**Lab 9: Predator-Prey Stella Modeling - Instructions**

**PREDATOR MODEL 1:**

* **PredModel1 - Step-by-step instructions**
  + Look at document “Lab 9 Description for PredModel1 through 4,” PredModel 1 – Exponential growth of prey
  + GOAL: Model of prey exponential growth
  + Make sure you are on the Model tab
  + Create a stock for the victims (prey)
    - Label: “Prey stock”
  + Create input flow (click and drag flow ending inside box – box will be highlighted)
    - Label “Prey births”
    - Inputs will be added from stock **automatically**
    - Units are numbers per time
  + Create output flow (click and drag starting inside box)
    - Label “Prey deaths”
    - Outputs will be subtracted from stock **automatically**
    - Units are numbers per time
  + Create converter for prey birth rate
    - Label “Prey birth rate”
  + Create converter for prey death rate
    - Label “Prey death rate”
  + Make connections for inflows (point arrow tip inside converter or stock and drag):
    - Connect Prey birth rate to Prey births
    - Connect Prey stock to Prey births
  + Make connections for outflows (point arrow tip inside converter or stock and drag):
    - Connect Prey death rate to Prey deaths
    - Connect Prey stock to Prey deaths
  + Parameterize model! (use values in lab manual) – double click on what you want to populate
    - Prey stock abundance = 4
    - Prey birth rate = 0.80 [*note: using bmax in handout*]
    - Prey death rate = 0.05
  + Build in equations
    - Note: Can click on item names in box above (not case sensitive; underscores are important)
    - Inflow: *bvV* (“Prey\_birth\_rate \* Prey\_stock”)
    - Outflow: *dvV* (“Prey\_death\_rate \* Prey\_stock”)
  + Model Notes:
    - Useful model for looking at just prey dynamics
    - E.g., effects of constant proportional harvest (just increase prey death rate)
  + Set simulation parameters (go to Run menu, Run specs)
    - Use 100 time steps [to: 100]
    - Set time step (dt) = 1 [DT: 1]
    - Set integration method to Runge-Kutta 4
  + Add graph to model (click on Graph Pad icon)
    - Specify graph to output Prey stock (double click on graph)
    - Select “Prey\_stock” to move over (>>)
    - Click tack icon to pin
  + Add table to model (click on Table Pad icon)
    - Specify table to output Prey stock
    - Select “Prey\_stock” to move over (>>)
    - Click tack icon to pin
    - Can grab vertical line to draw out column width
  + Run model (watch the flow!)
    - **The numbers are going to look weird b/c using data that works for final model**
    - Prey exponential growth
  + **Save model as: PredModel1.stm**

**PREDATOR MODEL 2:**

MODIFY to include density dependence:

* **PredModel2 - Step-by-step instructions**
  + Look at document “Lab 9 Description for PredModel1 through 4,” PredModel2 – density dependence of prey
  + GOAL: Add density dependence to prey birth rate function
  + Make new converters
    - “Prey max birth rate”
    - “Prey carrying capacity”
  + Make connections to Prey birth rate converter:
    - Connect Prey stock to Prey birth rate
    - Connect Prey max birth rate to Prey birth rate
    - Connect Prey carrying capacity to Prey birth rate
  + Parameterize model
    - Prey max birth rate = 0.80
    - Prey carrying capacity = 20
  + Specify logistic equation in birth rate converter
    - Remove constant
    - Birth rate is now a function of three parameters: V, K, bmax
    - Prey\_max\_birth\_rate \* (1 – (Prey\_stock / Prey\_carrying\_capacity))
  + Run model
    - Density dependent prey growth to K growth
  + **Save model as: PredModel2.stm**

**PREDATOR MODEL 3:**

MODIFY to include predation:

ADD:

* **PredModel3 - Step-by-step instructions**
  + Look at document “Lab 9 Description for PredModel1 through 4,” PredModel3
  + GOAL: Add predator!
  + Highlight all prey boxes and arrow (click and drag box over space) and move down
  + Create predator stock
    - Label: “Predator stock”
  + Create inflows and outflows
    - Inflow: “Predator births”
    - Outflow: “Predator deaths”
  + Add converters to inflow
    - “Conversion efficiency”
    - “Attack rate” 🡪 put by prey
  + Make connections for inflow
    - Connect Conversion efficiency to Predator births
    - Connect Attack rate to Predator births
    - Connect Predator stock to Predator births
    - Connect Prey stock to Predator births
  + Add converter to outflow
    - “Predator death rate”
  + Make connections to outflow
    - Connect Predator death rate to Predator deaths
    - Connect Predator stock to Predator deaths
  + Modify prey
    - Connect Attack rate to Prey deaths
    - Connect Predator stock to Prey deaths
  + Parameterize model
    - Predator stock abundance = 2
    - Conversion efficiency = 0.60
    - Predator death rate = 0.60
    - Attack rate = 0.10
  + Specify Predator births equation
    - Predator births are a function of: Attack rate, Conversion efficiency, Prey stock, and Predator stock: *acVP*
    - Attack\_rate \* Conversion\_efficiency \* Prey\_stock \* Predator\_stock
  + Specify Predator deaths equation
    - *dpP*
    - Predator\_death\_rate \* Predator\_stock
  + Re-specify Prey deaths equation
    - Prey deaths occur through two ways! *dvV + aVP*
    - KEEP: Prey\_death\_rate \* Prey\_stock
    - ADD: + Attack\_rate \* Prey\_stock \* Predator\_stock
    - We add the new term (not subtract) because the sum will be subtracted from stock
  + Change graph output
    - Output Predator stock, too
    - Select “Predator\_stock” to move over (>>)
  + Change table output
    - Output Predator stock, too
    - Select “Predator\_stock” to move over (>>)
  + Run simulation
    - Predator-prey fluctuations then level to equilibrium
  + **Save model as: PredModel3.stm**

**PREDATOR MODEL 4:**

KEEP:

KEEP:

ADD: via qualifying statement: PREDATOR TERRITORIALITY

* **PredModel4 - Step-by-step instructions**
  + GOAL: Add predator territoriality
  + Create converter for predator ceiling (Look at document “Lab 9 Description for PredModel1 through 4,” PredModel4)
    - Label: “Predator ceiling”
    - i.e., a ceiling for the predator population beyond which it will not increase, no matter how productive the prey are
  + Create connection
    - Connect Predator ceiling to Predator births
  + Parameterize model
    - Ceiling = 100 🡪 Scramble predator
    - Ceiling = 5 🡪 Contest predator (highly territorial – only 5 territories)
  + Re-specify Predator births
    - IF(Predator\_stock < Predator\_ceiling) THEN (Attack\_rate \* Conversion\_efficiency \* Prey\_stock \* Predator\_stock) ELSE (0)
    - Means that if predator stock is below ceiling, predator births are a function of the usual: *acVP*, otherwise, births are zero (and population will fall below predator ceiling)
  + Run simulation
    - Predator-prey fluctuations then level to equilibrium
  + **Save model as: PredModel4.stm**

**🡪 Over to PowerPoint**