Predator and Prey with SAGE

We have a system with rabbits (x) and foxes (y) each has a set of parameters, r_p is the growth rates of rabbits and r_f the rate at which foxes turn eaten rabbits into new foxes. The d_r is the rate at witch fozes eat rabbits and d_f is the death rate for foxes

$$\frac{dx}{dt} = r_p x - d_p xy$$

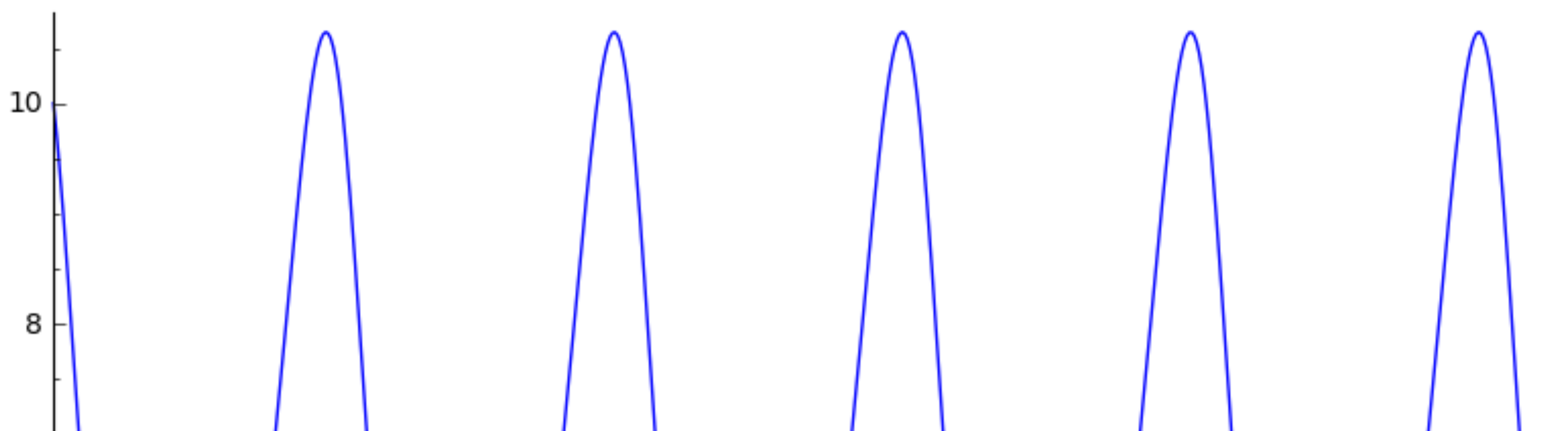
$$\frac{dy}{dt} = r_f xy - d_f y$$

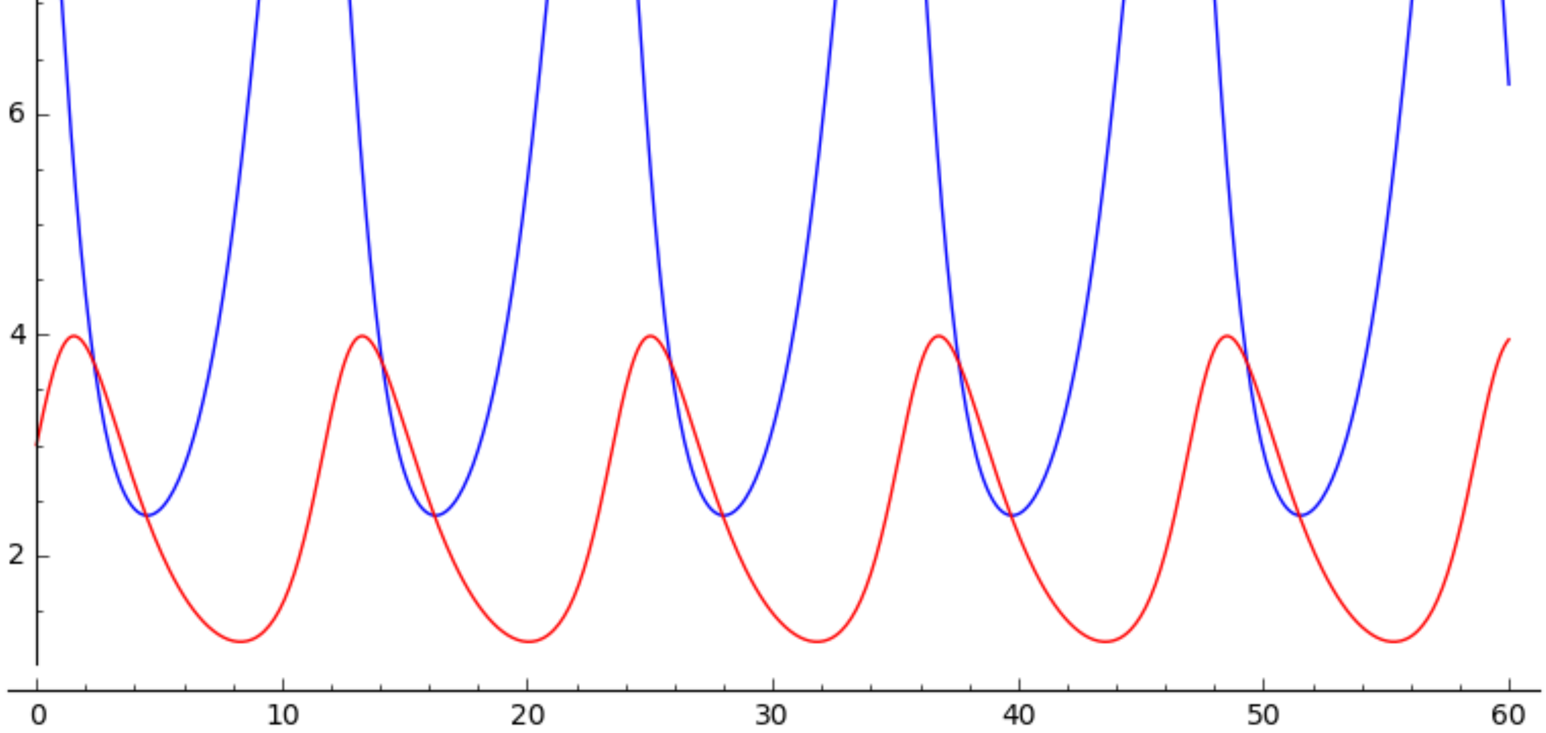
In [22]:

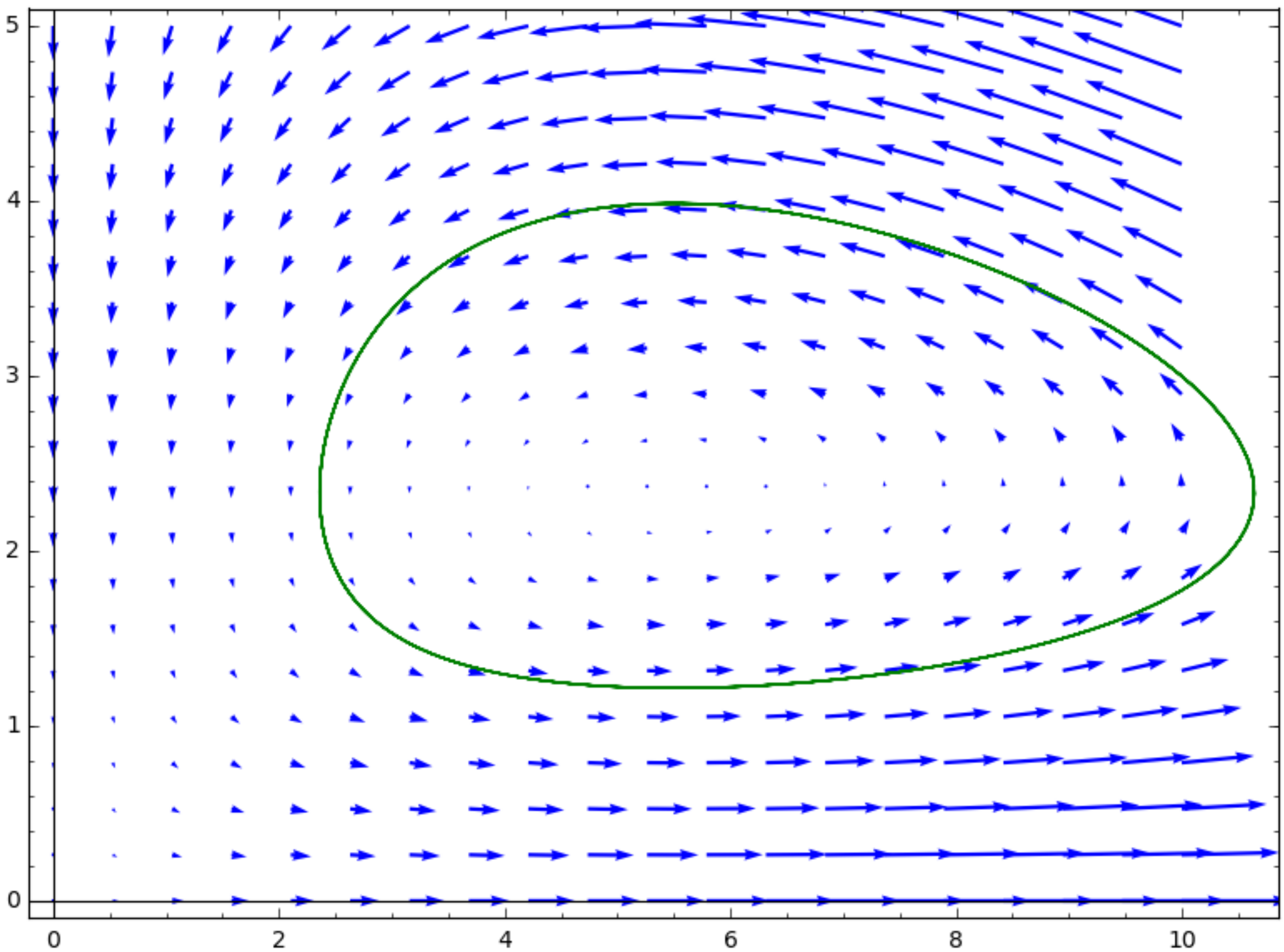
```
t = var('t x y')
```

In [56]:

```
from sage.calculus.desolvers import desolve_system_rk4
x,y,t=var('x y t')
r_p = 0.7
d_p = 0.3
r_f = 0.08
d_f = 0.44
p = r_p*x - d_p*x*y
f = r_f*x*y - d_f*y
sol =desolve_system_rk4([p,f],[x,y],ics=[0,10,3],ivar=t,end_points=60)
Q=[ [i,j] for i,j,k in sol]
R=[ [i,j] for i,j,k in sol]
LP = Graphics()
Qp=[ [i,j] for i, j, k in sol]
Fp=[ [i,k] for i, j, k in sol]
QF=[ [j,k] for i, j, k in sol]
LP += list_plot(Qp, plotjoined=true, color='blue')
LP += list_plot(Fp, plotjoined=true, color='red')
show(LP)
V= Graphics()
V += list_plot(QF, plotjoined=true, color='green')
V += plot_vector_field([p,f], (x,0,10), (y,0,5),color='blue')
show(V)
```







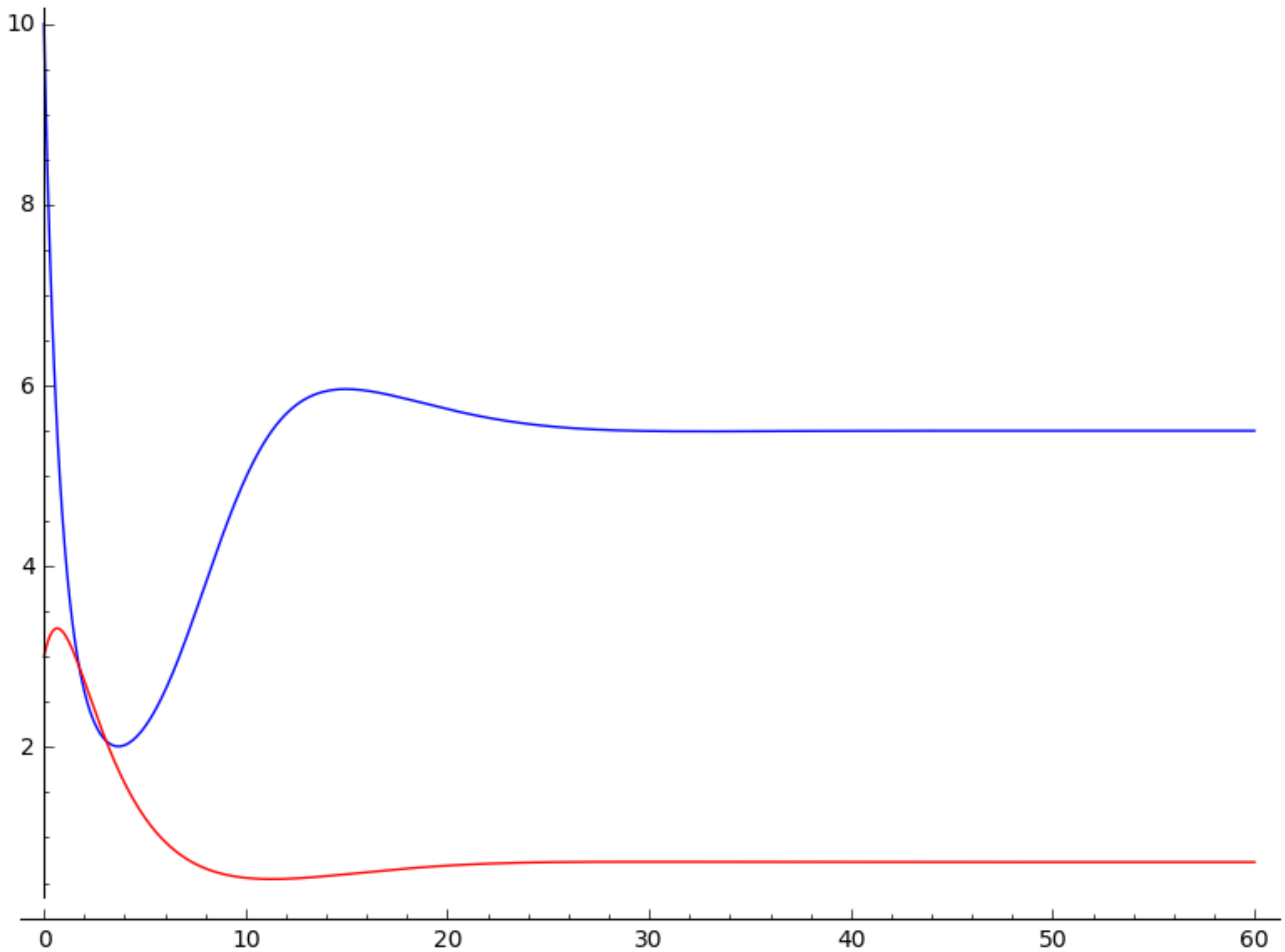
Changing the system so that the rabbits have an upper limit changes the dynamics (m is the carrying capacity)

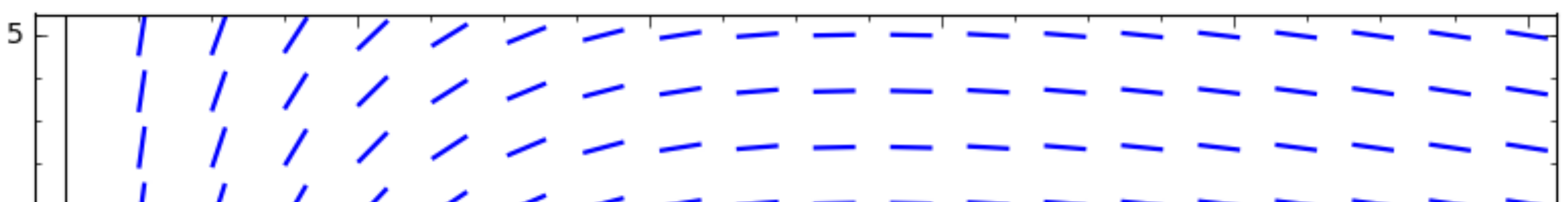
$$\frac{dx}{dt} = r_p(1 - \frac{x}{m})x - d_p xy$$

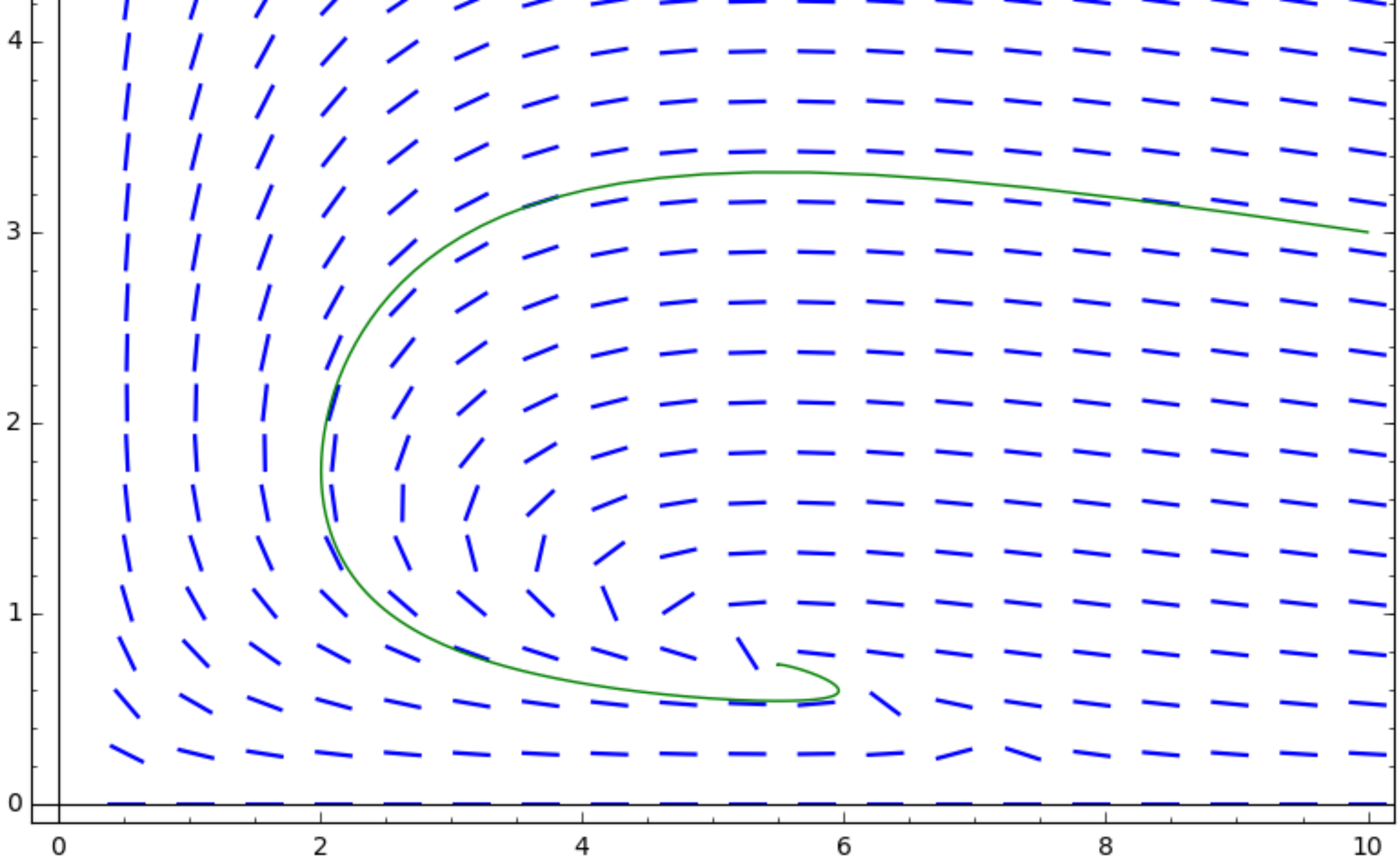
$$\frac{dy}{dt} = r_f xy - d_f y$$

```
In [55]:
```

```
x,y,t=var('x y t')
r_p = 0.7
d_p = 0.3
r_f = 0.08
d_f = 0.44
m = 8
p = r_p*(1-x/m)*x - d_p*x*y
f = r_f*x*y - d_f*y
sol =desolve_system_rk4([p,f],[x,y],ics=[0,10,3],ivar=t,end_points=60)
Q=[ [i,j] for i,j,k in sol]
R=[ [i,j] for i,j,k in sol]
LP = Graphics()
Qp=[ [i,j] for i, j, k in sol]
Fp=[ [i,k] for i, j, k in sol]
QF=[ [j,k] for i, j, k in sol]
LP += list_plot(Qp, plotjoined=true, color='blue')
LP += list_plot(Fp, plotjoined=true, color='red')
show(LP)
V= Graphics()
V += list_plot(QF, plotjoined=true, color='green')
V += plot_slope_field(f/p, (x,0,10), (y,0,5),color='blue')
show(V)
```







In [ ]: