1.4.5 Quiz Part 5: Creating a Phase Plane

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- Draw arrows along the $S = \frac{20}{3}$ nullcline, using your answer to the previous problems.
- Repeat this process for the arrows on the three other nullclines.
- Notice that the nullclines have divided the plane into regions. Within a single region, $\frac{dM}{dt}$ and $\frac{dS}{dt}$ cannot change sign because of the key fact mentioned previously.

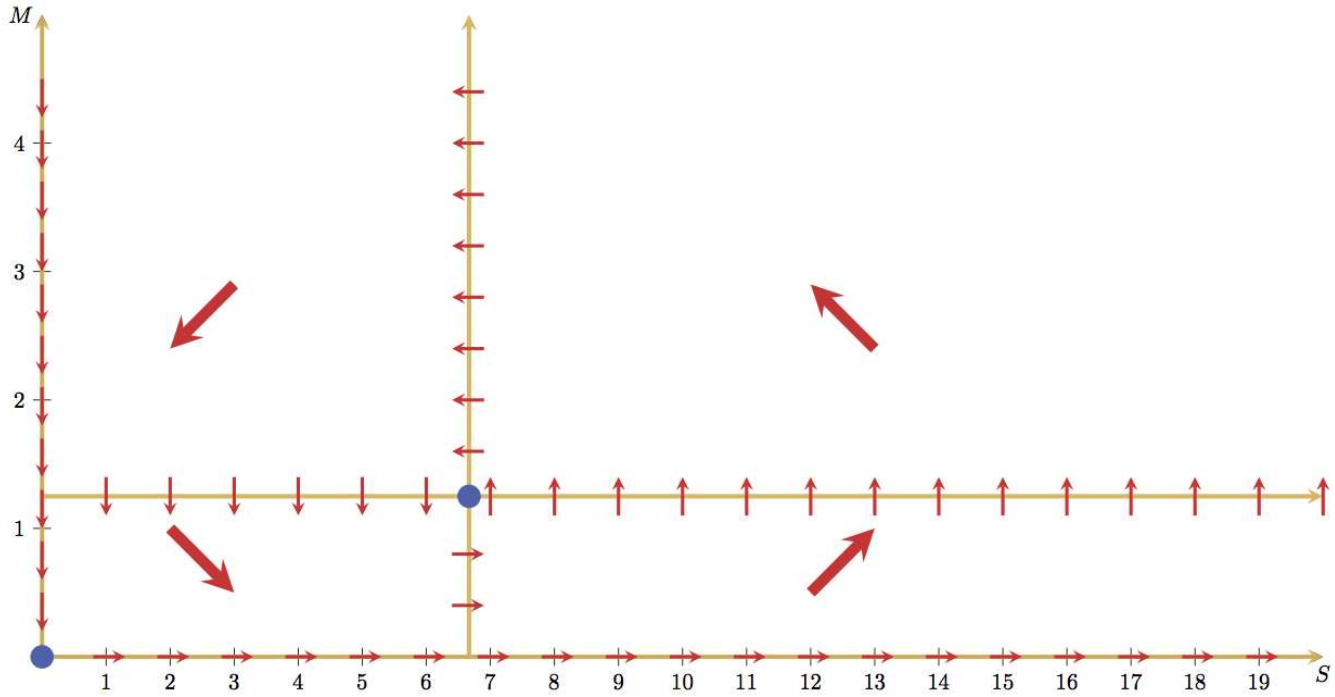
  In each region decide the general direction of trajectories in that region (“up and left,” “up and right,” “down and left,” or “down and right”) and sketch in the appropriate arrows. If you’re not sure what direction an arrow should go, find out by substituting its coordinates into the equations:

$$\frac{dS}{dt} = 0.5S - 0.4SM$$

$$\frac{dM}{dt} = -0.2M + 0.03SM.$$

- Finally, you can use the arrows to sketch possible trajectories. For example, if we start on a $\frac{dM}{dt} = 0$ nullcline, where do the arrows point? Once we’re in that region, where are the arrows leading us? In this way, we get a sense of how the predator and prey fish populations change over time.

As you have discovered, the predator prey phase plane looks like this:



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Summary of Phase Plane Analysis

Our qualitative analysis of the system of differential equations, or **phase plane analysis** consisted of the following steps:

- For each variable, calculate the nullclines along which its derivative with respect to time is 0.
- Find the equilibrium points at which both derivatives are 0.
- Along each nullcline, determine where the value of the other variable is increasing or decreasing.
- Within each region created by the nullclines, determine whether each variable is increasing or decreasing.
- Use the information you have sketched to estimate possible trajectories.

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