After significant communication with the owners of Fish.net, they agreed on our model equation as it related to their business decisions. Upon agreeing with that model, they informed us that they initially allowed a harvesting rate of 12 (k=12). Upon plugging in the determined value for the harvesting rate, we were left with a quadratic equation.

$$\frac{dP}{dt} = 2P(1 - \frac{P}{25}) - (12)$$

$$\frac{dP}{dt} = -\frac{2P^2}{25} + 2P - 12$$

Given that the equation models the rate at which population changes, if we set the quadratic equal to zero and solve for population, P, we are therefore able to see where the population plateaus for different initial conditions. Given that the model is a quadratic, we can simply plug it into the quadratic formula to get our solution.

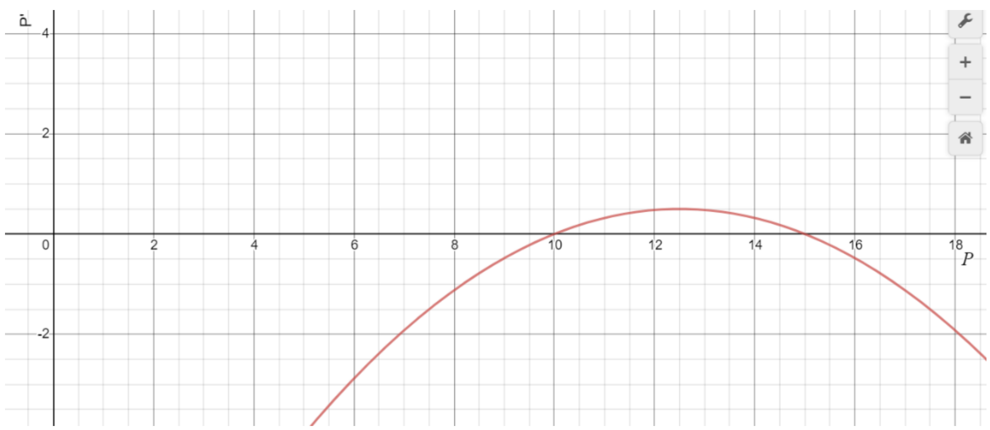
$$\frac{dP}{dt} = -\frac{2P^2}{25} + 2P - 12 = 0$$

$$a = -\frac{2}{25}, b = 2, c = -12$$

$$P = \frac{-(2) \pm \sqrt{(2)^2 - 4(-\frac{2}{25})(-12)}}{2(-\frac{2}{25})}$$

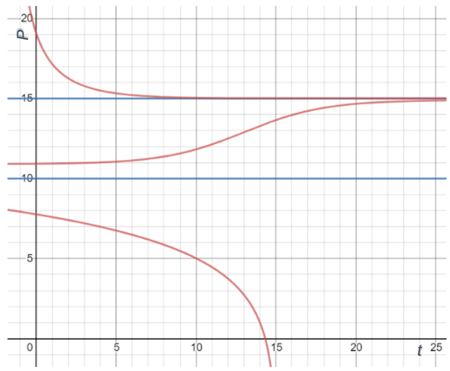
$$P = 10 \; and \; P = 15$$

Given these values, we know where the population remains unchanged, but we don't know the behavior around those values. To easily view this behavior, we can graph our model equation with the given harvesting rate.



Population Rate of Change v. Population (Desmos.com)

It is clear to see that with this harvesting rate if the initial population was less than 10,000 fish, the population would decrease until the population was completely depleted. If the population lies somewhere between 10,000 and 15,000 fish, the population will grow logistically approaching a plateau at 15,000 fish. Finally, if the population lies anywhere above 15,000 fish, the population will decrease and over a significant amount of time slowly approach a plateau at 15,000 fish. This behavior can be visualized in the following graph where the blue horizontal line represents the value at which the population plateaus and the red lines represent some initial condition within each range.



Population v. Time (Desmos.com)