Name: ______________________________ Class: _________________________ Date: ____________

How Much is Too Much?

Overfishing has become a major environmental issue. According to National Geographic, about 90% of large fish in the world's oceans are gone, compared to the populations in 1950. Put another way, only 10% of large fish remain. And as fish stocks become depleted, fish becomes more valuable, and prices go up, giving fishermen even more incentive to take what little is left. So how can scientists and government officials solve this problem? The answer lies in simple Algebra.

$$P = P_0 e^{rt}$$

When populations grow, they follow the equation above. Look complicated? Yes, but it's really not. In this case, *P* just stand for the population of fish at any moment. P_0 stands for the initial population (at a time of zero). The little "*e*" is a number on your calculator, sort of like π. Next, *r* is the growth rate; it is how fast the fish reproduce, and it depends on the species. And *t* is, of course, time. The only two variables are *P* and *t*. As *t* changes, the equation determines how *P* changes too.

For our example, let's focus on tuna fish. They are delicious. And let's assume that each tuna has 0.13 babies per year. This is a decent average, according to the researchers Reynolds and Jennings . Let's also assume that, before commercial fishing, there were 300,000 tuna fish in the Atlantic (again, a decent estimate). But today, there are only about 30,000. So for tuna fish, our equation looks like…

$$P = 30{,}000 e^{0.13t}$$

That's not so confusing anymore, especially when you remember that "e" is just a number. Now, we need our last assumption. Since the ocean is only so big, let's assume that 300,000 is the maximum population the ecosystem can support. After all, fish can't reproduce if they start running out of food or places to lay their eggs. So for this example, we will say the carrying capacity of the Atlantic Ocean is 300,000 tuna.

1. If a new law was passed, and we stopped fishing for tuna tomorrow, how long would it take the population to rebound and get back up to 300,000?

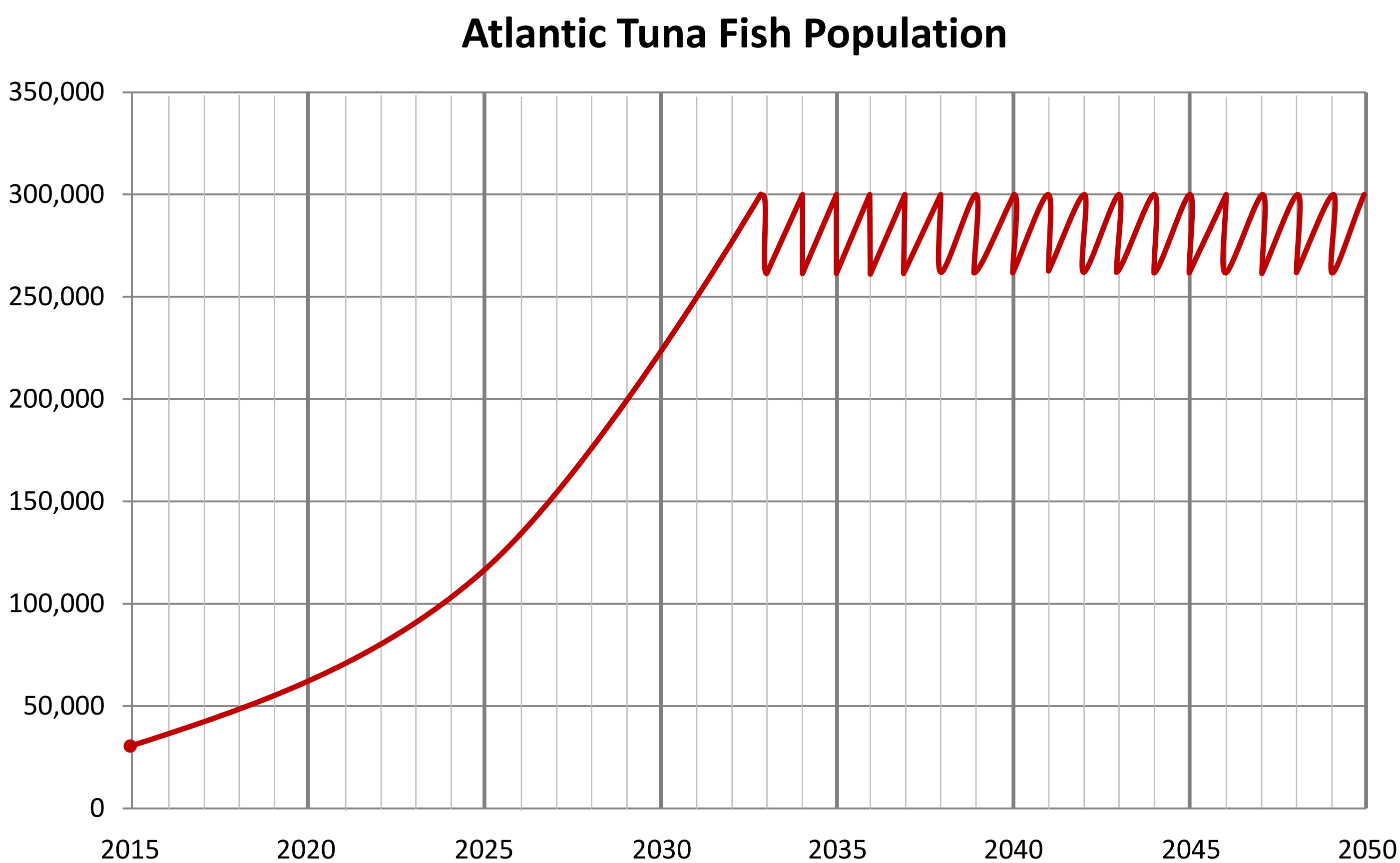
17.71 years

That is faster than one might think. Now if only we got the politicians to take Mr. Murphy's math class and Mr. A's science class, we might have a chance of making this happen. But lately the White House has not been returning my emails. Oh well. Now for an even more important question: *How Much is Too Much?* If we first let the fish population get back to normal, what is the maximum amount of tuna we could take each year while still allowing the population to fully replenish?

2. Assume the tuna fish population is back at 300,000. How many could we kill in a single year if the population needed to replenish back-to-normal by the end of that year?

36,571 fish

3. A "Sustainable Fishing Plan" is a plan that government would put in place to manage the fish populations. The goal of the plan is to maximize how many fish can be taken without threatening the species. Graph your Sustainable Fishing Plan below. You can assume that all fish are killed at midnight on December 31st. Unrealistic? Yes, but it will make the graphing a lot easier!



4. Assuming your Sustainable Fishing Plan was properly maintained, what would the average tuna fish population be from 2035 on?

About 382,000 fish

5. Keep in mind that right now the NOAA allows roughly 3,500 tuna to be caught in the Atlantic each year. So in the long term, would your plan help or hurt the fishing industry?

It would help. Instead of taking 3,500 tuna per year (Atlantic Bluefin), you could take over 36,000!

6. If the math is this clear, why won't the government do something about it?

They do. There are laws that set fishing quotas. But the quotas aren't as low as they should be. Politicians and voters don't seem to have the patience to wait 17 years for the populations to replenish.