$\boxed{8B \#4}$

Pg 88. 9.1

1. a) $\frac{dN}{dt} = rN[1-(N/K)^{\theta}]$ equilibrium

$0 = rN[1-(N/K)^{\theta}]$

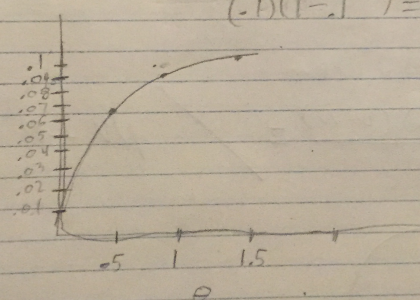
b) $\frac{dN/dt}{N} = r[1-(N/K)^{\theta}]$ $= 1$

$= .1[1-(\frac{10}{1000})^{\theta}]$ (1)

$(.1)(1-.1)^{1.5} \rightarrow \theta > 1$ $= .097 = \frac{dN/dt}{N}$

$(.1)(1-.1)^{1} = \rightarrow$ $.090 = \frac{dN/dt}{N}$

$(.1)(1-.1^{.5}) = \rightarrow$ $.068 = \frac{dN/dt}{N}$



c). ~~Ost~~ for different values of θ you can see different results in terms of the per capita growth rate. as θ increases you begin to see a plateau of the growth rate. this might be ~~superior~~ to the logistic model. because it is indicative of the way that the curve changes for the R vs n graph

2. $dN/dt = rN(N - a)\,[1 - (N/K)]$

a) equilibria

$0 = rN(N-a)\,[1 - N/K]$

$0 = (rN^2 - rNa)(1 - (N/K))$

$\frac{0}{N} = \frac{rN^2 \cdot (-rN^2 \cdot N/K) - (-rNa) \cdot (-rNa \cdot N/K)}{N}$

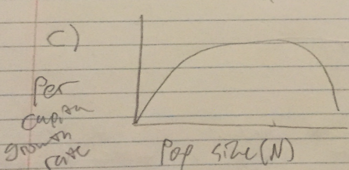
$0 = \frac{rN(N-a)(1-(N/K))}{N}$

? $\frac{0}{N} = rN(N-a)(1-(N/K))$

b) stability of equilibrium

$0 = \frac{(N-a)(K-N)}{K} = \quad NK - N^2 - aK + aN$

c)



D) contrast w/ logistic model, This differs from the logistic model because This model uses a. The value of a is the minimum popul[illegible] necessary for a population to increase rather Than starting at zero.

2a.

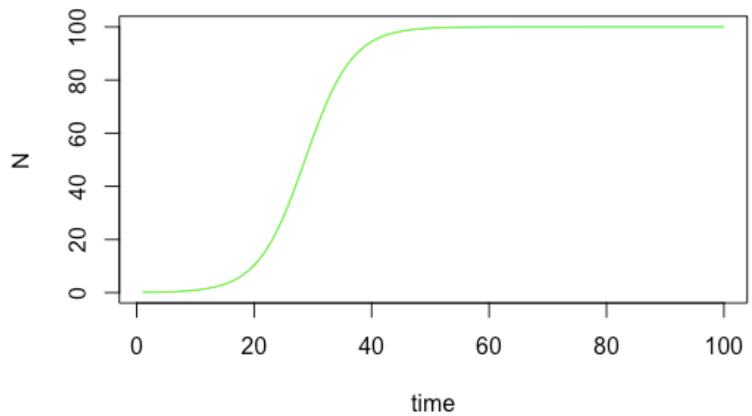
```
## write  logistic growth equation by editing exp.growth with *(1- (N/K))
log.growth <- function(t, y, p) {
  N <- y[1]
  with(as.list(p), {
    dN.dt <- r * N *(1- (N/K))
    return(list(dN.dt))
  })
}

## set up parameters, run if selects number at random. runif wants # of # you want, min and max… WHY USE runif?*******
p <- c('r'= 0.25, 'K'= 100)
y0 <- c('N'= runif(1, min= .01, max = .1))
t <- 1:100

sim <- ode(y=y0, times=t, func = log.growth, parms = p, method = 'lsoda')
```

Then I enter simulated function into data frame
sim <- as.data.frame(sim)

plot simulation
plot(N~ time, data = sim, type = 'l', col = 'green')



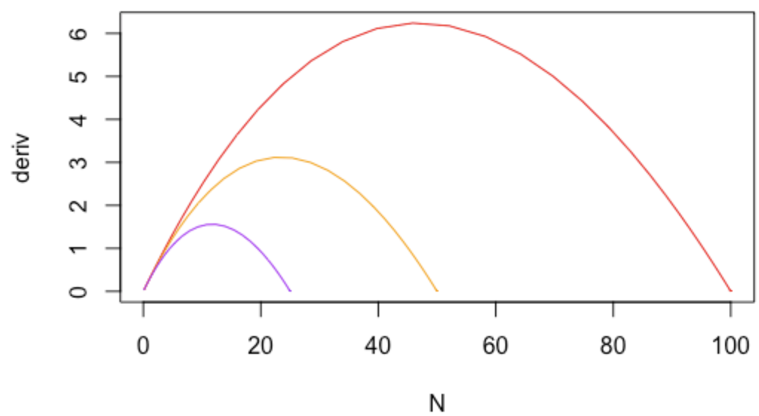
2b.
Here I simulate the model with K = 25
p.2 <- c('r'=.25, 'K'= 25)

sim.2 <- ode(y=y0, times = t, func= log.growth, parms = p.2, method = 'lsoda')
sim.2 <- as.data.frame(sim.2)

next I simulate the model with K = 50
p.3 <- c('r'=.25, 'K'= 50)
sim.3 <- ode(y=y0, times = t, func = log.growth, parms = p.3, method = 'lsoda')
sim.3 <- as.data.frame(sim.3)

Next I will compute the population growth rates (derivatives) for model simulations 1, 2, and 3, and then add these values to my sim data frame.
sim$deriv <- c(diff(sim$N), NA)
sim.2$deriv <- c(diff(sim.2$N), NA)
sim.3$deriv <- c(diff(sim.3$N), NA)

Here I graph the population growth rates calculated above vs. population abundance (N) on the same plot
plot(deriv~N, data = sim, type = 'l', col= 'red')
points(deriv~N, data = sim.3, type = 'l', col= 'orange')
points(deriv~N, data = sim.2, type = 'l', col= 'purple')



2c.

```
max(sim$deriv, na.rm =TRUE)
sim$N [which(sim$deriv == max(sim$deriv, na.rm =TRUE))]
sim.2$N [which(sim.2$deriv == max(sim.2$deriv, na.rm =TRUE))]
sim.3$N [which(sim.3$deriv == max(sim.3$deriv, na.rm =TRUE))]
```

(c) Find the population abundance that yields the maximum population growth rate for each of the above three simulations. Visualize the effect of carrying capacity on population size at maximum growth rate by plotting these values against their corresponding K parameter. Include any code and figures.

```
 which(sim$deriv == max(sim$deriv, na.rm = TRUE)
sim$N[which(sim$deriv == max(sim$deriv, na.rm = TRUE))]
sim.2$N[which(sim.2$deriv == max(sim.2$deriv, na.rm = TRUE))]
sim.3$N[which(sim.3$deriv == max(sim.3$deriv, na.rm = TRUE))]

Nmax<-sim$N[which(sim$deriv == max(sim$deriv, na.rm = TRUE))]
Nmax.2<-sim.2$N[which(sim.2$deriv == max(sim.2$deriv, na.rm = TRUE))]
Nmax.3<-sim.3$N[which(sim.3$deriv == max(sim.3$deriv, na.rm = TRUE))]

##this was K/2

population.at.max.growth<- c(Nmax, Nmax.3, Nmax.2)

K<- c(100,50,25)
Plot(population.at.max.growth~K, type='l', col='red')
```

Suppose you manage a fishery and are tasked with maximizing the fishery's yield by managing the populations of three fish species that grow according to the theta logistic growth model (see Hastings Ch. 4). A scientist visited the fishery and determined the theta value for each fish: 0.5 for species A, 1 for species B and 1.8 for species C. Which species will be maintained at the highest population abundance in your fishery? Include any code and figures.

3.

```
log.growth <- function(t, y, p) {
  N <- y[1]
  with(as.list(p), {
    dN.dt <- r * N * (1 - (N / K)^theta)
    return(list(dN.dt))
  })
}

##set up parameters, use runif

p <- c('r' = 0.5, 'K' = 20, 'theta' = 1)
y0 <- c('N' = 0.05)
t <- 1:100


 ##Assigning different values of theta
p.a<-c('r'=0.25, 'K'=100, theta=0.5)
p.b<-c('r'=0.25, 'K'=100, theta=1)
p.c<-c('r'=0.25, 'K'=100, theta=1.8)

 ##Simulation
sim.a<-ode(y=y0, times=t, func=log.growth, parms=p.a, method='lsoda')
sim.a<-as.data.frame(sim.a)
sim.b<-ode(y=y0, times=t, func=log.growth, parms=p.b, method='lsoda')
sim.b<-as.data.frame(sim.b)
sim.c<-ode(y=y0, times=t, func=log.growth, parms=p.c, method='lsoda')
sim.c<-as.data.frame(sim.c)

 ##Plot
plot(N~t, data=sim.a, type='l', lwd='2', col='purple')
points(N~t, data=sim.b, type='l',lwd='3', col='blue')
```

```
points(N~t, data=sim.c, type='l',lwd='4', col='orange')
```