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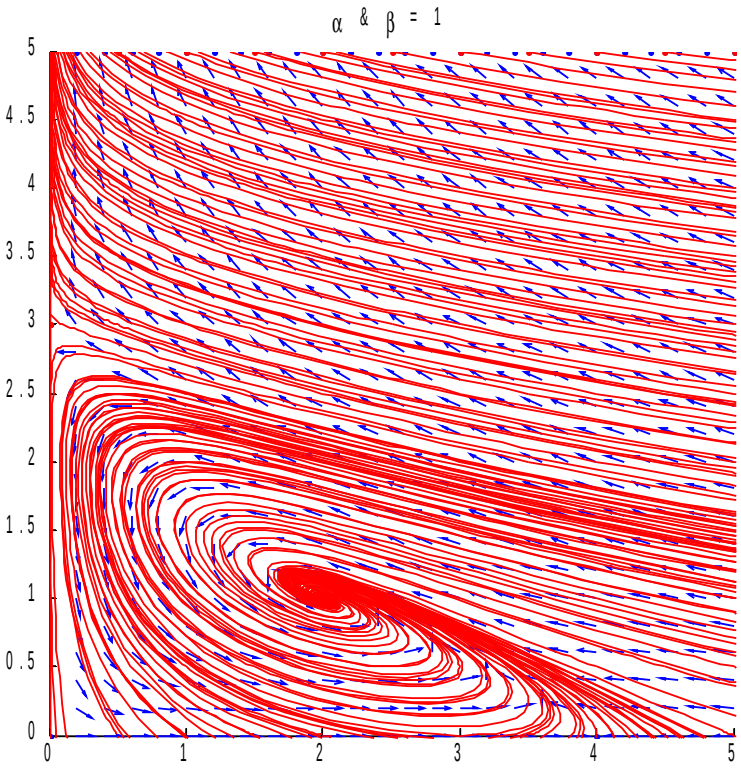
Exploring Preditor/Prey Relationships

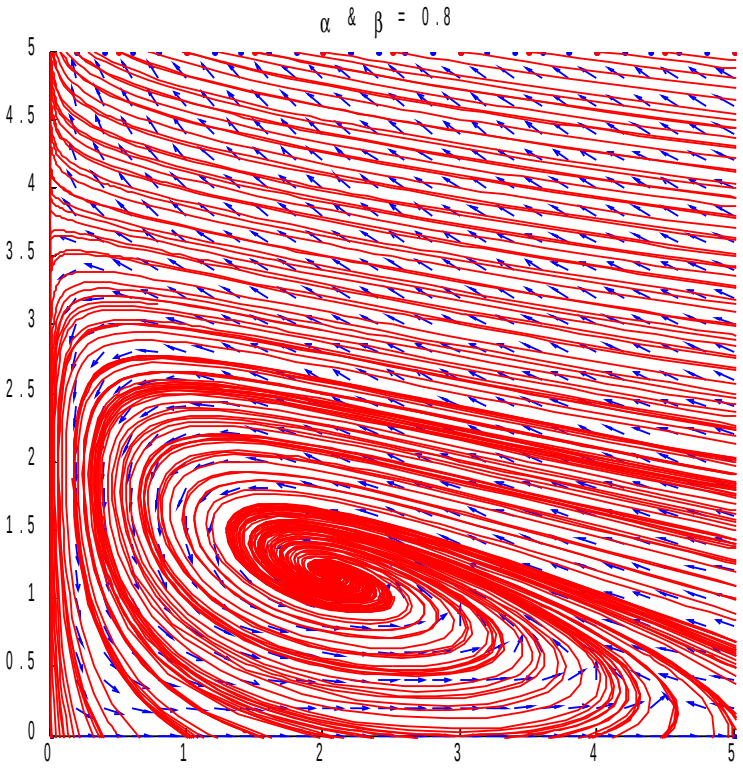
```
[X,Y] = meshgrid(0:.2:5, 0:.2:5);
warning off all
%Starting of simulation
for al=0:.2:1
    figure;
    hold on
    U=X.*(4-2*Y-al*X);
    V=Y.*(-3+X+al*Y);
    L=sqrt(U.^2+V.^2);
    quiver(X,Y, U./L,V./L,.5)%plot vector field
    axis equal
    %Phase Plot Equation
    k=@(t,x)[x(1)*(4-2*x(2)-al*x(1)); -3+x(1)+al*x(2)];
    for a=0:.5:5%Phase plot loop
       for b=0:.5:5
          [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
 alp=num2str(al);
 bet=num2str(al);
 tl=['\alpha & \beta = ' alp ];
 axis([0 5 0 5])
 title(tl)
 end
```

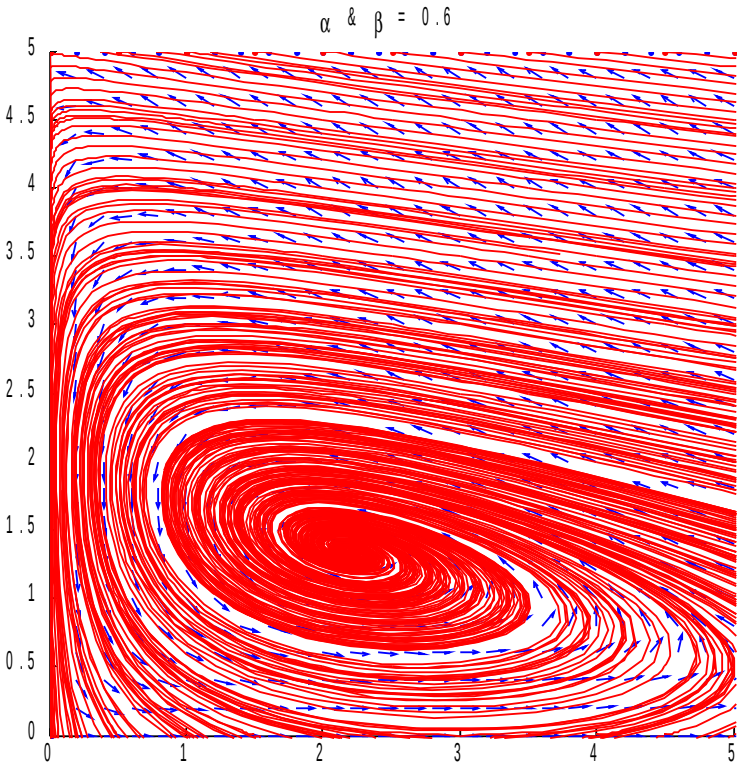
Statement of Exploration:

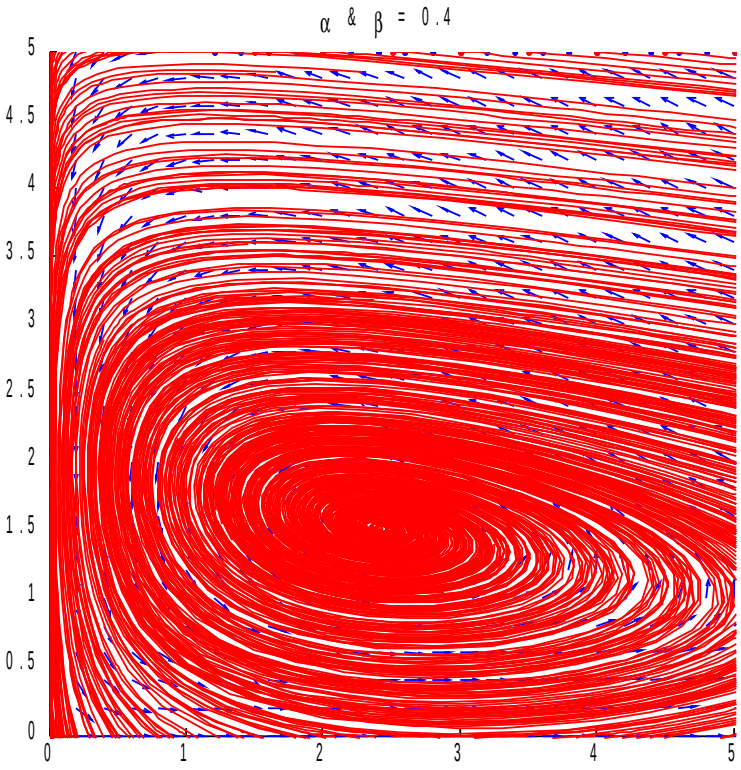
For this project a few conditions were held in order to explore the Predator Prey relationship between Wolves and Deer. This project explores an additional condition to the standard predator/prey model by adding two dynamic variables alpha and beta. Alpha represents the degree at which Wolves will display pack like behavior when hunting while the Beta variable represents the Deer's competition for vegetation and other resources. Throughout this simulation alpha and beta will be equal and be increase from 0 to one in 20 percent increments.

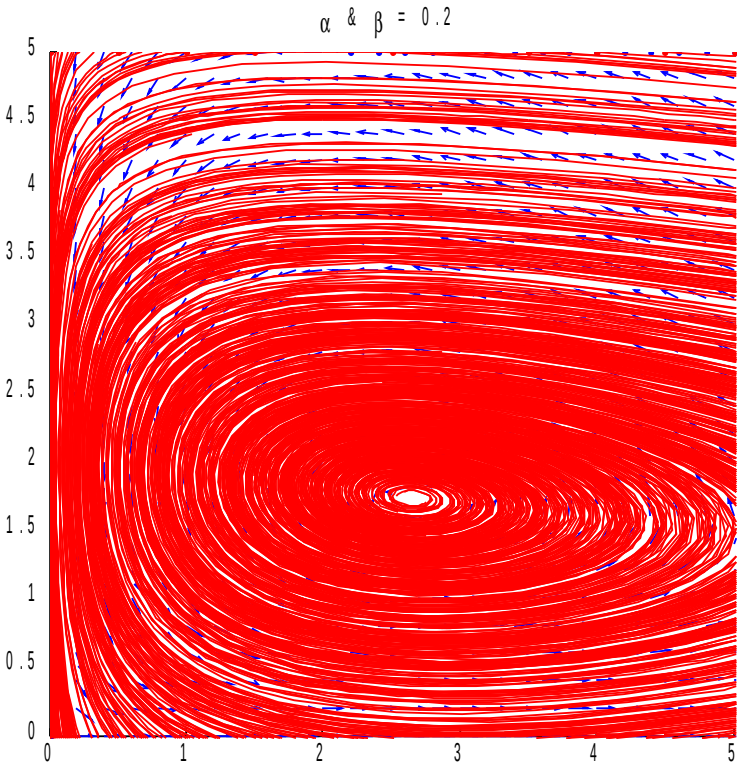


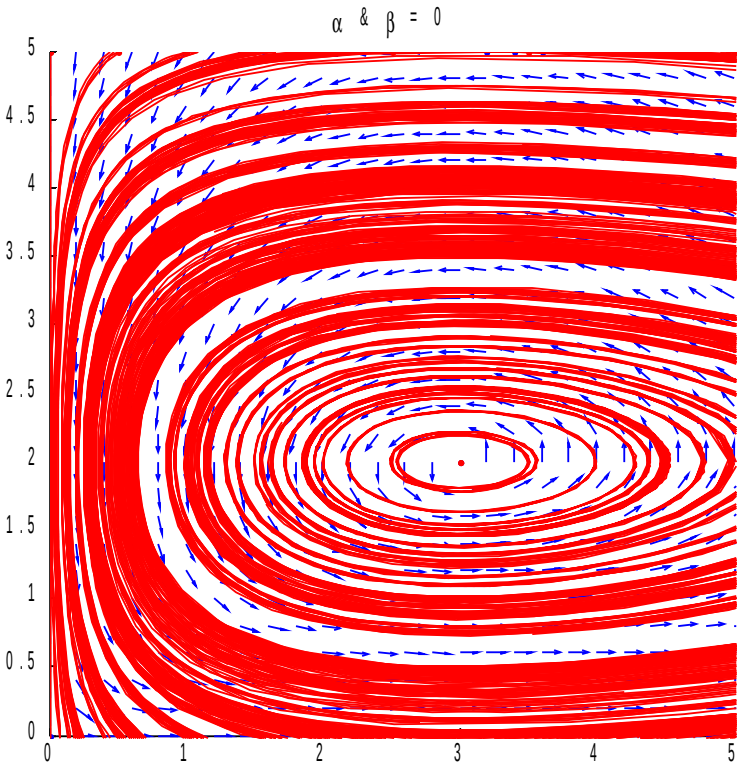
In this scenario, Wolves have a strongest ability to hunt and gain the most benefit from larger number as they work as a cohesive team. Furthermore the deer are most competitive for food and therefore would be at even more of a disadvantage when in larger numbers. From our plot of these behaviors it can be seen that for initial conditions relatively near the critical point (2, 1), there is a spiral sink behavior in which the wolves make the deer population decrease very heavily. However an interesting point is that above the critical point (0,3) all initial conditions are extremely unstable and repelling. This is due to the fact that the advantage of the wolves is so great. Furthermore the deer are at even more of a disadvantage since there is a large competition for food. For these initial conditions the deer are at too great of a disadvantage to ever sustain their populations. Therefore the Deer quickly go extinct and the wolves soon follow as they no longer have any prey.


α & β = 0.8
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
1
2
3
4
5


α & β = 0.6
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
1
2
3
4
5


α & β = 0.4
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
1
2
3
4
5


α & β = 0.2
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
1
2
3
4
5



This Graph represents the behavior of a center Phase plane portrait. As the wolves became less cooperative and the Deer have less competition for food a more stable relationship was achieved. In this scenario the deer are not competitive and the wolves gain no benefit from pack hunting behaviors. We see that there is much fairer competition and deer actually have a chance at surviving since there is an abundance of food and the fact that the wolves are no longer stronger in numbers.

General Analysis and Learning:

The general trend that becomes evident from these graphs is that the wolves are having an inherent superiority when in larger numbers as. As the Alpha and Beta conditions decreased and more fair competition was allowed between the deer and the wolves, a more stable relationship was made and this habitat was able to have a sustainable relationship.