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))

})

}

p <- c('r' = 0.2, 'K' = 1.05, 'theta' = 1.05)

y0 <- c('N' = 0.01)

t <- 0:100

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

plot( N ~ time, data = sim, type = 'l', lwd = 2, bty = 'l', col ='blue', ylim= c(0,1.2))

p.2 <- c('r' = 0.28, 'K' = 0.75, 'theta' = 1.25)

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

sim.2 <- as.data.frame(sim.2)

points(N ~ time, data = sim.2, type = 'l', lwd = 2, bty = 'l', lty = 2, col = 'red')

p.3 <- c('r' = .15, 'K' = 1, 'theta' = 1)

sim.3 <- ode(y = y0, times = t, func = log.growth, parms = p.3, method = 'lsoda')

sim.3 <- as.data.frame(sim.3)

points(N ~ time, data = sim.3, type = 'l', lwd = 2, bty = 'l', lty = 3, col = 'purple')

sim$deriv <- c(diff(sim$N), NA)

plot(deriv ~ N, data = sim, type = 'l', col = 'blue', ylim = c(0, 0.25), bty = 'l')

sim.2$deriv <- c(diff(sim.2$N), NA)

points(deriv ~ N, data = sim.2, type = 'l', col = 'red')

sim.3$deriv <- c(diff(sim.3$N), NA)

points(deriv ~ N, data = sim.3, type = 'l', col = 'purple')

max.Ns <- c(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))])

r's' <- c(p['r'], p.2['r'], p.3['r'])

plot(max.Ns ~ r, pch = 21, bg = 'skyblue', type = 'b', lty = 2)