they weren't widely used until the 1800s, and we all benefited from that.

And, finally, we've gotten a lot better at living comfortably in inhospitable places. That is to say, people have been living in deserts and tundra for thousands of years, but in the 20th century we expanded the human habitat to pretty much everywhere in the world, thanks to heating and air conditioning and warm clothes and airplanes and trucks that bring food everywhere from Svalbard, Norway to New South Wales.

===== Human Carrying Capacity (5:22) =====

So for all those reasons and more, humans have been able to avoid that old party pooper carrying capacity, which is good, 'cause I don't like it when people die, it's just, it's just a downer. And a lot of smart scientists and mathematicians and economists have argued that each person born in the past 350 years has not only represented another mouth to feed, but also two hands to work to raise the human carrying capacity, just enough for themselves and a teensy bit more. So then as our population grows, our carrying capacity grows right along with it, like some really steep escalator going up

and the ceiling just above our heads, and if it stayed there, we'd all get squished but it keeps moving.

But of course, this can't go on forever. The human population does have a carrying capacity, it's just that nobody's sure what it is. Back in 1679, it was Leeuwenhoek himself who was the first to publicly hazard a guess about the earth's carrying capacity for humans, guessing it to be around 13.4 billion people. Since then, estimates have ranged from 1 billion to 1 trillion, which is one thousand billion, so that seems a little extreme, but the averages of these estimates are from 10-15 billion folks.

===== Ecological Footprints (6:27) =====

And we need a lot of obvious things to survive--food, clean water, non-renewable resources like metals and fossil fuels--but everything that we consume requires space, whether it's space to grow or space to mine or produce or put our waste. So a lot of ecologists make their estimates of how many people this planet can handle based on an ecological footprint, a calculation of how much land and how many resources each person on the planet requires to live.

That footprint is very different depending on where you live and what your habits are. People in India use a lot fewer resources and therefore, space, than Americans for example. Meat eaters require a lot more acreage than vegetarians; in fact, if everybody on the planet ate as much meat as the wealthiest people in the world do, current food harvests could feed less than half of the present world's population.

So despite the fact that the earth is a very big place, space is a real limiting factor for us, and as our population grows, there will probably be more conflict over how our space is used. For instance, if there really were a trillion people on the planet, everybody would have to live, grow food on, and poop on, a 12-by-12 meter patch of ground, about half the size of a tennis court. So it could be that you could fit a thousand billion people on earth, but I can guarantee that those people would have a hard time getting along with each other.

===== Effects of Human Population Growth on Other Species (7:38) =====

But how about we stop thinking about ourselves just for a moment? As we take up more space, we also leave less space for other species, and as we use resources like trees and soil and clean water, that reduces the amount available to all kinds of other organisms. This is why biologists say that we are currently living through one of the biggest extinction events in recent geological history. We're outcompeting other species for the very basics of life. And eventually, or in the case of oil and water, already, we're starting to compete with ourselves as a species.

So serious stuff here, but here's a little glimmer of hope, unlike some other animals, a lot of our actions are based on a little thing called culture, and human culture has brought about some huge changes in the last 50 years. The fact is, even though the human population continues to grow, the rate of population growth actually peaked around 1962 and has been declining every since. At its peak, the human population was growing at about 2.2% per year, in these days, it's declined to about 1.1% and it's still falling. Families in most industrialized countries are getting smaller and smaller, but why?

===== Causes of Decline in Human Population Growth Rate (8:43) =====

Well, part of that has to do with women. As women in developed nations get more education, they're having babies later in life, and when an animal doesn't reproduce to its fullest potential--meaning it doesn't start having babies as soon as it's like, sexually able to--that animal is going to have fewer offspring. Also, if you get women more choices and more education, they might be more liable to choose a second career in astrophysics rather than becoming a mother.

Another reason for the falling population growth rate has to do with the way that we live our lives. Back in the early 20th century, more of the world worked on farms, and maybe ate their own food. Kids were a real asset to a farm back then, it's a good example of that idea about more hands doing more work to increase the carrying capacity of the human population. Yeah, kids were an extra mouth to feed, but they were also a really important work source and you could just feed the kids the stuff you were producing. That's what we call a positive feedback loop; as the population grows, the workforce gets bigger and the place, as a result, supports more of us.

But these days, that's not happening so much anymore. More and more people are living in cities where you don't need kids to help with the crops, so fewer people are having them, because a.) they cost a lot of money to raise, b.) they're not bringing in money like they were back on the farm, and c.) a lot of people have access to good birth control, so they don't have as many "oops"-children. All these factors together are forming a negative feedback loop, the effects of reproduction in this case work to slow down the rate of reproduction.

But just because our population's growth rate is decreasing doesn't mean that this juggernaut of humanity is going to stop anytime soon. In addition to reminding us that the rules of ecology apply to us just like any other organism, human population is important to think about because we kind of need to do something about it. And I think pretty much every other species on the planet would agree with me on that.

===== Credits (10:21) =====

Thanks for watching this episode of *Crash Course: Ecology*, and thanks to all the people who helped us put it together. If you want to review anything from this episode, there's a table of contents over there, and if you have any questions or ideas or comments, we're on Facebook and Twitter and of course, down in the comments below. We'll see you next time.