**Lab 9: Predation – Stella Models**

**PredModel1 - Prey exponential growth**

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**PredModel1 - Prey exponential growth - Equations**

Prey\_stock(t) = Prey\_stock(t - dt) + (Prey\_births - Prey\_deaths) \* dt

INIT Prey\_stock = 4

INFLOWS:

Prey\_births = Prey\_birth\_rate\*Prey\_stock

OUTFLOWS:

Prey\_deaths = Prey\_death\_rate\*Prey\_stock

Prey\_birth\_rate = 0.8

Prey\_death\_rate = 0.05

**Notes:**

**Prey grow exponentially**

**PredModel2 - Prey density dependent growth**



**PredModel2 - Prey density dependent growth - Equations**

Prey\_stock(t) = Prey\_stock(t - dt) + (Prey\_births - Prey\_deaths) \* dt

INIT Prey\_stock = 4

INFLOWS:

Prey\_births = Prey\_birth\_rate\*Prey\_stock

OUTFLOWS:

Prey\_deaths = Prey\_death\_rate\*Prey\_stock

Prey\_birth\_rate = Prey\_max\_birth\_rate\*(1-(Prey\_stock/Prey\_carrying\_capacity))

Prey\_carrying\_capacity = 20

Prey\_death\_rate = 0.05

Prey\_max\_birth\_rate = 0.80

**Notes:**

**Prey grow to equilibrium abundance (V\*) in the absence of predation**

**IMPORTANT: V\* (=18.75) is not the same as carrying capacity (=20)!**

Start with: $^{dV}/\_{dt}=b\_{max}\left(1-\frac{V}{K}\right)V-d\_{v}V$

Set equation equal to 0: $0=b\_{max}\left(1-\frac{V^{\*}}{K}\right)V^{\*}-d\_{v}V^{\*}$

Move prey deaths to other side of equation: $d\_{v}V^{\*}=b\_{max}\left(1-\frac{V^{\*}}{K}\right)V^{\*}$

Cancel V\*: $d\_{v}=b\_{max}\left(1-\frac{V^{\*}}{K}\right)$

Distribute bmax: $d\_{v}=b\_{max}-\frac{b\_{max }V^{\*}}{K}$

Rearrange components: $\frac{b\_{max }V^{\*}}{K}= b\_{max}-d\_{v}$

Multiply both sides by K: $b\_{max}V^{\*}= K\left(b\_{max}-d\_{v}\right)$

Divide both sides by bmax: $\frac{b\_{max}V^{\*}}{b\_{max}}= \frac{K\left(b\_{max}-d\_{v}\right)}{b\_{max}}$

Result: $V^{\*}= \frac{K\left(b\_{max}-d\_{v}\right)}{b\_{max}}$

After simplifying: $V^{\*}= K\left(1-\frac{d\_{v}}{b\_{max}}\right)$

**Plug in parameters:**  $V^{\*}= 20\*\left(1-\frac{0.05}{0.80}\right)=18.75$

**PredModel3 - Prey density dependent growth with scramble predator**

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**PredModel3 - Prey density dependent growth with scramble predator - Equations**

Predator\_stock(t) = Predator\_stock(t - dt) + (Predator\_births - Predator\_deaths) \* dt

INIT Predator\_stock = 2

INFLOWS:

Predator\_births = Attack\_rate\*Conversion\_efficiency\*Prey\_stock\*Predator\_stock

OUTFLOWS:

Predator\_deaths = Predator\_death\_rate\*Predator\_stock

Prey\_stock(t) = Prey\_stock(t - dt) + (Prey\_births - Prey\_deaths) \* dt

INIT Prey\_stock = 4

INFLOWS:

Prey\_births = Prey\_birth\_rate\*Prey\_stock

OUTFLOWS:

Prey\_deaths = Prey\_death\_rate\*Prey\_stock+Attack\_rate\*Prey\_stock\*Predator\_stock

Attack\_rate = 0.1

Conversion\_efficiency = 0.6

Predator\_death\_rate = 0.6

Prey\_birth\_rate = Prey\_max\_birth\_rate\*(1-(Prey\_stock/Prey\_carrying\_capacity))

Prey\_carrying\_capacity = 20

Prey\_death\_rate = 0.05

Prey\_max\_birth\_rate = 0.80

**Notes:**

**Prey and predators grow to equilibrium abundances (V\* and P\*)**

**See Part A of Lab 9 for calculations**

**PredModel4 - Prey density dependent growth with contest predator**

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**PredModel4 - Prey density dependent growth with contest predator**

Predator\_stock(t) = Predator\_stock(t - dt) + (Predator\_births - Predator\_deaths) \* dt

INIT Predator\_stock = 2

INFLOWS:

Predator\_births = IF(Predator\_stock<Predator\_ceiling) THEN (Attack\_rate\*Conversion\_efficiency\*Prey\_stock\*Predator\_stock) ELSE (0)

OUTFLOWS:

Predator\_deaths = Predator\_death\_rate\*Predator\_stock

Prey\_stock(t) = Prey\_stock(t - dt) + (Prey\_births - Prey\_deaths) \* dt

INIT Prey\_stock = 4

INFLOWS:

Prey\_births = Prey\_birth\_rate\*Prey\_stock

OUTFLOWS:

Prey\_deaths = Prey\_death\_rate\*Prey\_stock+Attack\_rate\*Prey\_stock\*Predator\_stock

Attack\_rate = 0.1

Conversion\_efficiency = 0.6

Predator\_ceiling = 5

Predator\_death\_rate = 0.6

Prey\_birth\_rate = Prey\_max\_birth\_rate\*(1-(Prey\_stock/Prey\_carrying\_capacity))

Prey\_carrying\_capacity = 20

Prey\_death\_rate = 0.05

Prey\_max\_birth\_rate = 0.80

**Notes:**

**Prey and predators grow to equilibrium abundances (V\* and P\*)**

**See Part A of Lab 9 for calculations**

**Note: With prey carrying capacity = 20, predators equilibrium abundance (=3.5) is less than predator ceiling**