Abbott & Nolting (2016) Ecological Complexity

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Trying to recreate the figures

```
library(tidyverse)
library(deSolve)
library(QPot)
```

Derived from Rosenzweig & MacArthur model

From Abbott & Nolting and also shown in Shoemaker et al. (2020) Ecology. Shows sustained transient cycles that keep bumping the trajectory away from the stable state.

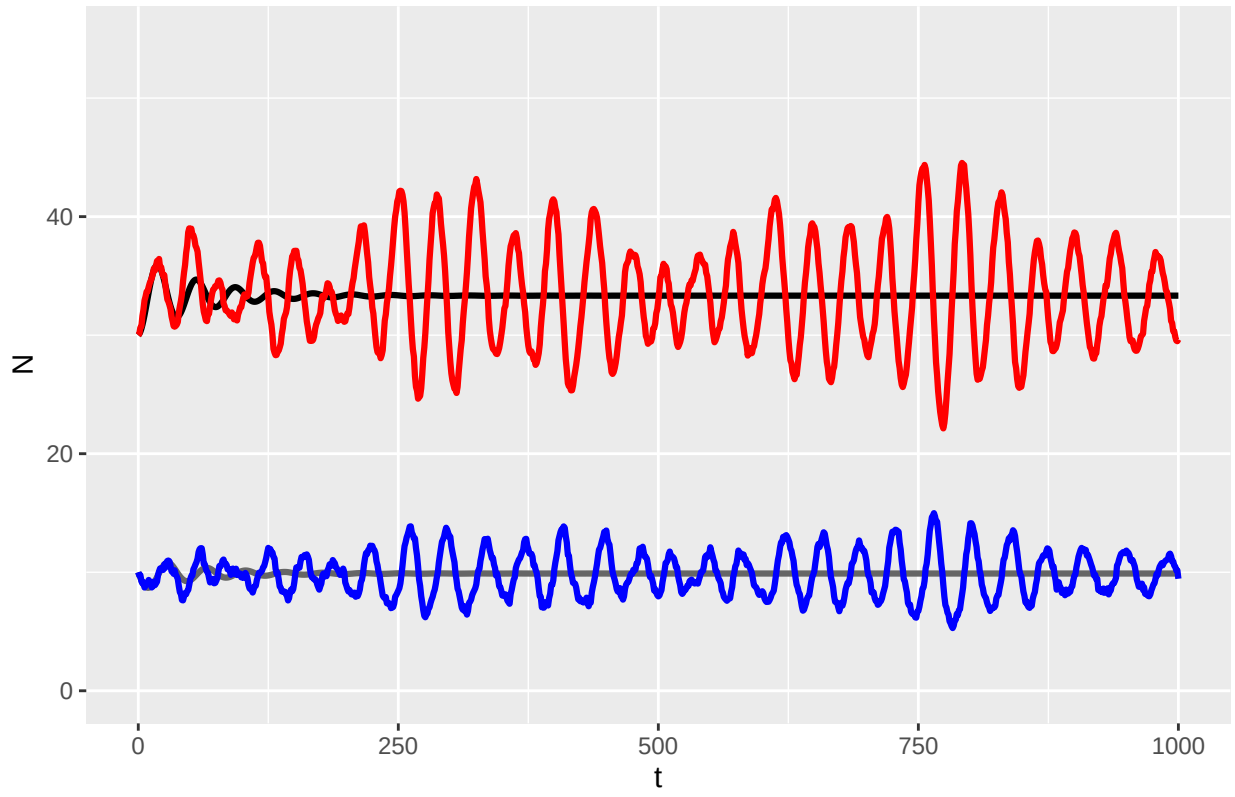
$$\frac{dN}{dt} = rN(1 - \frac{N}{K}) - \frac{mNP}{1 + mhN} + N\zeta_n\sigma_{t,n}$$

$$\frac{dP}{dt} = \frac{cmNP}{1 + mhN} - dP + P\zeta_p\sigma_{t,p}$$

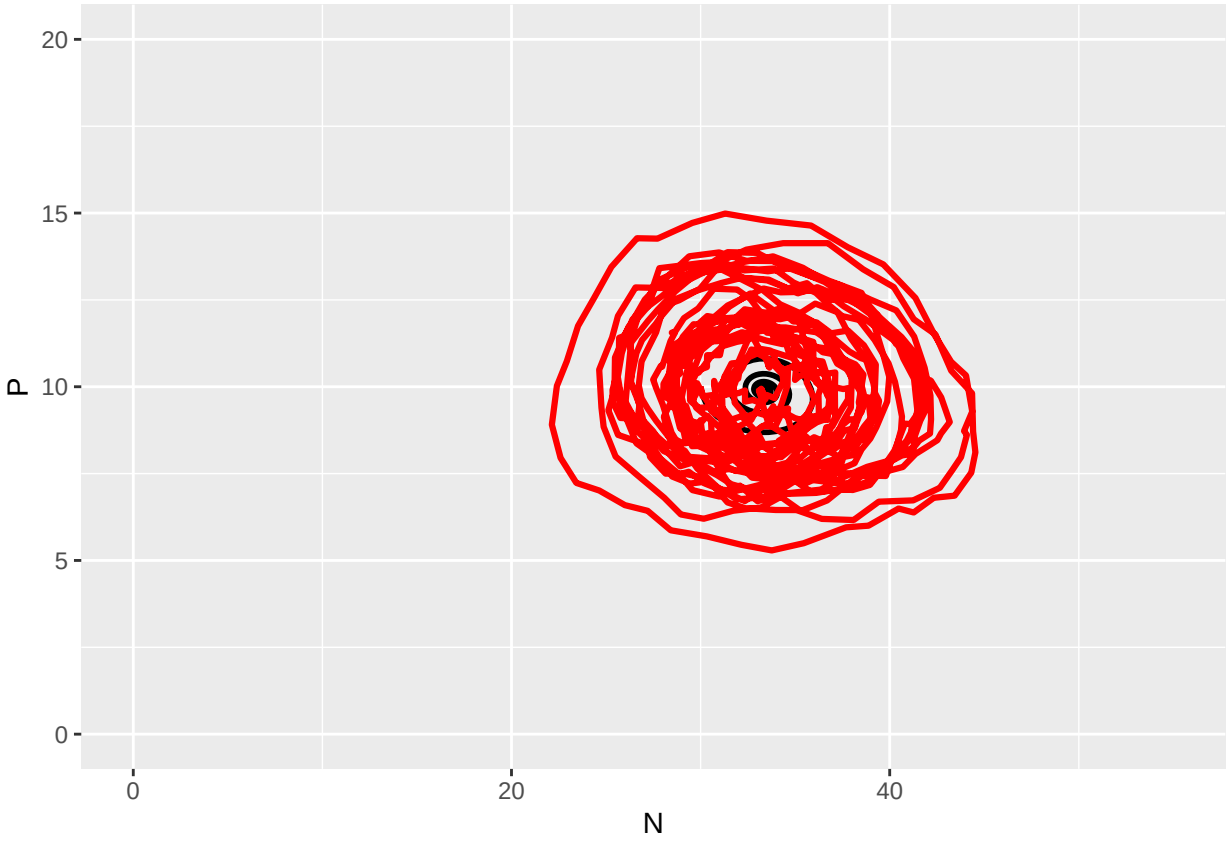
```
#### non-stochastic code
predprey <- function(Time, State, Pars){
  with(as.list(c(State, Pars)), {
    dN <- r*N*(1-N/K) - m*N*P/(1+m*h*N)
    dP <- c*m*N*P/(1+m*h*N) - d*P
    return(list(c(dN,dP)))
  })
}

# params
p <- c(r = 0.2, K = 82, m = 0.02, h = 1, c = 1, d = 0.4)
y <- c(N = 30, P = 10)
t <- seq(0,1000,by=1)

out <- as_tibble(ode(y, t, predprey, p)[,-1])

#### stochastic code

var.eqn.x <- "r*N*(1-N/K) - m*N*P/(1+m*h*N)"
var.eqn.y <- "c*m*N*P/(1+m*h*N) - d*P"
model.parms <- c(r = 0.2, K = 82, m = 0.02, h = 1, c = 1, d = 0.4)
parms.eqn.x <- Model2String(var.eqn.x, parms = model.parms, supress.print = T)
parms.eqn.y <- Model2String(var.eqn.y, parms = model.parms, supress.print = T)
model.state <- c(N = 30, P = 10)
```

```
model.sigma <- 0.25
model.time <- 1001
model.deltat <- 1 # frequency of stochastic perturbation

out2 <- as_tibble(TSTraj(y0 = model.state, time = model.time, deltat = model.deltat,
               x.rhs = parms.eqn.x, y.rhs = parms.eqn.y, sigma = model.sigma))
```

```
# time-series
out %>%
  ggplot(aes(t)) +
  geom_line(aes(y = N), color = "black", lwd = 1.1) +
  geom_line(aes(y = P), color = "grey40", lwd = 1.1) +
  geom_line(aes(y = out2$N), lwd = 1.1, color = "red") +
  geom_line(aes(y = out2$P), lwd = 1.1, color = "blue")+
  ylim(c(0,55)) +
  ggtitle("")
```




```
# state-space
out %>%
  ggplot(aes(N,P)) +
  geom_path(lwd=1, color = "black") +
  geom_path(aes(x = out2$N, y = out2$P), lwd = 1.1, color = "red") +
  xlim(c(0,55))+
  ylim(c(0,20))
```


20
15
10
5
0
P
0
20
40
N