Type III Simulations

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Simulating gopher and vole control using a Type III functional response.

Gophers

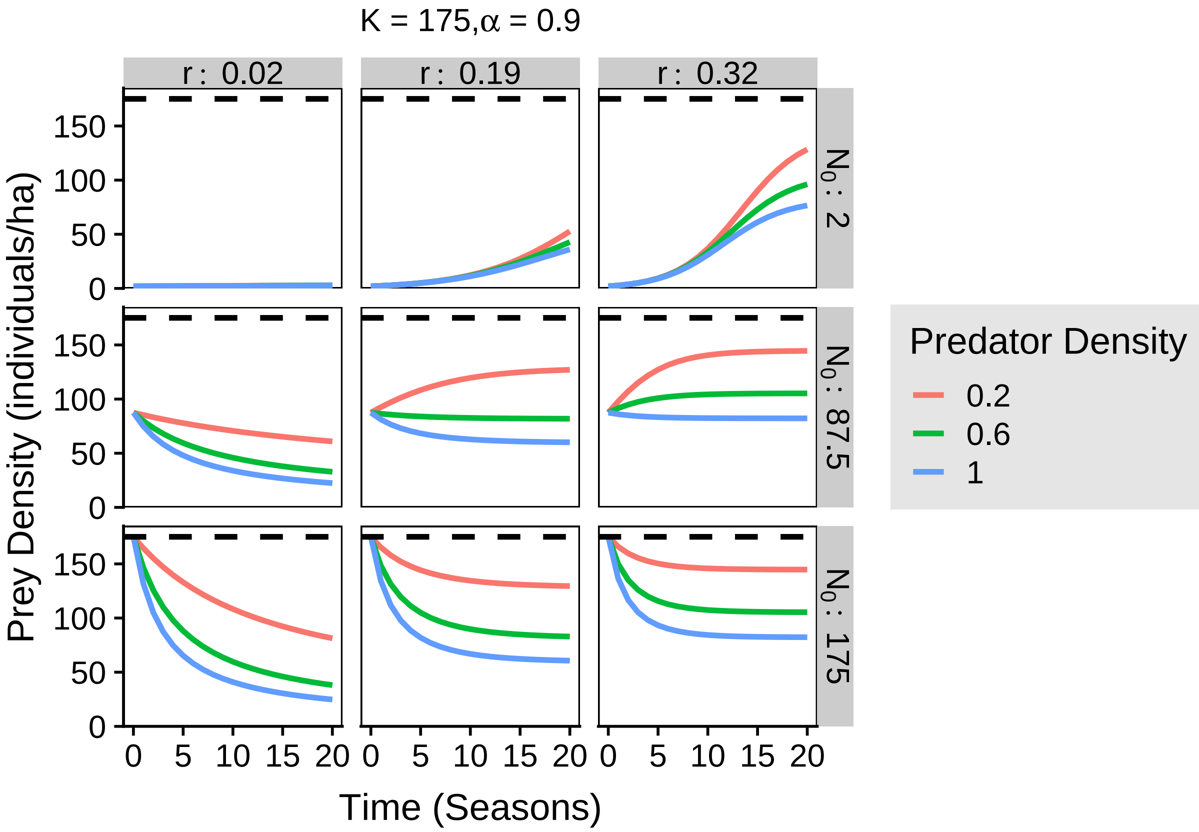
We will use the same seasonal growth rates of gopher and voles. Growth rates were calculated from reconstructed life tables for each species. For gophers, because it is unclear if they reproduce on a six or nine month time scale, the minimum, mean, and max were calculated for both possible time steps. The minimum and max from the pooled six and nine month growth rates were taken as minimums and maximums and the mean of the two calculated mean growth rates was used as the mean.

```r
r_gopher <- c(0.02, 0.19, 0.32)

#Parameters
alphaP<-0.9
K_prey <- 175
k_max <- 378
h <- 1/k_max
D <- 1/(alphaP*h)
r <- r_gopher
q <- 1
parameters <- c(r = r_gopher, alphaP = 0.9, K_prey = 175, k_max = 378, D = 1/(alphaP*h), q=1)

#State variables:
N=c(K_prey, K_prey, K_prey,
    0.5*K_prey, 0.5*K_prey, 0.5*K_prey,
    2,2,2)

P=c(0.2, 0.6, 1.0,
    0.2, 0.6, 1.0,
    0.2, 0.6, 1.0)
state<-cbind(N, P)
times<- seq(0, 20, by=1)


pred_preyT3 <- function(t, state, parameters){
  with(as.list(c(state, parameters)), {
    #type III Functional response
    dprey=(r*N*(1 - (N/K_prey)))-((k_max*N^(q+1))/(N^(q+1) + D^(q+1)))*P #with density dependence
    dpredator=0 #constant number of predators

    #return rate of change
    list(c(dprey, dpredator))

  })
}
```

Gopher Simulations

Table 1: Final Gopher Abundance

N0	time	N	P	r	K	alphaP
175.0	20	81.318293	0.2	0.02	175	0.9
175.0	20	38.075066	0.6	0.02	175	0.9
175.0	20	24.776629	1.0	0.02	175	0.9
175.0	20	129.522237	0.2	0.19	175	0.9
175.0	20	82.942200	0.6	0.19	175	0.9
175.0	20	60.672250	1.0	0.19	175	0.9
175.0	20	144.739739	0.2	0.32	175	0.9
175.0	20	105.422894	0.6	0.32	175	0.9
175.0	20	82.310418	1.0	0.32	175	0.9
87.5	20	60.933779	0.2	0.02	175	0.9
87.5	20	32.853659	0.6	0.02	175	0.9
87.5	20	22.452376	1.0	0.02	175	0.9
87.5	20	127.040105	0.2	0.19	175	0.9
87.5	20	81.878044	0.6	0.19	175	0.9
87.5	20	60.112013	1.0	0.19	175	0.9
87.5	20	144.492663	0.2	0.32	175	0.9
87.5	20	105.277448	0.6	0.32	175	0.9
87.5	20	82.223118	1.0	0.32	175	0.9
2.0	20	2.906065	0.2	0.02	175	0.9
2.0	20	2.791450	0.6	0.02	175	0.9
2.0	20	2.685532	1.0	0.02	175	0.9
2.0	20	52.737120	0.2	0.19	175	0.9
2.0	20	42.817723	0.6	0.19	175	0.9
2.0	20	36.027607	1.0	0.19	175	0.9
2.0	20	128.379914	0.2	0.32	175	0.9
2.0	20	96.207450	0.6	0.32	175	0.9
2.0	20	76.624301	1.0	0.32	175	0.9



Vole Parameters

From the literature review (Sarah this is the average data from the model summary data), we constructed minimum, average, and maximum vole stage structured matrices. It is important to note that survival measurements are from M. townsendii and fertility measurements were from M. californicus because no studies on either species contained both measurements. We took the minimum, maximum, and mean calculated growth rates.

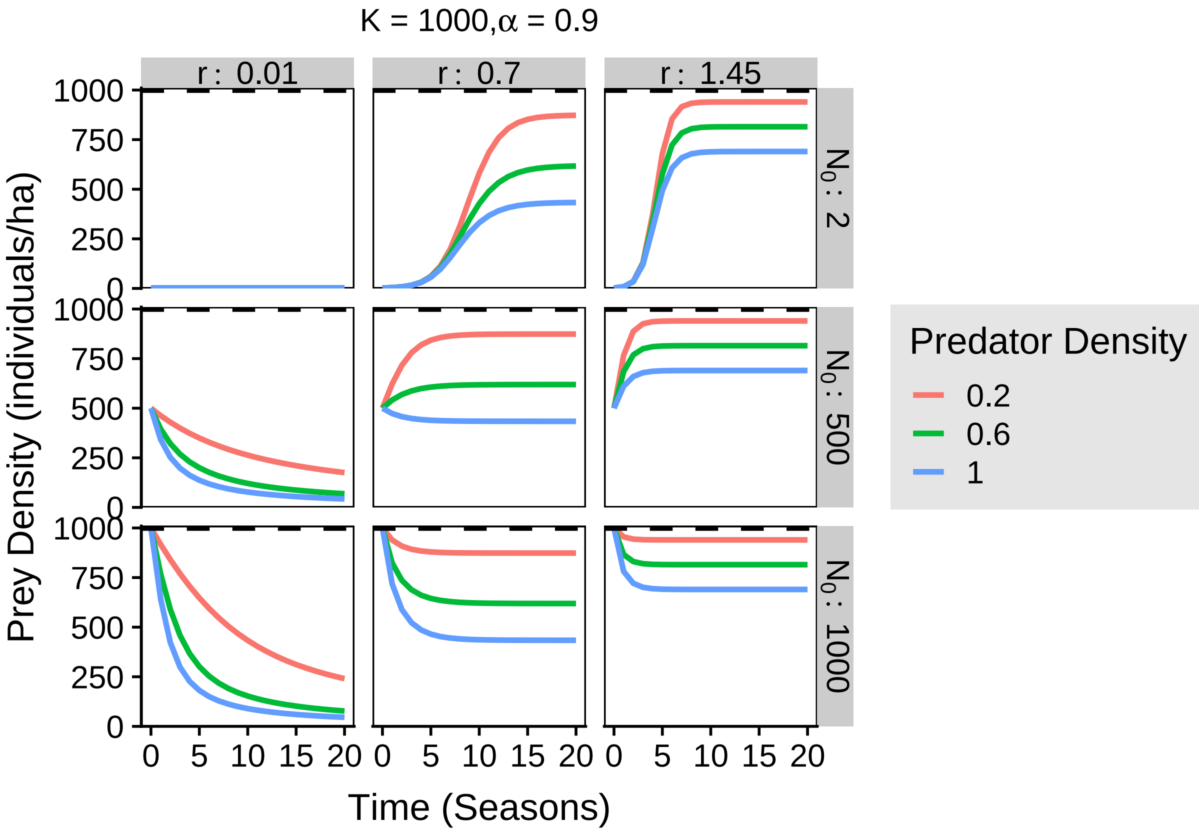
```
r_vole <- c(0.01, 0.70, 1.45)
#Parameters
alphaP=0.9
K_prey=1000
k_max=654
h=1/k_max
D=1/(alphaP*h)
r=r_vole
q=1
parameters <- c(r, alphaP, K_prey, k_max, D, q)

#State variables:
N=c(K_prey, K_prey, K_prey,
    0.5*K_prey, 0.5*K_prey, 0.5*K_prey,
    2,2,2)

P=c(0.2, 0.6, 1.0,
```

```
    0.2, 0.6, 1.0,
    0.2, 0.6, 1.0)

state<-cbind(N, P)
times<- seq(0, 20, by=1)
```

Vole Simulations

Table 2: Final Gopher Abundance

N0	time	N	P	r	K	alphaP
1000	20	240.468042	0.2	0.01	1000	0.9
1000	20	77.291350	0.6	0.01	1000	0.9
1000	20	45.669703	1.0	0.01	1000	0.9
1000	20	873.578526	0.2	0.70	1000	0.9
1000	20	619.195344	0.6	0.70	1000	0.9
1000	20	434.020900	1.0	0.70	1000	0.9
1000	20	939.931014	0.2	1.45	1000	0.9
1000	20	815.012042	0.6	1.45	1000	0.9
1000	20	690.069088	1.0	1.45	1000	0.9
500	20	175.370204	0.2	0.01	1000	0.9
500	20	68.734620	0.6	0.01	1000	0.9
500	20	42.543804	1.0	0.01	1000	0.9
500	20	873.573474	0.2	0.70	1000	0.9
500	20	619.165317	0.6	0.70	1000	0.9
500	20	434.005505	1.0	0.70	1000	0.9
500	20	939.931014	0.2	1.45	1000	0.9
500	20	815.012042	0.6	1.45	1000	0.9
500	20	690.069088	1.0	1.45	1000	0.9
2	20	2.415245	0.2	0.01	1000	0.9
2	20	2.363971	0.6	0.01	1000	0.9
2	20	2.314830	1.0	0.01	1000	0.9
2	20	872.469765	0.2	0.70	1000	0.9
2	20	617.070199	0.6	0.70	1000	0.9
2	20	433.120791	1.0	0.70	1000	0.9
2	20	939.931018	0.2	1.45	1000	0.9
2	20	815.012032	0.6	1.45	1000	0.9
2	20	690.069030	1.0	1.45	1000	0.9



K = 1000,α = 0.9
r : 0.01
r : 0.7
r : 1.45
N0 : 2
N0 : 500
N0 : 1000
Prey Density (individuals/ha)
Time (Seasons)
Predator Density
0.2
0.6
1