THE NUMBERS OF EXTINCTION

We have met the enemy and he is us.
Pogo

Legend has it that once there was a powerful Persian leader who had built a magnificent building. He wanted a special inscription for it and asked his wise men to come up with a text that would always be true in any circumstance. After some deliberation, they came up with: *And This Too Shall Pass Away.*

There are many versions of this story, but they all state the same thing; nothing is eternal, including us. 99.9%. of all the species that have ever existed have gone extinct. Many long ago, many today. As to our own extinction, it is not a question of *if*, but *when*. Extinction is not something we spend a lot of time worrying about, but the time has certainly come wherein we should.

There are primitive societies in the world even today whose counting system is; one, two and many. What an uncomplicated and simple life they must lead. Counting goes back at least two hundred thousand years and quite possibly four hundred thousand. Nomadic people would have little need for record keeping so counting remained quite elementary for ages.

Once agriculture arose counting took on a much more significant role in everyday life. Today it governs almost everything we do. It tells us how old, how much, how tall, how heavy, how far, how fast and more. Perhaps, more than anything else, numbers define us.

In most common instances, we can conceptualize these numbers. We have a clear mental concept of an inch, a foot, a yard, a pound, a gallon and more. As the numbers grow larger we lose this ability to conceptualize rather quickly. It is somewhat difficult to get a real concept of a mile. We can relate to it by thinking of a distance between known objects, between my house and the post office is a mile. This is not exactly a real concept, but it is useful.

From the moment we are born virtually everything we encounter is defined by numbers; the hour and date of our birth and our weight. In time our bank account, the value of our house and car, the fuel consumption of the car. When we attend sporting events the winner is always the one with the highest number of points. Averages and statistics are more numbers.

We can get a good mental image of three hundred feet as that is the length of a football field. In a sense the football field has become a de facto unit of measure. It is easier to think of the length of a Nimitz Class Aircraft Carrier as three and a third football fields than it is to think of a thousand feet.

A million miles and we are totally out of it. If we could drive continuously at sixty miles an hour it would take about two years to go a million miles. We can get a real feeling of large distances if we use as our moving object the Discovery Space Probe. This object has left the Heliosphere and is now zipping through interstellar space. It is moving away at about forty thousand miles an hour. By terrestrial standards that is fast, New York to Los Angeles in about four and half minutes. All the way to the moon in six hours.

The probe is traveling about a million miles a day. As such, it would take some three years to travel one billion miles; about three thousand years to go a trillion miles. This means eighteen thousand years to go one light year and about eighty thousand years to the nearest star. Fascinating numbers, but they still provide no actual concept of the incredible distance to the nearest star.

As we look at the moon the mind cannot grasp the fact that the moon is about two hundred and thirty thousand miles away. Two hundred and thirty thousand is just a relatively abstract number. In most instances this is of no importance. Scientists work easily with light years even though not one can conceive of six trillion miles

String theorists and particle physicists deal with

quantities so small that even they cannot visualize them. Take, for instance, the Plank Length. Using scientific notation, we can write this down; $1.6162287 \times 10^{-35.}$ If we were to write this in regular notation, it would look like this;

.00000000000000000000000000000016162287

Another way to look at a Plank Length is that is that it 10^{-20} times the size of a proton. There are more cubic Plank Lengths in a cubic centimeter than there are stars in the visible universe. We can define more than we can conceptualize. We are facing a situation now wherein this lack of conceptualization becomes a real and serious problem.

In February 2015 Senator Jim Inhofe appeared on the Senate floor with a snowball. This apparently was his folksy, Oklahoma way of telling us that global warming is a hoax. "There's no global warming; look, here's a snowball!" We've grown somewhat used to less than bright people entering the congress, but Senator Inhofe is a special case. He is the chairman of the Senate's Environment and Public Works Committee. It is both inevitable and a bit alarming that the fate of the species rests with politicians and not climate scientists. This is not

to say that politicians are the cause of the climate problem. We are all guilty to one degree or another for that. A true scientist is one who has intelligence, considerable schooling and usually much experience. One the other hand anyone can run for congress

It appears that most members of Congress are treating the climate debate as just another debate, much like abortion rights, same sex marriage, minimum wage and who gets to use which bathroom. Climate change is a bit different in that in this debate we cannot afford to be wrong. The climate of the earth is insidiously complex. So much so that even with many brilliant and educated people using very sophisticated equipment it seems, sometimes, that Meteorology would seem to be just one step above Astrology. It seems this way because there are so many variables.

When we speak of the cause of climate change we are, for the most part, referring to one thing; carbon. It is the unique qualities of carbon that makes life itself possible. The molecules of life are so complex that an entire branch of chemistry exists just the study them. It is ironic that another property of this element may well destroy us. The molecules of extinction are very simple, carbon and oxygen (Carbon Dioxide, CO_2) and carbon and hydrogen

(Methane, CH_4).

Along with the myriad properties carbon possesses is its ability to collect and store infrared radiation. There are other compounds that trap Infrared Radiation but the one most prevalent in our discussions is Carbon Dioxide. Methane is discussed to a lesser extent, but Methane is becoming more meaningful as its supply increases. Methane survives in the atmosphere for a much shorter time than $CO_{2.,}$ statistically about twelve years.

Our inability to conceptualize anything but relatively small numbers limits our understanding of the manifestations of climate change. This mental restriction causes us to think very locally. The world we perceive stretches very little beyond what we can mentally grasp. This makes it difficult to understand why our behavior, which often seems harmless, can affect the entire globe. If we look abstractly at the universe we can state that we are but a speck orbiting an average star way out in the boondocks of an ordinary galaxy. It has been recently ascertained that we are part of a huge structure containing one-hundred million galaxies. This makes us feel quite small.

This is why Senator Inhofe could make the statement that man could not possibly affect the climate of the

planet. Man is so small, and the world is so big. There is a very simple reason why man can and indeed does affect the climate, there are nearly seven and a half billion of us. That's a number that we can't get our minds around and our inability to grasp that number is a major reason for the dilemma in which we find ourselves involved. If we were to lay everyone on the planet head to toe the line of people would reach more than seven and a half million miles. That's to the moon and *back* more than sixteen times or around the earth at the equator more than two hundred and eighty-eight times.

The most significant way CO_2 gets into the atmosphere is by combustion. Most of the things we burn are carbon-based compounds. Even when we breathe we are putting CO_2 into the atmosphere. Statistically a human being expels about three and a half pounds of CO_2 a day. That means the seven billion people put more than thirteen million *tons* of CO_2 into the air a day simply by breathing. That works out to a figure approaching 5 billion tons a year. Then there are all the rest of the animals which defy counting. We must assume they contribute at least a similar amount.

TRANSPORTATION AND WORK VEHICLES

As of this writing, there are some 1.2 billion cars in the world. If each one of those cars burned one gallon of gasoline they would produce some twelve and a half million tons of CO_2 and of course cars use much more fuel than that.

Cars have an interesting feature in that they spend the biggest part of their lives parked. We drive to work, and the car is parked while we work. We drive to dinner and the car is parked while we eat. We drive to visit someone, and the car is parked while we visit and so on. Cars are for the most part parked all night. The same is true for privately owned small trucks. Commercial vehicles are something else. A large semi is very expensive to buy and to operate and so it must be kept on the road as much as possible. Many such trucks have sleeping arrangements and multiple drivers so that the truck is on the road continuously.

Cars have a big swing in the number of miles they get from a gallon of fuel. They get anywhere from about fifteen miles to the gallon to perhaps thirty-five miles to the gallon. A large commercial truck, on the other hand, gets about five to eight miles a gallon. There is a movement afoot to get all such trucks producing eight

miles a gallon.

A world figure for the number of trucks is hard to come by but as of around 2008 there were some fifteen and a half million trucks in the US and they were using about 53.6 billion gallons of fuel a year. That puts about six hundred million tons of CO_2 in the atmosphere.

Diesel electric locomotives are complex, and mileage can be hard to determine. On average such a locomotive will burn 4 to 6 gallons an hour idling and from 165 to 249 gallons when pulling a load. When compared to other forms of freight hauling the locomotive is quite efficient, but the CO_2 ingested is still immense. The number of busses is equally difficult to find but its number is in the millions as well as do heavy equipment such as bulldozers, tractors and large earth moving machines. Transportation accounts for about 27% of CO_2 production in the US.

AIRPLANES

Not long ago the number of commercial flights passed one hundred thousand a day. That's another number that is hard to wrap our brains around. Airliners on average consume between about 3500 and 4000 gallons an hour. An automobile that gets 25 miles per gallon could drive

for 100,000 miles on 4000 gallons of gasoline. Between October 2013 and September 2014, the airlines burned 16.2 billion gallons of aviation fuel. That would fill 25 Olympic swimming pools and would produce 154 million tons of CO_2, equal to the weight of 422 Empire State buildings. This would allow a car that gets 20 miles to the gallon to drive virtually all the way to Jupiter and back.

The same car with this much fuel could drive around the world at the equator 3,240 times. There are of course cargo planes and private aircraft, but that just makes a relatively incomprehensible number even larger.

The exhaust from airplanes does dreadful things to clouds and the upper atmosphere. There are some fine documentaries showing this. Statistically, there are more than eleven thousand passenger airplanes in flight at any given time. If we use the lower number for airliner fuel consumption we see that airliners are burning more than thirty-eight million gallons of fuel an hour – every hour.

Construction of new airliners will continue for some time. In 2013 Airbus delivered 648. However, Airbus had orders for 5,559 new planes and Boeing had orders for 5.080. New designs are coming online for these companies and there are more companies building new

airliners. Like everything else air travel is growing and growing fast.

SHIPS

Now we will move to boats and ships. It takes considerable force to move an object in the water as anyone who rowed a small boat knows. It took the Titanic one and a half tons of coal to travel one mile. As to small boats there are in the US a bit over eight million outboard motor boats and a bit over one and a half million inboard motor boats. While these contribute a sizeable amount of CO_2 the amount is small in comparison to the larger boats. The Queen Mary 1 got thirteen feet on a gallon of fuel. The more efficient Queen Mary 2 got forty-one feet on a gallon of fuel. Both ships were slightly over a thousand feet in length, about the same as a Nimitz Class aircraft carrier.

As of January 1, 2015, there were some 50,420 Merchant ships involved in international trade. The breakdown is most interesting: 16, 916 Bulk Carriers. These are the ships that carry unpackaged goods such as grains, coal, ore and cement etc. There are 10, 696 General Cargo ships: these carry things like heavy equipment. Next there are the Crude Oil Tankers. There

are 6971 of these. There are 5,097 Container ships, 4,999 Chemical Tankers and 1,677 Liquefied Natural Gas Tankers.

These are all large vessels. They will use 30 to 60 gallons of fuel to travel their own length, which means 106 to 176 gallons of fuel to travel one mile. The fuel they burn is so called Bunker Fuel. This is the waste product of the oil refineries, the stuff they would normally discard. It is truly dreadful. This oil spews out about 269 times the sulfur as the fuel used in cars and trucks. Bunker Fuel is basically the same as asphalt. When it hardens you can walk on it.

There are some five thousand large cargo ships operating. One such ship burns as much fuel as fifty million cars. About 20 of larger container ships put out as much pollution as do all the automobiles in the world. Again, numbers such as these are hard to grasp.

South Korea has designed a container ship that carries some 22,000 containers and is nearly 1500 feet long. The fleet of these ships is constantly growing.

Statistically a large ship sinks on average every four days. Such ships, like large trucks, are designed to make money so they are kept sailing as much of the time as is possible. When theses ships approach a country with

environmental laws prohibiting Bunker Fuel they switch to regular diesel fuel when they are within the twelve-mile limit. They can usually resupply the ship and reload the containers and put to sea again in usually two days. Then, once they leave the twelve-mile limit they switch back to Bunker Fuel. No country has any jurisdiction over the open ocean so once it is out there a ship can do just about anything it pleases. It is estimated that the exhaust from Bunker Fuel kills as many as a million people a year.

Tankers burn about three thousand to ten thousand gallons an hour. NSA states that there are 4295 tankers in the world. They burn the same fuel as cargo ships. Both Container ships and Tankers travel about 30 mph. This, especially for a large ship, is fast. These ships could use much less fuel by reducing their speed. They will only do this if the savings in the cost of the fuel they use is equal to or greater than the fees they will lose by making fewer deliveries and that is highly unlikely.

There are some 230 cruise ships in service and another 44 scheduled to come on line. Cruise ship companies pride themselves on a quick turnaround. A cruise ship can get cleaned and resupplied in one day, so the ship is virtually always in operation. As with other large ships,

cruise ships get about forty or fifty feet on a gallon of oil.

Recently a cruise ship came on line named the 'Harmony of the Seas'. This ship is a true monster. Cruise ships seem to be the big thing today in vacationing, so it is worth taking a brief look at what this ship contains. It is 200 feet longer than a Nimitz Class aircraft carrier. It has 16 decks, 20 restaurants and 23 swimming pools. It has the Casino Royal, and this is a casino with everything you would expect in a casino. It has a full-size basketball court, a miniature golf course, a Studio B Ice Rink, the Aqua Theater, which has an open-air stage for diving, aerial and acrobatic shows and a 1400 seat theater. It has a Boardwalk area with a carousel and snacks and entertainment. It has a Central Park area with 10,000 plants and fifty trees. It can house 6,360 passengers and 2,100 members of the crew. That is just about the size of the town in which I was born, and that town housed the Allegheny Ludlum Steel plant.

There is quite a bit more, but the things we are concerned with are the three four stories high, sixteen-cylinder Diesel engines. These engines develop 18, 860 kW. There are also three twelve-cylinder diesels that develop 13, 860kW This allows the ship to travel about 34 miles an hour.

These engines burn about 66,000 gallons of fuel a day. A car that gets 15 miles to a gallon could drive a million miles on this much fuel. The fuel they burn is among the most polluting fuels in the world. To add to this the land traffic created when the ship is in port is huge. At the time of this writing this ship is making seven-day excursions. One of these excursions burns about half a million gallons of Bunker Fuel.

Since this was written two Cruise Ships have appeared which are even bigger that the Harmony of the Seas.

THE MILITARY

The American military is the largest institutional user of petroleum and energy in the world. It burns more fuel than many countries and yet, if you have looked at the things that are putting CO_2 into the atmosphere, you may have noticed that there are never any mentions of the military. It is as if the military does not exist. This is by design. The Pentagon has been exempted from all international climate agreements and discussions This was a condition demanded by Bush the Second. He would not agree to join the Kyoto Convention unless this was observed. It was agreed to but then he decided not to go along with the Kyoto Conversion as he thought it would

harm our economy. It must be mentioned that Bunker Fuel is part of this exclusion. The military has ever since been excluded from anything having to do with climate. Harming the economy is the climate change deniers' most significant argument.

There was recently a meeting of many countries in Paris to create plans to check the burning of fossil fuels. It was a first of sorts and while it is still a long way from a solution it was at least a step. There was absolutely no mention of any military in these talks. When it comes to climate discussion, it is as if the military does not exist. It is hard to imagine an effective plan to curb Global Climate Change if the world's largest polluter is completely ignored. As of this writing the military is about to lose this exemption.

The military has something like a thousand bases around the world. Since military vehicles are usually armored they are heavy and that means they use a huge amount of fuel. The military burns about 100 million *barrels* of oil a year. This powers vehicles, ships, aircraft and ground operations. A car getting 25mpg could circle the earth 4 million times with this much fuel.

Military aircraft is another huge user of aircraft fuel. A jet fighter can easily use as much fuel as a passenger

airliner. A fighter could easily use forty thousand gallon an hour when using afterburners. The B-52 apparently burned about eight thousand gallon an hour. In the Iraq war it took as much fuel to transport the fuel as the fuel that was being transported.

STEAM ENGINES

Thus far all the fuels mentioned are hydrocarbons. Hydrocarbons are rather recent in the panoply of fossil fuels. Most of the technology was developed in the nineteenth century, but they really did not come into their own until the twentieth. Cars, trucks and airplanes could not exist to any significant degree until the development of both the internal combustion engine and the jet, both of which burn hydrocarbons. I suppose if we wanted to say who started the dilemma we find ourselves in we could name James Watt. Watt did not actually invent the steam engine as there were many engines that went back well into the eighteenth century. What Watt did was to sophisticate the design enough to make the steam engine practical. The Watt engine replaced water wheels and windmills and gave rise to the modern factory. The steam engine was later refined and became small enough to be used in conveyances such as trains and steamboats.

Here is a short bit about the physics of water and heat. We will use for our discussion the calorie. While the calorie is little used in science these days it works for what we need. A calorie is the amount of heat needed to raise the temperature of one cubic centimeter of water one degree centigrade. We will allow our initial temperature to be twenty degrees centigrade. This can be described as room temperature, sixty-eight degrees Fahrenheit. To raise this CC of water to the boiling point would of course require thirty-two calories. This would not produce steam, but merely water at one hundred degrees. To change the water at one hundred degrees into steam at a hundred degrees requires another eighty calories. Therefore, you can get a rather nasty burn from your tea kettle and why you feel cold on a very hot day when you come out of a swimming pool. Simply by evaporation the water draws considerable heat from the body.

To be used to power a steam engine the steam must be enclosed and made considerably hotter. Steam engines require a great deal of heat to operate. The British Isles had a great deal of coal and coal was used to produce heat for many, many years. Coal indeed produces a lot of heat, but it also produces the soot and grime that gave us the London of Charles Dickens.

Wood was often burned for fuel, especially in the American West but that proved impractical and coal became the fuel of choice. As factories increased in size along with steamships and trains, coal usage grew significantly.

Toward the end of the nineteenth century Edison perfected the electric light and Tesla developed AC and invented the polyphase motor. The electrification of the world had begun. Something had to produce the electricity and we experienced the growth of the power plant.

COAL

The use of coal as a fuel goes back many years. It was used initially for such things as heating and smelting. Coal is, perhaps, the worse type of fuel there is. While Bunker fuel may be more polluting coal remains far worse for two reasons. Unlike the hydrocarbons, (gasoline, diesel fuel, methane and the rest) coal, once the nasty stuff burns away, is relatively pure carbon and as such it puts out twice as much CO_2 as the other fossil fuels. There are of course more sources of CO_2 than those shown, such as brush fires, forest fires, smelters, cement plants etc. but these give a reasonably good idea of the

magnitude of what we are dealing with.

For a long time homes were heated with coal. Through most of my youth our house was heated with coal. Most people today have little idea of how tied to the furnace we were when we heated or homes with coal. You had to go to the cellar several times a day and shovel coal into the furnace.

The fire was on a grill a couple of feet above the floor, so you could shake the ash down into the area below the fire. Bituminous coal produces prodigious amounts of a very nasty ash. This you shoveled into large buckets and the buckets were collected by the township several times a week. That ash is also mildly radioactive.

At night you banked the fire wherein you reduced the amount of air reaching the coal. While this kept the fire burning all night it also reduced the heat output and the house was quite cold in the morning. It took a while for the fire to rejuvenate. I remember most of my school days beginning with getting dressed on the grill in the floor that let the heat into the house.

The worst part was when you went away, even for a few days. You had to shut off the water outside and drain all the interior pipes. When you returned the house was very cold. Anyone who has started a coal fire knows how

difficult that can be. Once the fire was started it seemingly took forever to reheat the house. When we switched to gas it was a touch of paradise.

The amount of coal burned by a train varies greatly with the load and the topography of the land. They averaged about nine tons an hour. This required a separate man in the engine whose job was just to shelve coal into the burner.

From the time of Fulton's Claremont to about the time of the Titanic, steamships burned coal. These were all types; River Boats, Ferries, Cargo ships et al. The amount of coal burned varied of course with the size of the ship. The Titanic burned 825 tons of coal a day. Other smaller ship of the Canard Line burned 1050 tons, but they were less efficient than the newer Titanic. That ship could hold 6,611 tons of coal and produced 100 tons of ash a day. Once these ships converted to oil the number of men needed dropped considerably and the amount of CO_2 was cut in half.

Toward the end of the nineteenth century the work of men such as Edison and Tesla launched the means of electrifying the world, a process that continues to this day. This gave rise to the power plants. The use of coal in these plants greatly exceeded the coal usage of homes,

trains and steamships.

A 2000-Megawatt power station burns 1600 tons of coal an *hour*. Such a plant is indeed large, but even small local plants will burn 500 to 600 tons an hour. There are at least seven plants that have a capacity of 5000 Megawatts or more and burn 4000 tons an hour.

Power plants are usually referred to by the Megawatts they produce. This gives us another inconceivable number. Here is a better look at this. This is a list of the coal fired power plants in the world.

http://globalenergyobservatory.org/list.php?db=PowerPlants&type=Coal

Despite all attempts to really curb the construction of coal fired plants, China, which already has considerable over capacity, is undertaking such construction that will mean one new coal fired power plant each week until the end of 2020. If a plant switches to methane it reduces the CO_2 level by about half, but that is still too high to stop the rise in atmospheric CO_2.

The latest thing to come down the line is ‘clean coal’. This must be the most outrageous oxymoron since the one that gave us the calculus –that being ‘instantaneous speed’. Coal is and will always be the worst possible

fossil fuel available.

There are other sources of these Greenhouse gasses such as home heating and factories, but they add little to the immense amount of the CO_2 that we are adding to atmosphere each day.

THE REAL ROOT OF THE PROBLEM

In 1968 Paul Ehrlich wrote his 'Population Bomb'. It made quite a stir at the time. In it, he predicted the onset of world famine in the 1970s. He foretold the death of millions. Of course, this did not occur. What allowed the world to avoid this horror was the Green Revolution.

The Green Revolution was hailed as an amazing scientific achievement which indeed it was. It avoided famine in many areas of the globe and staved off Ehrlich's dire predictions.

On the other hand it could well be that the Green Revolution is driving us to extinction. When Ehrlich wrote that book the world population was three and a half billion. Now the population is approaching seven and a half billion. It will reach ten billion in the 2040s and fifteen billion in the 2080s. The Bible tells us that when the Great Flood receded, God told Noah to 'be fruitful and multiply and replenish the earth'. I don't think he had ten

billion in mind.

People seem to be more squeamish about population than just about anything. Even those who believe in climate change have trouble accepting overpopulation. The usual response to any discussion of population growth is met with the statement 'Oh, we can feed ten billion people'.

Feeding that many people is not the primary issue. As the population grows the need arises for more cars, more trains, more busses, more airliners, more ships, and more power plants. This is coupled with the growing needs of the developing world. This, of course, will cause a huge jump in the production of CO_2.

Often very intelligent persons will state the they have flown over the country many times and there is plenty of room for many more people.

Currently automobiles are increasing at a rate of sixty million a year. Even without the population rise this will grow. With the rise it will become quite extensive. It will mean many more airline passengers. The only two major airliner manufacturers are Boeing and Airbus and they are committed right now to producing something like five thousand new airliners. This will increase as the population rises. Remember that an average airliner burns

between 3000 and 4000 gallons an hour. An airliner can easily burn 800 gallons just to take off.

One reason for the aversion to confronting population growth is that there actually is very little we can do about it. Any attempt to 'trim the herd' comes up against everything that makes us human. I find it disturbing just to mention it. Unfortunately, one way or another the herd will be trimmed.

Hitler systematically exterminated perhaps eleven million people and the problems he faced were huge. He was forced to build literally thousands of death camps and the emotional problems suffered by those doing the exterminations were massive. He had to take trains from the military to move the people to the camps. Even were we to thwart our emotional prohibitions the logistics of trying to solve our present dilemma by extermination would be virtually insurmountable.

A serious population growth occurred in the late Middle Ages. The eleventh. twelfth and thirteenth centuries were exceptionally warm. The term commonly used was 'balmy', At first this was quite beneficial to the populace. An abundance of food allowed a growth of cities and other things. Thomas Malthus stated that as the food supply increases arithmetically the population grows

geometrically. By the end of the thirteenth century, this became obvious.

If the warmth of the preceding centuries had continued through the Fourteenth we well might have seen a true Malthusian catastrophe, but this did not happen.

Soon after the start of the Fourteenth Century came the onset of the Little Ice Age and the warm centuries came to an end. Soon after the start if the Little Ice Age the rains began, and the food rotted in the fields. This caused the Great Famine of 1317. The rains did not last long, but it was not until 1325 that food production returned to normal and the population started to rise again.

The famine was brutal. The people killed their draft animal and ate most everything else. There were even cases of reported cannibalism. It killed at least ten per cent of the population. Despite this the overpopulation problem was not over.

In 1348 a ship docked in the harbor at Messina in Sicily. As always, the rats left the ship in droves. These rats carried the Oriental Flea and that flea carried what has been dubbed the deadliest pathogen in human history, the bacterium Yersinia pestis. This was the pathogen that caused the dreadful Black Death.

In the four years 1348 to 1352 the plague ravished all

of Europe. The plague reappeared periodically in virtually each generation until the later nineteenth century, although never as severe as the initial outbreak. The outbreaks were also more localized. By the end the fourteenth century as much as two thirds of the population of Europe was gone.

Europe went through what many consider to be the highest standard of living Europe ever experienced. The population remained low until the nineteenth century.

The people of the late thirteenth and early fourteenth century were just as unable to trim the herd as we are today, so the four ghastly years of the Black Death solved their problem. It is important to remember that today's world population is about sixteen times greater than the world population in the years prior to the plague of 1348.

While we are mostly fixated on the European version of the Plague it is important to note that in the years before 1348 the Plague swept through China and India and followed the trade routes to the west.

There is much speculation as to the future of current world population. We will certainly reach ten billion around the 2040’s and fifteen billion before the end of the century. Some feel that the population will start to decline after this and others that think the growth will continue

relatively unchecked.

The governments of the world cannot tolerate a reduction in the population for several reasons. We need population growth to cover the costs incurred by an increasing older generation. We need growth to replenish the military, but the primary reason that governments cannot tolerate population reduction is economic.

The main economic system of the world is Capitalism. As an economic system, Capitalism has been very successful. That is, in fact; the problem, it has become too successful. Capitalism requires growth. It is a fact that if a corporation ceases to grow it stagnates and dies. This is almost axiomatic.

The most universal pitch used by the world's politicians is that we must grow the economy. We measure a country's success by its economic growth. Such growth requires an increase in the population. What we have is a growth system in a finite world. It does not require much mathematical acumen to see where that is going.

It seems that the only viable solution is the same as the one that saved the society in the fourteenth century. It is estimated that the world population in the fourteenth century was reduced by more than sixty percent. The

same reduction in today's population would mean a population reduction of just under three billion. What we will probably need is an incurable airborne pathogen with an eighty or ninety percent kill ratio.

This would be an unimaginable catastrophe, but then so was the Black Death. This works on paper, but the real question is; could we survive such a catastrophe? It would mean something like six billion bodies in a very short period. It is hard to imagine this occurring without a major social breakdown. The Black Death bacterium is still out there and without the ability to administer antibiotics it could and would return.

The fear and confusion caused by any social breakdown of this magnitude could, and likely would, trigger a nuclear exchange. The only possible upside to a nuclear war would be that it would be very short. If a full exchange happened, it would probably be all over in less than an hour.

THE MOST IMPORTANT NUMBER

There is yet another number that puts it all in perspective, a rather small number. This is Parts Per Million or ppm. This is a count of how many molecules of CO_2 are present in every million molecules of the

atmosphere. Since this is a simple three-digit number such a small relative amount would appear to be insignificant but, considering the enormous volume of the atmosphere, it specifies a very large actual amount.

We have a reasonably good record of the variability of the ppm measurements going back at least 800,000 years. Since that time the concentrations of CO_2 varied between 180 - 210 during the ice ages and 280 - 300 in the warmer interglacial periods. In the decades preceding the advent of the industrial revolution the ppm readings were a relatively consistent 288 ppm.

During this time there was the so-called Carbon/Oxygen cycle. Various events would add CO_2 to the atmosphere during the day and then the plants and trees would absorb it during the night and release Oxygen. This probably was in effect for as long as enough green vegetation was around. Then came the Industrial Revolution, which was sparked by the steam engine and the need for a powerful heat source. Once the steam engine could be made small enough, it appeared in ships and trains. For the first time in millennia the ppm count started to rise.

In 1950 the ppm hit 310. This was the highest it had ever been in all human history. It should have raised an

alarm, but who among us ever even heard of parts per million or, for that matter, climate change? Even meteorology was so engulfed by the huge numbers of variables in the weather and ecological systems that, as a science, it often appeared to be just a small notch above Astrology.

The advancement of meteorological science with sensors and satellites and the supercomputers allowed the science of meteorology to flourish over the next thirty years. These people are now referred to as Climate Scientists. There is a very interesting quality about the science of Climate Change. In most scientific disciplines, there is a constant challenge and debate and scientists are quite rightly concerned about the validity of their respective claims.

We see little or no such diversity in the science of climate. For the most part Climate Scientists are quite in agreement with that which is being put forward.

In the early 1970's an emerging climate scientist figured that the real problem was with particulate matter. His name was James Schneider. He felt that climate cooling was the main problem. Around 1974 he recalculated and discovered the real problem was with the so-called greenhouse gasses. He said that we should not

allow the ppm of CO_2 to exceed 350 ppm. This, of course, was exceeded by the end of the 1980's.

He also predicted that if the ppm level were to rise to 400 ppm this would seriously affect the climate of the planet. We would see extreme weather conditions; some areas with extreme droughts and other areas with well above normal rainfall. There would be a significant increase in wildfires and the wildfires would no longer be seasonal in nature. There would be an increase in the strength and occurrence of storms. We have now crossed the 400-ppm level and everything Schneider predicted has begun to occur.

On May 1, 2016 a fire erupted south of Fort McMurray in Alberta, Canada. It swept through the town displacing 88,000 people. It went into Saskatchewan and finally destroyed approximately 1,500,000 acres before it was contained. It became the greatest natural disaster in Canada's history. Huge fires have erupted all over the world and there is no longer a fire season, Fires can happen at any time.

California went through five years of a devastating drought. Some heavy rainfall patterns stopped the drought for a spell, but all indications suggest that it is back. It recently went through what was perhaps its most

destructive fires. Drought conditions and high heat levels are happening worldwide. Record breaking typhoons have struck the western Pacific and some months ago the strongest hurricane ever recorded occurred off the northwest coast of Mexico. It made landfall between two cities, so about the worst it did was to dump a huge amount of rain on Texas.

There was a huge flooding in France and Germany some months ago and a flooding along the Mississippi that was as devastating as Katrina. There have recently been record breaking Typhoons in the Eastern Pacific. Even West Virginia suffered a flash flood that washed away houses and caused fatalities. The predictions of Schneider and Hansen et al are happening as predicted. Such events are increasing with disturbing regularity around the world.

WHAT'S TO COME

It's tough to make predictions, especially about the future, as Yogi Berra said some time ago. All the numbers and descriptions mentioned thus far are concrete. They are not necessarily rigorously accurate, but for this dissertation they do not need to be. They are all a bit on the low side.

Some things we can predict. The coastal cities and other low-lying lands will flood. There is no way we ca stop that. Just recently the scientists were surprised when the temperature of the Artic was fifty degrees above its normal for this time of the year. Where it should have been below zero the temperature was above freezing. This is bad, very bad.

Somewhere soon what is referred to as a tipping point will occur. Exactly what is a tipping point? We hear about it all the time from climate people. The Cambridge English Dictionary informs us a tipping point is the time at which a change or an effect cannot be stopped. As to climate this means that the effects of heat capture by greenhouse gasses become irreversible.

There are those who think we might have already passed this tipping point. Others think it is well into the future. The scientists best qualified to fix this mostly agree it is around 450 ppm. We are at this point at about 402 ppm and the yearly increase is near 3 ppm. Climate scientists now tell us we have twelve years before we hit the tipping point.

In that same time, the Ogallala aquifer will quite likely be emptied. This aquifer underlies an area of roughly 174, 000 square miles in portions of eight states; South Dakota,

Nebraska, Wyoming, Colorado, Kansa, Oklahoma New Mexico and Texas. All these states draw water from this aquafer and in less than twenty tears it may be gone.

Anyone who has flown over Lake Mead is aware that the lake is at least half empty. Apart from our natural reluctance to admit we are in such trouble the major thing impeding any meaningful attempts at solving this desperate climate problem is the corporate structure. The thing that drives human behavior now is not hunger, or sex or even fear of death. It is greed. A close companion to greed is the lust for power. These two give rise to the amoral behavior that permeates the modern corporation.

Even after many rather well meaning, but unsuccessful campaigns to limit smoking, tobacco kills 43,000 people a year in the United States. In 2015 tobacco killed 6,400,00 people worldwide. The industry apparently considers this acceptable, the cost of doing business, so to speak. In a world population of nearly seven and a half billion such a number seems almost negligible. Bunker Fuel is alleged to kill a million people a year, still small in proportion to the population. In China coal fumes also kill a million people and that is also considered to be acceptable.

A smaller but equally amazing episode was Ralph Nader's campaign to force the auto makers to install seat

belts. The auto industry fought him tooth and nail. The cost of adding seat belts to a car was not large, but the industry did not want to install them even though the cost to the industry was not that great. Seat belts save 13,000 lives a year in the US.

Because of this corporate mentality it is not surprising that the corporations turn a deaf ear to curbing greenhouse gasses. Bush II pulled out the Kyoto deal because it was believed that it would hurt the economy. It probably will but not participating in such endeavors will ultimately hurt considerably more. Trump has recently done the same in the Paris agreement. Neither the Kyoto nor the Paris agreements will solve the climate problem, but it does point us in the right direction and alerts the public to the extreme dangers we are facing.

Each time the scientists inform us of some new wrinkle in the ongoing climate saga the report seems to always end with the statement, “it is happening faster than scientists expected”. It is hard to avoid the feeling that we are living in a Science Fiction movie. There was a popular song some years ago that said that it is later than you think, and that is right where we are now. It is much later than we think.

Paul Hawken and a very intelligent group have a very

effective beginning that is designed to draw down the CO2 in the atmosphere. It is well worth the effort to explore their organization.

http://www.paulhawken.com/media/

Jim Hansen and others feel that we should be at 350 ppm to have the best environment. Getting down to that level will be difficult, but if we don't try it could well be over for the species.

The most dangerous misconception is that we have a lot of time to fix everything. The thought is that climate changes take long periods of time. In the past this was true, but we are living in a different age now. Here is an example of just how fast climate disasters can occur. All of what I am referring to happened nearly sixty years ago, so my memory of the time might be a bit faulty, but it is very close.

There are not a lot of people alive to today that remember what Lake Erie was like in the distant past. Lake Erie was amazing once. The water was wonderfully clear. You could watch the bottom go by with astounding clarity, even when water skiing in fifteen feet of water. When you swam under water the bottom was perfectly clear.

Lake Erie is quite shallow, and storms would appear suddenly, and breakers would pound the beach. This was great fun to in which to swim. After the storm the lake would slosh back and forth with what was known as ground swell. Finally, the lake would become flat calm like a mirror. Then was the time for boating and water skiing. The lake was endlessly entertaining.

For many of us it was a small fish known as the Lake Erie Blue Pike that was perhaps the most exciting thing the lake offered. We fished for it at night. You would go out a couple of miles and drop anchor. Then you would fasten three or four Coleman gasoline lanterns that were shielded as they were amazingly bright. This would light up the water around the boat and this would draw minnows. These were about three inches long and were so plentiful that water was white all around the boat. We called them shiners.

Fishing poles were much too cumbersome, so we fished with hand lines. You draped the line over your index finger. The pike were extraordinary fish. They would carefully take the minnow in their mouth and somehow were able to strip the minnow off the hook without getting hooked themselves. It took some practice to pull at just the right time to set the hook, too soon and

you pulled up the bait before the hook was set, too late and the fish had snatched the minnow. The pike were so plentiful that often we had to stop fishing because the boat would become full of fish.

Unlike with most fish you did not scale the pike. You simply made an incision with a very sharp knife along the rib cage. Then you peeled the flesh away from the rib and sliced the filet from the skin. This was really the only meat worth taking from the pike as they were rather small. Breaded and seasoned and fried in butter made an exquisite delicacy.

This went on through the years until one year there was a definite clouding of the water. It was surprising as such a thing had never happened before. The following year the clouding was much darker, and it was hard to see the bottom, especially swimming under water. There also bits of organic material floating in the water. Everyone complained that it was sewage from the towns and cities that surrounded the lake, but no one paid any attention. They just dumped their raw sewage directly into the lake.

In the third year the lake was very dark, and the bits of sewage were much greater. But the most worrisome thing was the catches of the Blue Pike were markedly reduced. The politicians said it was because of the commercial

fishing boats. These boats fished so far out on the lake that they looked like tiny toys. Lake Erie is a big lake. You cannot see the opposite shore.

From where we were Canada was seventy miles away. The pollution was worse, and it was now getting alarming. The most frightening thing was the fishing. So many people fished at night for the Blue Pike that it looked like a city on the lake. This year though all these lights were moving. Everyone tried to find a school of pike that might be accessible. Nobody was catching many fish, usually none.

The local towns and cities still denied that they were causing the problem. It is easy and quite unfair to put all the blame on the politicians. To stop the pollution meant significant cost and since most people abhor taxes they faced the quite real danger that they would be voted out of office. The problem, as it so often is, was us.

In the fifth year I, a cousin of mine and my father met for our usual spring ritual of getting the boat ready for the summer. We then drove it up to the lake. We had close friends who gave us space to store the boat for the summer. This part of the lake was surrounded by fairy high ground. This went down to the beach like a palisade. We parked the car and went down to see what the winter

storms might have done to the beach. It was different each year. What we found was the most dreadful smell I think I ever encountered. It was ghastly.

It was obvious immediately what was causing this dreadful smell. On the back of the lake a rolled-up carpet was a pile of algae. It was deposited there by the storms and was rotting. We were stunned. My father suggested we put the boat in the water and see how extensive it was. We went up the lake for miles and down the lake for miles. It was everywhere. We knew then that this wonderful, magical lake that had given us such pleasure was no more. Lake Erie was dead. The wonderful game fish, the Lake Erie Blue Pike, was now extinct.

We stood a long time on that beach and feelings of anger and sadness and helplessness swept over all of us. Before we left I said to my father that if they could do this to Lake Erie the could do it to the whole world. I did not at the time know how prophetic this statement was.

It turned out that while there was an enormous amount of just plain garbage the real culprit was the phosphates in the detergents everyone around the lake used. This fed the algae and the algae sucked up all the oxygen and this is what killed the lake. I never again went to Lake Erie, but the memory of that horrible day is still with me even after

all these years. In four, maybe five years Lake Erie went from a truly marvelous place to a smelly dead thing.

Even if we survive we are in for a bumpy ride. It will be virtually impossible to keep the coastal cities from flooding. As Schneider and Hansen and the rest predicted there will be terrible droughts and floods. There will be powerful storms. Where these will occur cannot be predicted but they will occur.

There are many intelligent and dedicate persons working on this and they seem to be able for the most part to work around the intransigence and stupidity of so many of our lawmakers.

Sometimes it is hard to look at the dreadful behavior of so many that anyone might think that human extinction would be no great loss. The population at large is not going to really get on board with saving the species until they become very frightened, which in time they will. We can only hope this fear occurs in time to head off what seems now to be almost inevitable extinction.

It is so easy to point fingers at the corporations and the politicians as so many misguided individuals, but the truth is we are all guilty. If we go down as a species we all share the blame, although blame will have no meaning then. Most species that have ever lived in this planet are

now extinct. Only a tremendous and concerted effort can keep us from joining them.

FINAL THOUGHTS

There are those who are beginning to realize the problem we are facing and now state that what we are experiencing is the new norm. This is not correct. What is happening is not a norm, rather it is the beginning of a continuous decline in the sustainability of the climate.

Denial seems to be built in to the human psyche. Intellectually we all know that someday we will die but down deep we really don't believe it. When patients are informed that they have a terminal illness, the first reaction is nearly always denial.

At the end of World War II, the horrors of the death camps were discovered, a rather well-known jurist was informed about this and he replied that he could not believe it. When assured that the information was true he replied that he did not say he did not believe it he said he *could* not believe it.

Even after the 1938 Kristallnacht many German Jews could not bring themselves to accept what was really happening in their country. They simply could not believe it and they stayed in Germany where they were ultimately

hunted down and killed.

Many are terrified of flying but will gleefully jump into their cars and drive everywhere. Even if they know cars are many times more dangerous than airliners feelings do not change.

In that day during the Cuban missile crises when the Russian freighters were approaching the American naval blockade I had a dinner alone and wondered if this would be my last meal. While I realized the possibility of this I do not remember my having any fear or anxiety. Once again this was the built-in protection denial at work.

This built-in denial mechanism could be a real stumbling block in our efforts to avert a climate catastrophe. As it is the odds of avoiding extinction are not good. There are some very good people working on stopping and possibly even reversing global warming. Hansen thinks we should go back to 350 ppm. While that is theoretically possible it will be extremely difficult to accomplish.

As previously mentioned the low coastal areas and the port cities are going to flood. There is no way we can stop that. Worldwide the glaciers are melting. The runoff from the Himalayan glaciers feeds much of India and the middle East. In India three hundred million are

experiencing severe water shortages. These problems could negatively affect a third of the world's population. The world now is concerned about refugees. What is coming will make the present crisis seem like a Sunday School picnic.

This will inevitably lead to wars. The first wars will be over water and then over food. These will be wars the likes of which we have never seen. The wars of the past half century were fought primarily for one reason, nothing can make money as quickly as a war.

Many of us wondered during the Vietnam War what the goal of this war was. The Gulf of Tonkin incident was a ruse to start the war. We did not fight this war to stop the domino theory as that was a myth. We certainly did not fight it for the Vietnamese people. They did not even want us there. It was fought to enrich the industries and service organizations that serve wars. In this it was very successful.

The last war we won was World War II; it was also the last war we fought. When the war is for profit the last thing you want to do is win it. Then the profits stop. Someone once remarked that peace is a waste of good weaponry.

The wars in Iraq and Afghanistan were made to order.

These wars were not only unwinnable but are virtually endless. We may never get out of Afghanistan.

The coming wars will be over survival and as such will be dreadful beyond belief. They will destabilize much of the civilized world. This will all be made more terrible by the continuous rise in global temperature. We may possibly survive the coming apocalypse but the world as we know it will be changed incredibly.

We are living in the age of a corporate oligarchy. One major thing keeping them in power is the fact that our congress is largely controlled by greedy, ambitious and venal old white men. Being an old white man myself I find this singularly disturbing.

Two things have occurred recently that offer perhaps the best signs of hope we have had in years. One is the awakening of women. The march that followed the inauguration of Donald Trump was one of the most the most hopeful things that has happened in a very long time. Even Hawken when he listed the first thing that we must do to avert global catastrophe was to empower the women.

I am writing this a week after another ghastly schools shooting in Florida. A nineteen-year-old entered a school with an AR-15 and killed fourteen students and three

teachers. He also wounded fourteen others. The reaction to this was something quite new. The anger among the students was amazing. Because of the power of the social media it has already become a movement. It is the young that must solve this dilemma. It is their world now.

Our problems are not going to solved by a group of greedy old men but by the young. Between the women and the young we may yet survive, For the first time in years there is a shred of hope.

A century Sarah Teasdale wrote a very powerful poem titled '

There Will Come Soft Rains

It is quite moving even today.

There will come soft rains and the smell of the ground,
And swallows circling with their shimmering sound;

And frogs in the pools singing at night,
And wild plum trees in tremulous white,

Robins will wear their feathery fire
Whistling their whims on a low fence-wire;

And not one will know of the war, not one
Will care at last when it is done.

Not one would mind, neither bird nor tree
If mankind perished utterly;

And Spring herself, when she woke at dawn,
Would scarcely know that we were gone.

Thomas Wagner
Norwalk CT
April 2018
www.tswagner.com

•