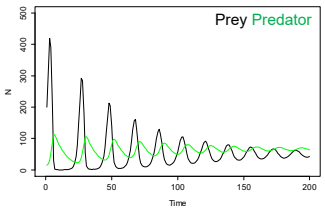
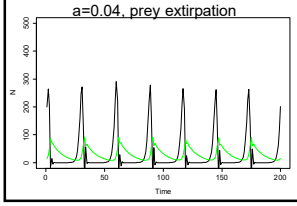
$$\frac{dN}{dt} = rN\left(1 - \frac{N}{K}\right) - aNP$$

$$\frac{dP}{dt} = faPN - qP$$

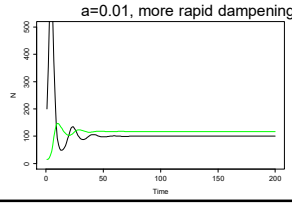
K=1000
R=2.5
a=0.02 (attack rate)
q=0.1 (predator death rate)
f=0.1 (predator conversion)
Type 1 response



a=0.04, prey extirpation



a=0.01, more rapid dampening



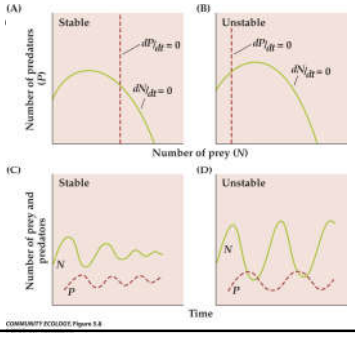
Rosenzweig-MacArthur Model

- Same model but with type II functional response

$$\frac{dN}{dt} = rN\left(1 - \frac{N}{K}\right) - \frac{aNP}{1+ahN}$$

- Combined with predator type II response

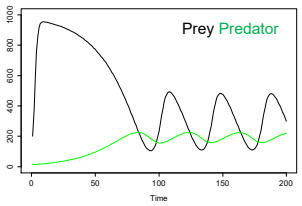
$$\frac{dP}{dt} = \frac{faNP}{1+ahN} - qP$$



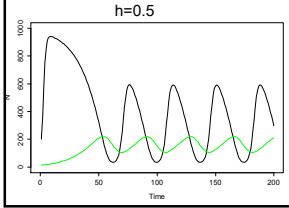
$$\frac{dN}{dt} = rN\left(1 - \frac{N}{K}\right) - \frac{aNP}{1 + ahN}$$

$$\frac{dP}{dt} = \frac{faNP}{1 + ahN} - qP$$

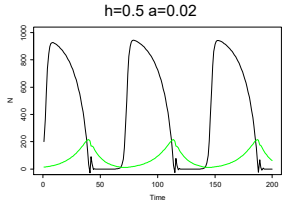
K=1000
R=2.5
a=0.01 (attack rate)
q=0.1 (predator death rate)
f=0.1 (predator conversion)
h = 1 handling time
Type 1 response



h=0.5



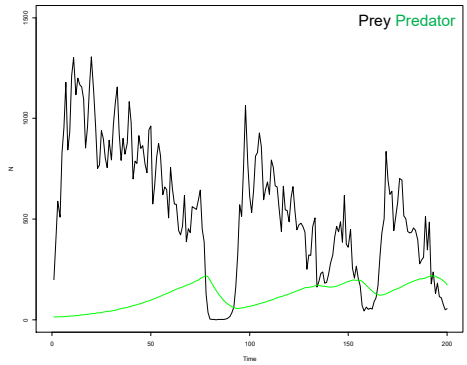
h=0.5 a=0.02



$$\frac{dN}{dt} = rN\left(1 - \frac{N}{K}\right) - \frac{aNP}{1 + ahN}$$

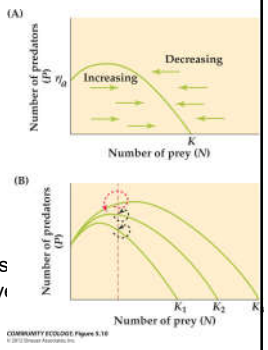
$$\frac{dP}{dt} = \frac{faNP}{1 + ahN} - qP$$

Same model with some stochasticity in R



Suppression-Stability Tradeoff

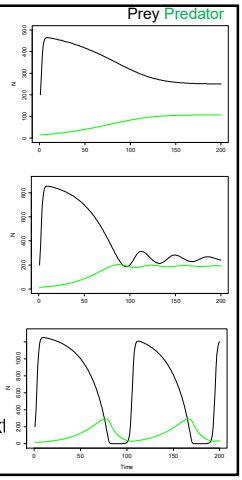
- Models make some unintuitive predictions about predator-prey systems.
- Systems become less stable as predators play a larger role in controlling (suppressing) prey populations.
- As resources become more abundant, K increases, but predators suppress prey at levels lower (relative to K).
- Evidence in natural systems – low diversity in nutrient enriched systems.



Suppression-Stability Tradeoff

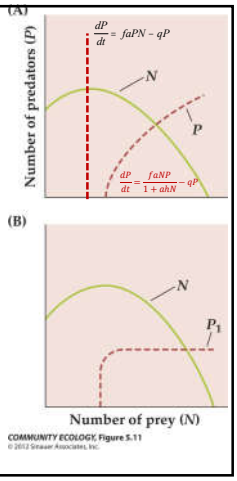
Prey Predator

- K=500, prey stabilize ~300
- K=900, prey oscillate more ~210
- K=1300, broader oscillations, prey ext



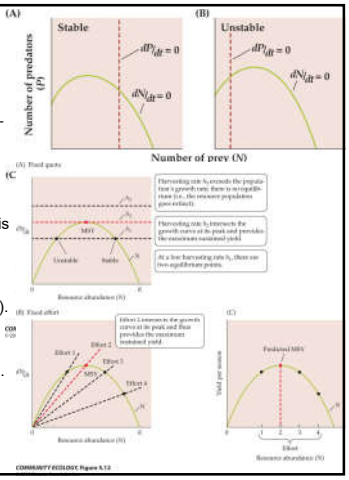
Predator Density Dependence

- We expect density dependent effects for both predator and prey.
- Prey effects modeled as resource availability (K).
- Predator effects modeled as resource availability (N) and efficiency in harvest (h).
- Other predator interactions may limit predator numbers (interference competition).



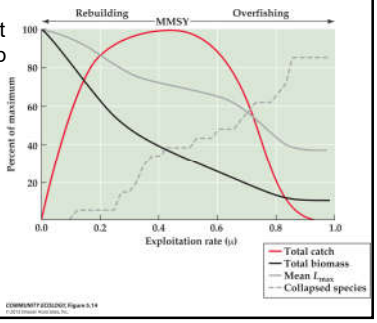
Humans as Predators

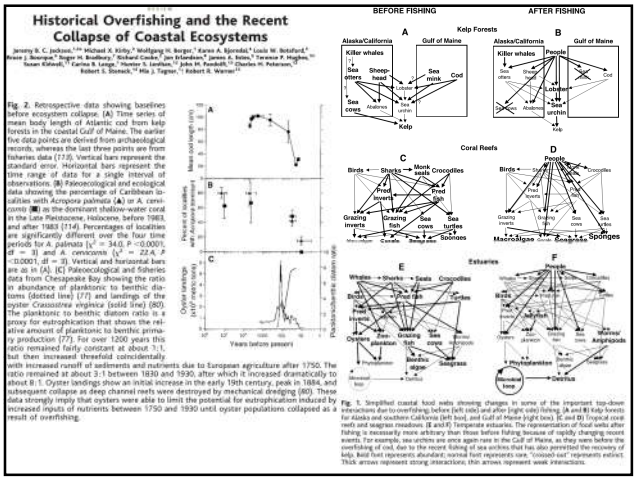
- Humans can be thought of as predators for a variety of species we harvest.
- **Maximum Sustained Yield (MSY)** – long term harvest rate where populations remain at equilibrium.
- Models indicate population growth is maximized below K. High predation is known to destabilize.
- Fixed harvest (quota) vs. fixed effort (similar to type I functional response).
- Fixed harvest could intersect populations at two equilibrium points.
- In practice, economic and political forces make it difficult properly regulate harvest.

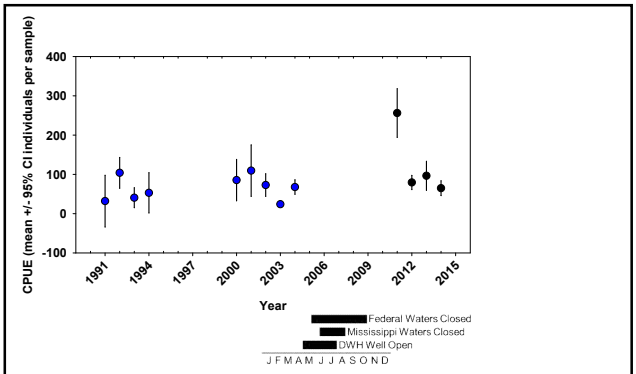


MSY and Fisheries Collapses

- Recall that it is difficult to know what population sizes are, R is variable, environment is stochastic.
- Tragedy of the commons – no expectation of individual harvestors working in the best interest of the resource population.
- In general, MSY has not collapses of harvested p







Estimated 35% of mortality in GOM due to fishing pressure.