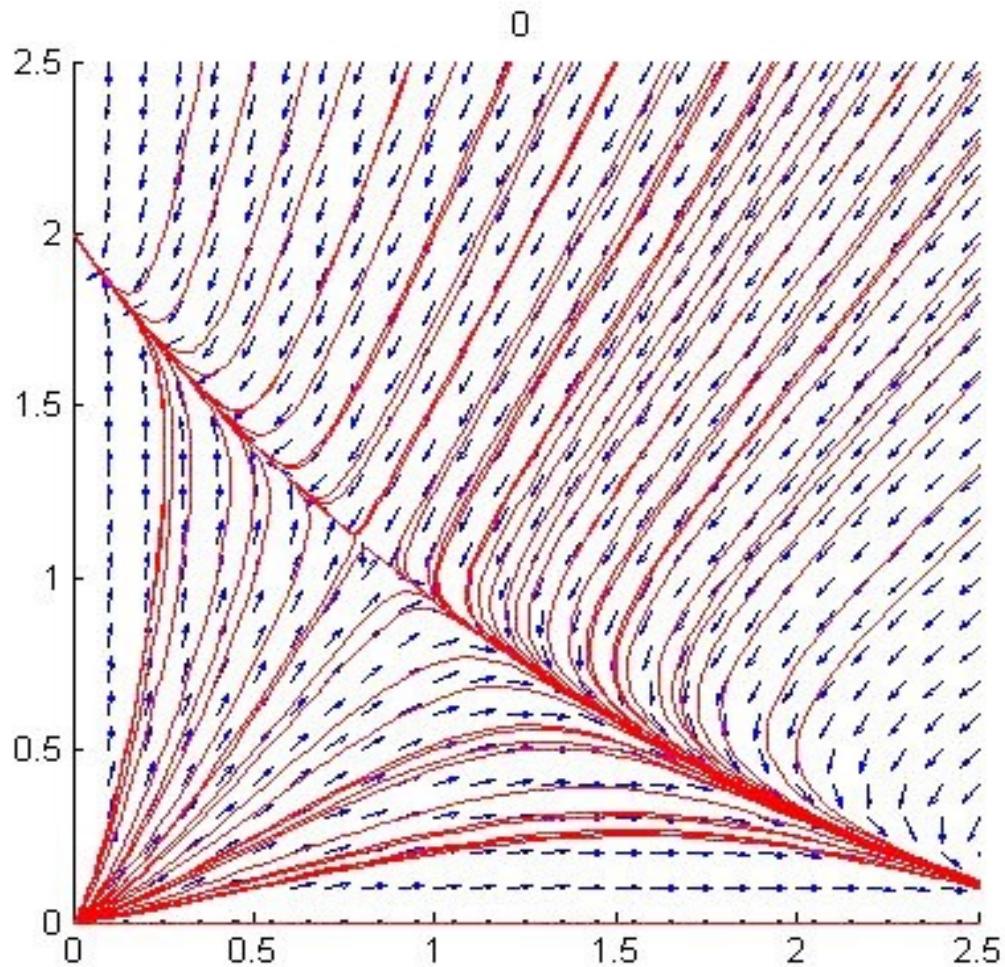


MATLAB code to produce the following model:

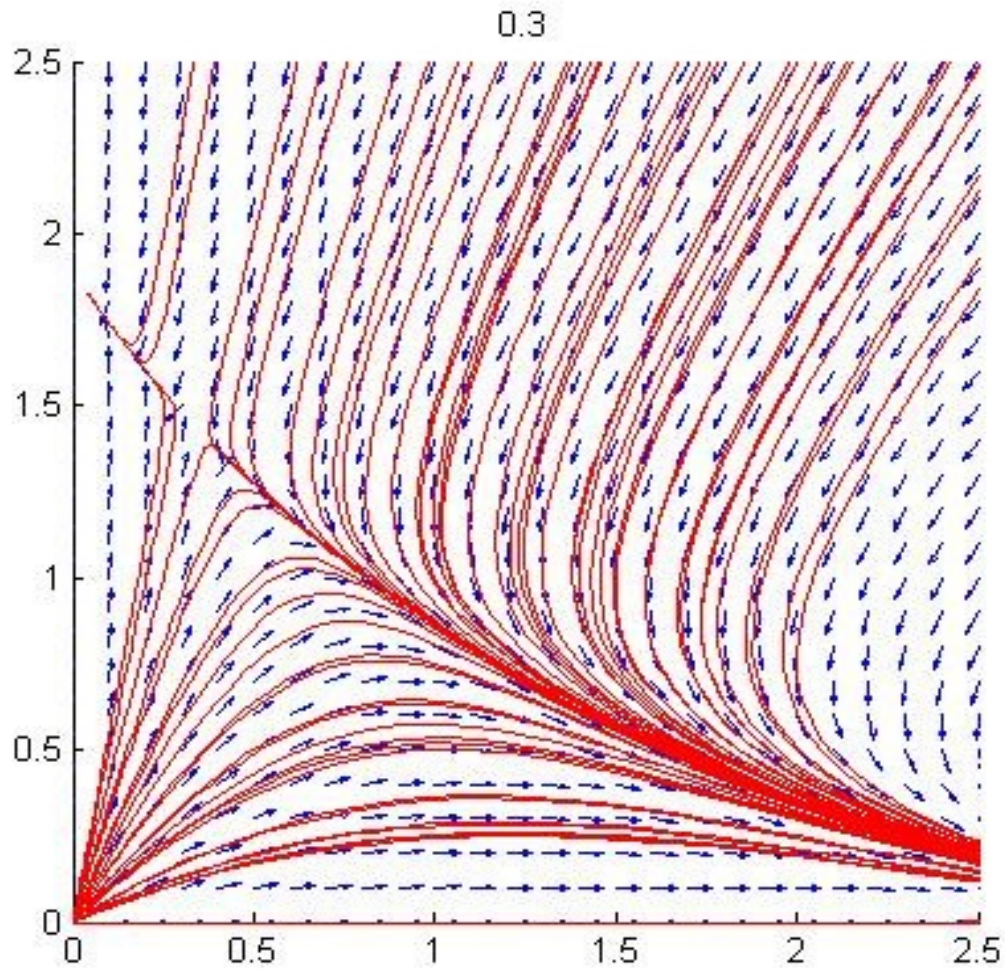
```
%Andrew Levinson
%April 28, 2009
%Competing species/Predator-Prey Model

%Set up parameters for vector field
[X,Y] = meshgrid(0:.1:2.5, 0:.1:2.5);
U1=X.*(1.5-.5*X-Y);
V1=Y.*(2-Y-1.125*X);
U2=X.*(1-.5*Y);
V2=Y*(-.25-.5*X);
warning off all
%Begin simulation
for alp=0:.01:1
    figure;hold on%Create new figure
    U=(1-alp)*U1+alp*U2;
    V=(1-alp)*V1+alp*V2;
    L=sqrt(U.^2+V.^2);
    quiver(X,Y, U./L,V./L,.5)%plot vector field
    axis equal
    %Phase plot equation
    k=@(t,x)[(1-alp)*x(1)*(1.5-.5*x(1)-x(2))+alp*x(1)*(1-.5*x(2));(1-alp)*x(2)*(2-x(2)-
1.125*x(1))+alp*x(2)*(-.25-.5*x(1))];
    for a=-2:.25:2%Phase plot loop
        for b=-2:.25:2
            [t,xa]=ode45(k,[0 10],[a b]);
            plot(xa(:,1),xa(:,2),'r');
            [t,xa]=ode45(k,[0 -5],[a b]);
            plot(xa(:,1),xa(:,2),'r');
        end
    end
    axis([0 2.5 0 2.5])
    title(alp)
end
end
```

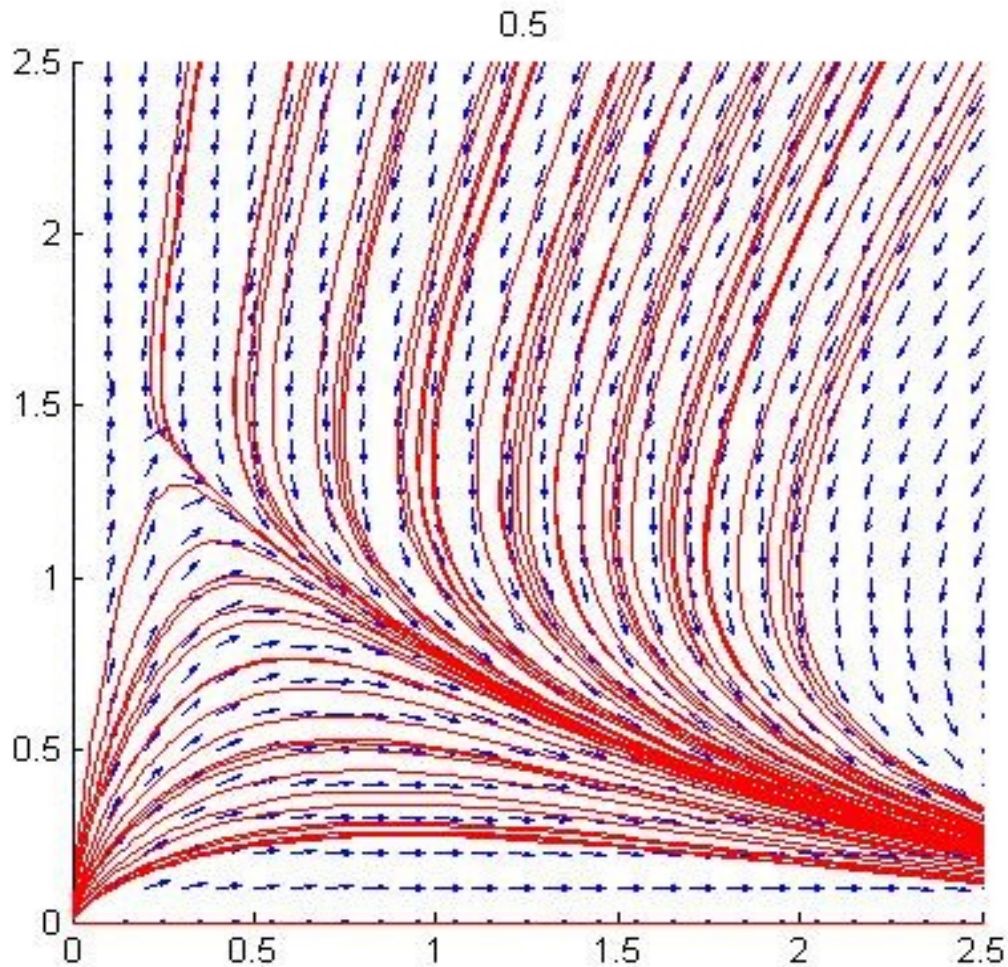
% The simulation takes about 13 minutes to run on a 2.33 Ghz Intel
% Centrio Duo with 2 GB of RAM running MATLAB R2007a



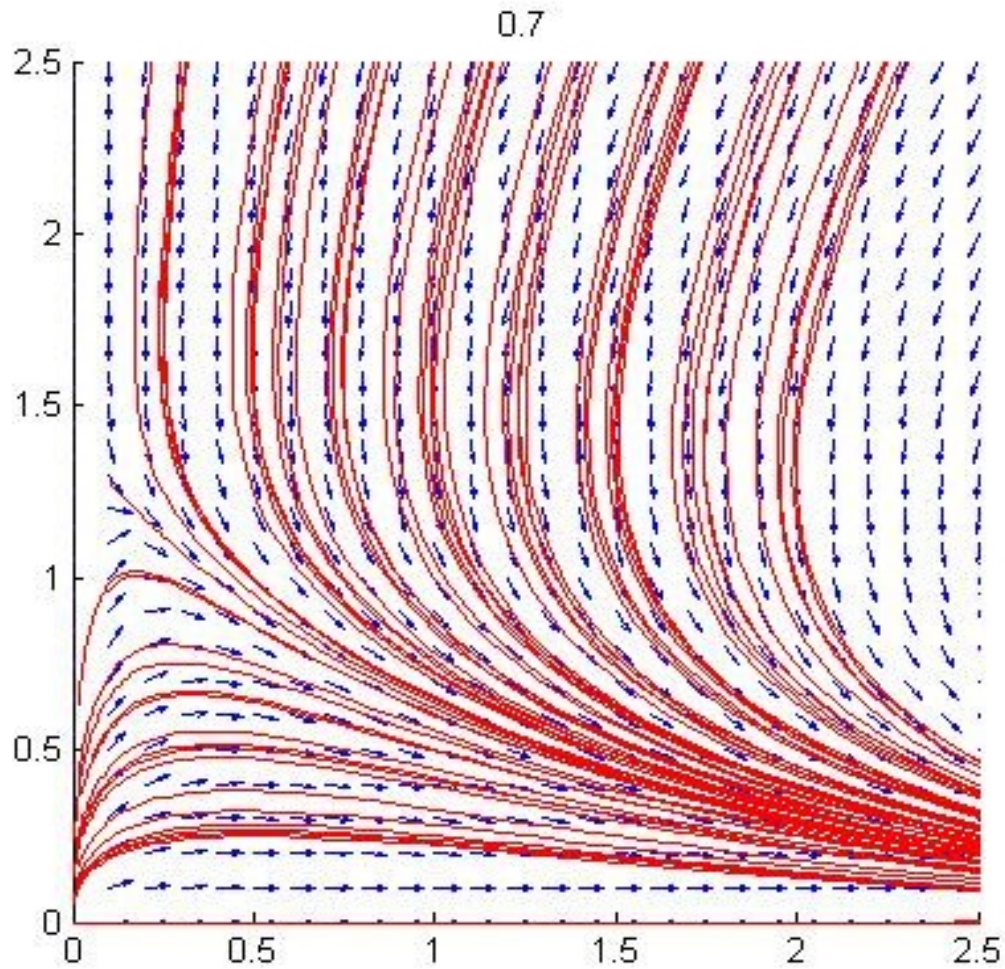
At $\alpha=0$ the model is purely competing species. There are critical points at $(0,0)$ and $(1,1)$. This model reflects a point in time when there are two species competing for the same supply of food. All the possible initial values tend towards a line that runs approximately from $(0,2)$ to $(3,0)$. This would be before any of either species adapted to be able to kill and consume the other for food. The phase portrait shows no signs of inward curl that is a trait of the predator-prey model.



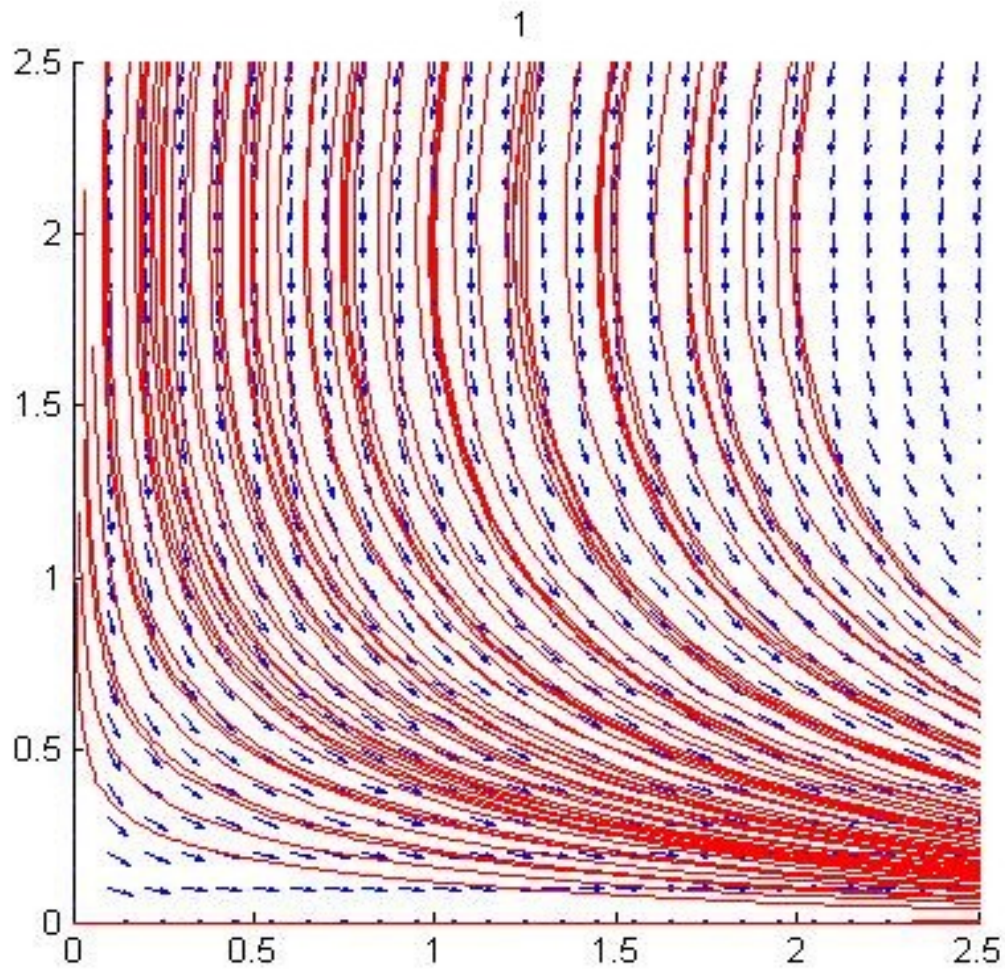
At this point $\alpha=0.3$ and the predator-prey model is beginning to take over the competing species model. The critical point at $(1,1)$ has shifted up and to the left and is now at $(.4,1.4)$ approximately. This would signify a point in time where some of one species has evolved to consume the other, but the population has not fully evolved to be able to consume its competitor. The phase portrait is starting to curl inwards on the right which is a characteristic of the predator-prey model.



At $\alpha=0.5$ the model is evenly split between competing species and predator-prey. The critical point at $(1,1)$ initially has now shifted to the y-axis. This signifies a point in evolution when a half of the predator population has adapted to eat its one time competitor as a source of food. The trait has not been bred into the entire predator population and will still take time before evolution is complete. There is now much less competition for the original food source as the predator population no longer requires as much of it to survive and there are less creatures overall who need it for nourishment. The phase portrait at this time is beginning to be dominated by the predator prey model as it now has significant inward curl.



At $\alpha = .7$ the predator-prey model has almost completely overwhelmed the competing species model. The critical point that had been shifted to the y-axis has now shifted down the y-axis to $(0, 1.25)$. The model now simulates a point in time where a significant portion of the predator species has evolved to be able to eat its former competitor for food, but there is some competition for food still as the rest of the predator species still relies on the initial food source as well as the prey. The phase portrait is beginning to weed out the competing species model as it only influences the area immediately around the origin.



At $\alpha=1$ the model is purely predator-prey. The critical point that had been on the y-axis has been eliminated. This model reflects the point in time where the predator species has evolved completely and no longer competes for the initial food source. The prey still relies on the food source, but the predator relies solely on the former competitor. The phase portrait is that of a pure predator-prey model.