1.

Coexistence

7.1

brown hydra $\frac{dN_1}{dt} = r_1N_1(1-a_{11}N_1 - a_{12}N_2) - mN_1$

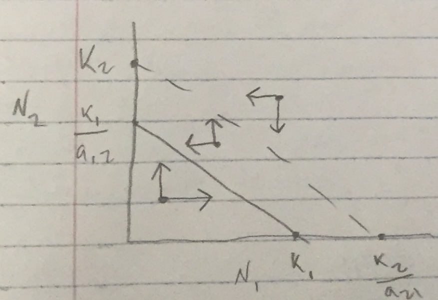
green $\frac{dN_2}{dt} = r_2N_2(1-a_{22}N_2 - a_{21}N_1) - mN_2$

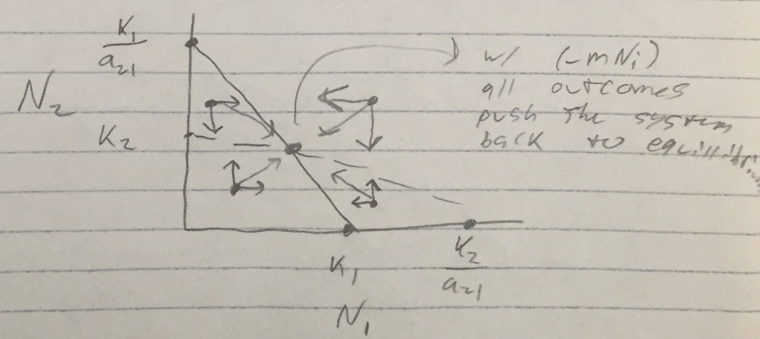
The change of adding $(-mN_i)$ to the equation makes coexistance possible is entirely sensible if you really analyze the equation and it's true meaning. This change alters the carrying capacity and through this means allows a unique niche to form and thereby allow both the brown and green hydra to exist ~~to~~ together without outcompeting each other.

For example)

No coexistance

w/ coexistance factored in





This gives competitive exclusion of species 1 by species 2.

(equation) 7.19 $\frac{dP_1}{dt} = m_1P_1(1-P_1) - eP_1$

(equation 7.20) $\frac{dP_2}{dt} = m_2P_2(1-P_1-P_2) - m_1P_1P_2 - eP_2$

7.2

a) Set equal to zero

$0 = m_1P_1(1-P_1) - eP_1$

$0 = m_1(1-P_1) - e$

$\frac{e}{m_1} = 1 - P_1$

$P_1 = 1 - \frac{e}{m_1}$

In order for this equilibrium to be positive, the rate of colonization must be greater than the rate of extinction

b) $0 = m_2P_2(1-(1-\frac{e}{m_1}) - P_2) - m_1(1-\frac{e}{m_1})P_2 - eP_2$

$0 = m_2(-1-\frac{e}{m_1} - P_2) - m_1 - \frac{\cancel{m_1}e}{\cancel{m_1}} - e$

$\frac{2e+m_1}{m_2} = -\frac{e}{m_1} - P_2$

$\frac{2e+m_1}{m_2} + \frac{e}{m_1} = \cancel{0} - P_2$

$\frac{2em_1}{m_2} - \frac{e}{m_1} = P_2$

In order ~~for~~ for both species to survive, m_2 has to be larger than $2em_1$ because this will give a ratio that is less than 1 allowing coexistance

c) Assuming start colonization/extinction rate allowed both species to survive and you slowly increased the extinction rate then species 2 would be the first to go extinct. This would happen because the extinction rate is multiplied by a factor of 2, ~~the~~ and the colonization rate of species 1 causing the extinction rate of species 2 more easy to reach extinction than species 2

7.2 D) The population decreased at a faster rate because the extinction crate plays a much bigger part in species 2 than it does in species 1

7.4 a)

- Lab setting will be easier to control and therefore more reliable due to the use of Lotka-Volterra equation whose constants are not as easily controlled for in a field setting.

b) Similarly, the lab setting is more reliable but for different reasons in this circumstance. In the lab it is much easier to have 2 species grow in conjunction while you control the available resources as well as interspecies interactions, that could skew results making the lab most accurate.

C). Once more the lab gives a better and more accurate result, while the field can do a much better job of demonstrating what actually happens w/ real life interactions.

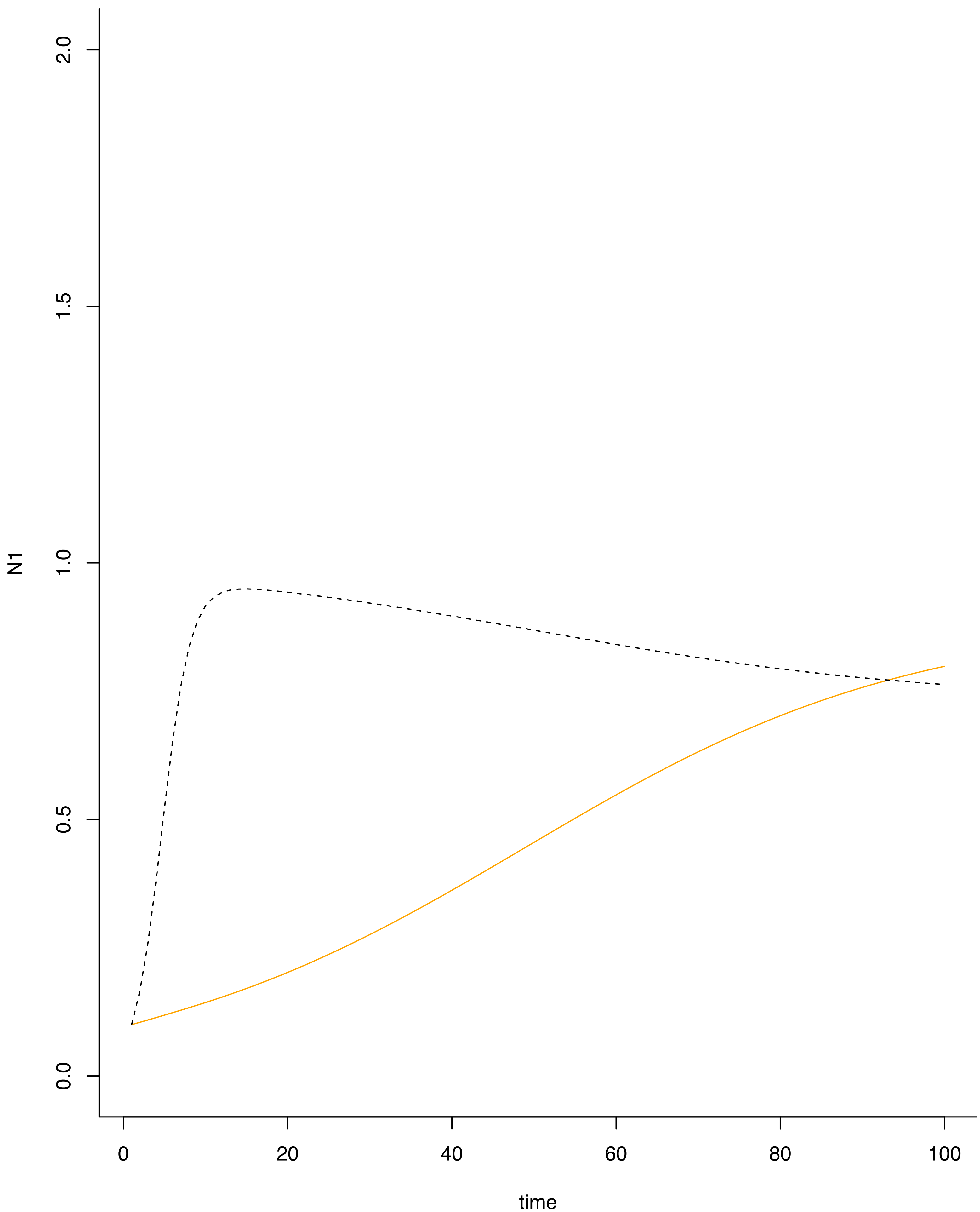
d) It is fairly reliable but has plenty of cons making it not always the best option. It requires far more man hours and environmental variation is likely uncontrollable which could lead to skewed results.

2.

```
library(deSolve)

comp <- function(t, y, p) {
N1 <- y[1]
N2 <- y[2]
with(as.list(p), {
dN1.dt <- (r1 * N1/K1) * (1 - N1 - a12 * N2)
dN2.dt <- (r2 * N2/K2) * (1 - N2 - a21 * N1)
return(list(c(dN1.dt, dN2.dt)))
})
}

p <- c('r1' = 0.1, 'K1' = 2, 'r2' = 0.6, 'K2' = 1,
'a12' = 0.15,
'a21' = 0.3)
y0 <- c('N1' = 0.1, 'N2' = 0.1)
t <- 1:20

sim <- ode( y= y0, times= t, func= comp, parms=p, method=
'lsoda')
sim<- as.data.frame(sim)

plot(N1 ~ time, type='l', col ='blue', bty='l', data = sim, ylim=
c(0,2))
points(N2~ time, type='l', lty=2, data=sim)


t2 <- 1:100

sim2 <- ode( y= y0, times= t2, func= comp, parms=p, method=
'lsoda')
sim2<- as.data.frame(sim2)

plot(N1 ~ time, type='l', col ='orange', bty='l', data = sim2, ylim=
```

```
c(0,2))
points(N2~ time, type='l', lty=2, data=sim2)
```

3. Amphibians and B. dendrobatidis:
https://docs.google.com/document/d/1N1GsRC1N1VOxvKqu_ViiDriuWQH6sSHeCadFQAshDMQ/edit



N1
0.0
0.5
1.0
1.5
2.0
0
20
40
60
80
100
time