NAME:

LAB OVERVIEW

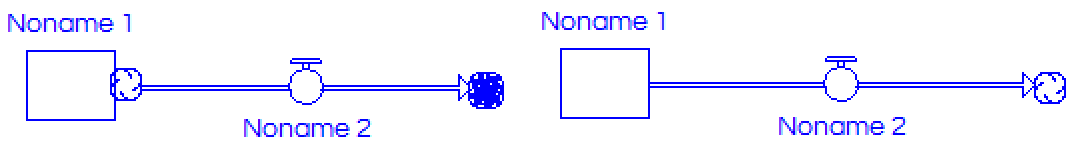
The objectives of this lab are to increase your understanding of fishery monitoring, specifically:

1. The link between effort and catchability and fishing mortality
2. The effects of these variables on catch per effort (CPE)
3. Why fishery independent monitoring is important

Responses to questions, at the end of this document, are **due by 5pm, one week from today's lab**. Responses are to be entered at https://goo.gl/forms/AQ3EzRDMee1Y2Ro53. *This lab is worth 25 points.*

Note

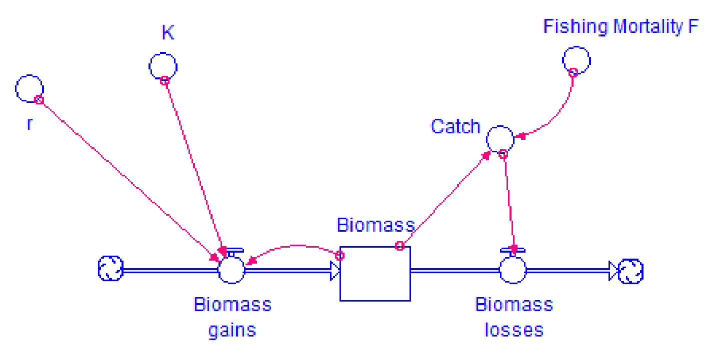
When constructing management model be sure that flows are connected to stocks. The image on the left is not connected. The image on the right is connected and correct.



******See the movie in lab contents folder for a review of how to put together a model using STELLA.******

EXERCISE 1: LINKING HARVEST AND EFFORT

MODEL SET UP



1) Open the STELLA (icon is on desktop and create the model above.
2) Parameterize the model as follows (this simulates a Graham-Schaefer formulation, logistic form, of biomass dynamics). **Be sure you are working in the model tab!**

Model component	**Value or equation**
r	0.6
K	10,000
Fishing Mortality F	0
Biomass	10,000

Model component	**Value or equation**
Catch	Fishing Mortality F * Biomass
Biomass gain	r * Biomass * ((K-Biomass)/K)
Biomass losses	Catch

3) Set your Run Specifications (RUN → Run Specs) as follows:

Run Spec	**Value**
From:	2018
To:	2118
DT:	0.125
Unit of Time:	Years
Sim Speed:	0.01

4) Set up a Graph Pad and Table Pad on your model canvas and **pin them down**. Once they are pinned down add **<u>Biomass</u>** and **<u>Catch</u>** to the data pad and graph pad and run the model.

ANALYSIS

1) Run the model using the default parameterization, **<u>except</u>** change Fishing Mortality F from 0 to 0.3. Record the **<u>Catch</u>** in the final year: _______________. (*NOTE: If you have set up the model correctly, Biomass in the final year should be 5,000*).
2) Looking in your data pad, **record the values for Biomass and Catch for the corresponding years in the table below**.

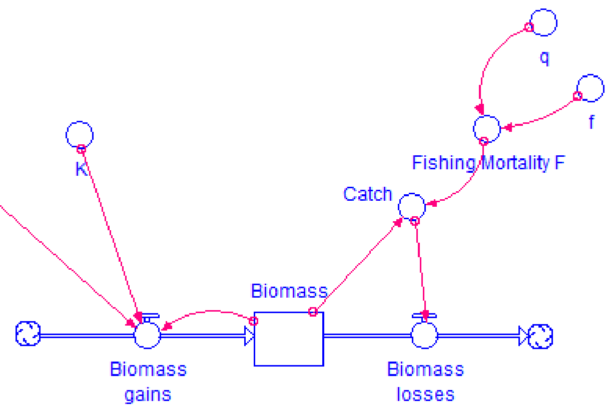
Year	Biomass (B)	Catch (C)
2018		
2019		
2020		
2021		
2025		
2050		
2117		

3) **Add a 'converter' for catchability** q **and effort** f to the model and specify with values of 0.0003 and 1000, respectively and then **'connect' those to Fishing Mortality** F **.**
4) In the model, specify Fishing Mortality F is: $F = q \cdot f$, where q is the catchability coefficient and f is effort. Double click on Fishing Mortality F **and replace 0.3 with** $q \cdot f$ **and rerun the model.**
5) Record the **<u>Catch</u>** in the final year: _______________. (*NOTE: If you have set up the model correctly, Biomass in the final year should be 5,000*).
6) Record the values for biomass and catch for the corresponding years in the table below (next page).
7) Calculate catch per unit effort (CPE) by dividing the catch (*C*) by the effort (*f*).

Year	Effort (f)	Biomass (B)	Catch (C)	Catch per effort $\frac{C}{f}$
2018	1000			
2019	1000			
2020	1000			
2025	1000			
2050	1000			
2051	1000			
2118	1000			

EXERCISE 2: EFFECT OF EFFORT ON BIOMASS DYNAMICS

MODEL SET UP



1) You should have the model above created from the previous exercise.
2) Parameterize the model as follows (this simulates a Graham-Schaefer formulation, logistic form, of biomass dynamics). **Be sure you are working in the model tab!**

Model component	**Value or equation**
r	0.6
K	10,000
Fishing Mortality F	q * f
f	1000
q	0.0003
Biomass	10,000
Catch	Fishing Mortality F * Biomass
Biomass gain	r * Biomass * ((K-Biomass)/K)
Biomass losses	Catch

3) Make sure you Run Specifications (RUN → Run Specs) as follows:

Run Spec	**Value**
From:	2018
To:	2118
DT:	0.125
Unit of Time:	Years
Sim Speed:	0.01

4) If you have not done this already, set up a Graph Pad and Table Pad on your model canvas and **pin them down**. Once they are pinned down add **Biomass** and **Catch** to the data pad and graph pad.

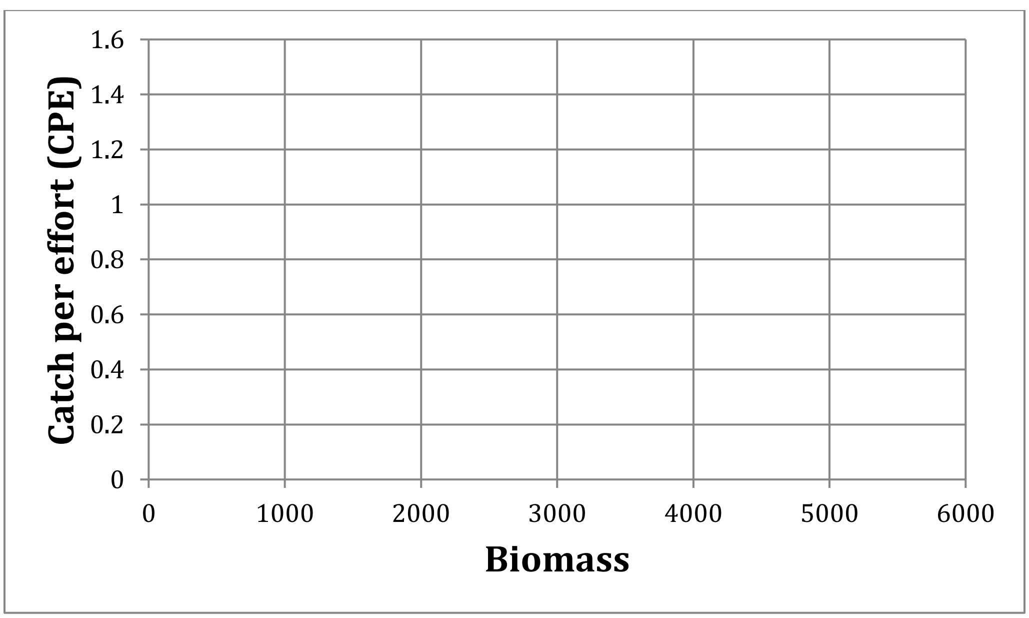
ANALYSIS

1) Change f from 1000 to 1250 and run the model. Record the biomass and catch for the final year of the simulation in the table below.
2) Repeat step 1 for the remaining effort levels 1250, 1500, 1750, and 200 and record the **final biomass and catch** in the table below.

3) Once you have filled in the table, calculate catch per effort (CPE) as $\frac{C}{f}$

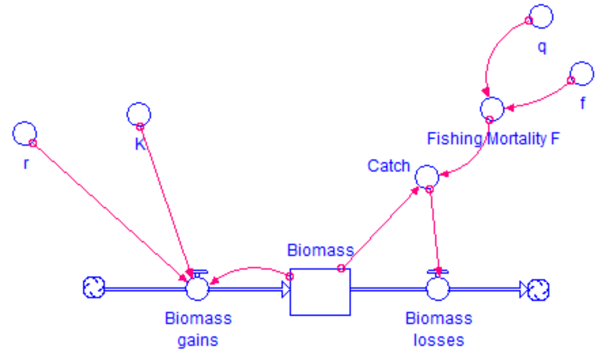
Effort (f)	Biomass (B) in 2118	Catch (C) in 2118	Catch per effort $\frac{C}{f}$
1000			
1250			
1500			
1750			
2000			

6) Plot biomass (*x*-axis) and CPE (*y*-axis) values in table above using the graph below (next page).



EXERCISE 3: TREND IN FISHERY CATCH

MODEL SET UP



1) You should have the model above created from the previous exercise.
2) Parameterize the model as follows (this simulates a Graham-Schaefer formulation, logistic form, of biomass dynamics). **Be sure you are working in the model tab!**

Model component	Value or equation
r	0.6
K	10,000
Fishing Mortality F	q * f
f	1000
q	0.0003
Biomass	10,000
Catch	Fishing Mortality F * Biomass
Biomass gain	r * Biomass * ((K-Biomass)/K)
Biomass losses	Catch

3) Make sure you Run Specifications (RUN → Run Specs) as follows:

Run Spec	**Value**
From:	2018
To:	2118
DT:	0.125
Unit of Time:	Years
Sim Speed:	0.01

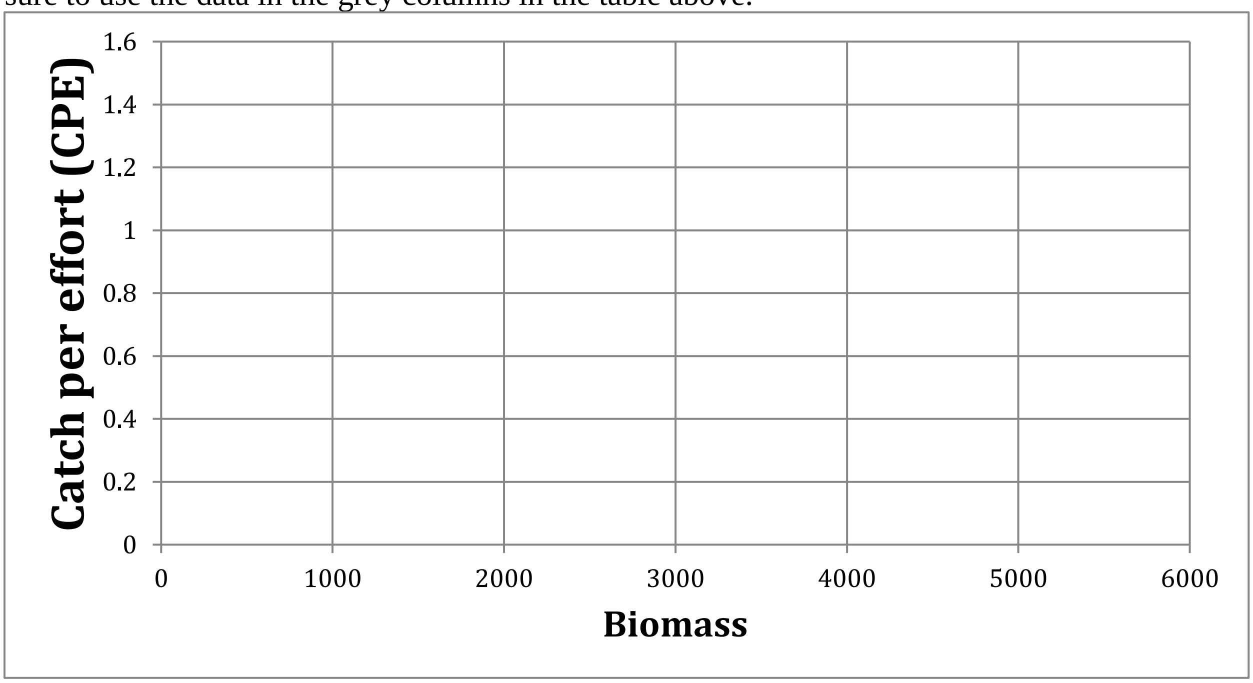
4) If you have not done this already, set up a Graph Pad and Table Pad on your model canvas and **pin them down**. Once they are pinned down add **<u>Biomass</u>** and **<u>Catch</u>** to the data pad and graph pad.

ANALYSIS

1) Run the model as parameterized and record the values for Biomass and Catch in the final year in the table below. Make sure effort (*f*) and catchability (*q*) are set to the default parameters.
2) Run the model again for q **values of 0.0004, 0.0005, 0.0006, and 0.007 and** record the values for **<u>Biomass</u>** and **<u>Catch</u>** in the **<u>final year</u>** in the table below.
3) Once you have filled in the table calculate catch per effort as $\frac{C}{f}$ (Note: Effort was fixed at 1000 for this exercise)

Effort (f)	Catchability (q)	Biomass (B) in 2118	Catch (C) in 2118	Catch per effort $\frac{C}{f}$
1000	0.0003			
1000	0.0004			
1000	0.0005			
1000	0.0006			
1000	0.0007			

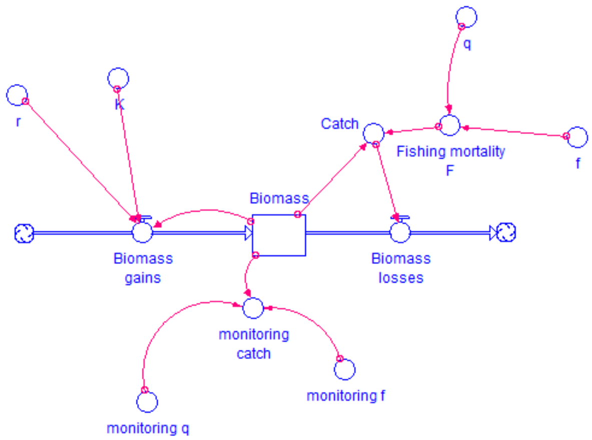
4) Plot biomass (*x*-axis) and CPE (*y*-axis) values in the above table using the graph below. Be sure to use the data in the grey columns in the table above.



EXERCISE 4: FISHERY INDEPENDENT DATA

The use of fishery dependent CPE data to monitor relative fish abundance can obscure trends because of variability in effort and catchability of commercial or recreational fishing gears. Therefore fishery independent monitoring data are collected by management agencies. Let's see how that works.

MODEL SET UP



1) You should have the most of the model above created from the previous exercise.
2) Add the monitoring components and parameterize the model as follows (this simulates a Graham-Schaefer formulation, logistic form, of biomass dynamics). **Be sure you are working in the model tab!**

Model component	**Value or equation**
r	0.6
K	10,000
Fishing Mortality F	q * f
f	1000
q	0.0003
Biomass	10,000
Catch	Fishing Mortality F * Biomass
Biomass gain	r * Biomass * ((K-Biomass)/K)
Biomass losses	Catch
Monitoring q	0.00006
Monitoring f	100
Monitoring catch	Monitoring q * Monitoring f * Biomass

3) Make sure you Run Specifications (RUN → Run Specs) as follows:

Run Spec	**Value**
From:	2018
To:	2118
DT:	0.125
Unit of Time:	Years
Sim Speed:	0.01

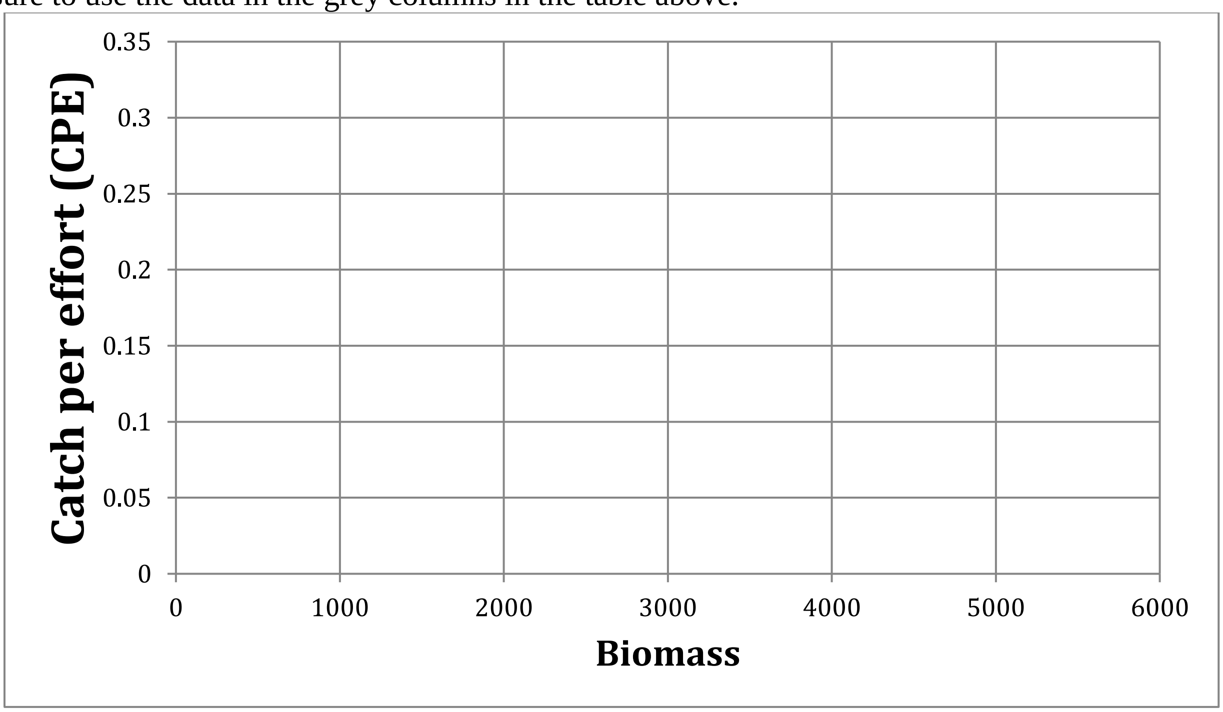
4) If you have not done this already, set up a Graph Pad and Table Pad on your model canvas and **pin them down**. Once they are pinned down add **Biomass** and **Catch** to the data pad and graph pad.

ANALYSIS

1) Run the model as parameterized and record the values for Biomass and Catch in the final year in the table below. Make sure effort (*f*) and catchability (*q*) are set to the default parameters.
2) Run the model again for q **values of 0.0004, 0.0005, 0.0006, and 0.007 and** record the values for **Biomass** and **Catch** in the **final year** in the table below. **Yes this is the same as the process for Exercise 3 except now we have fishery independent monitoring.**
3) Once you have filled in the table calculate catch per effort as $\frac{C}{f}$ for the fishery independent survey (Note: Monitoring effort was fixed at 100 for this exercise)

Monitoring Effort (f)	Catchability (q)	Biomass (B) in 2118	Monitoring catch (C) in 2118	Catch per effort $\frac{C}{f}$
100	0.0003			
100	0.0004			
100	0.0005			
100	0.0006			
100	0.0007			

4) Plot biomass (*x*-axis) and CPE (*y*-axis) values in the above table using the graph below. Be sure to use the data in the grey columns in the table above.



EXERCISE 1 QUESTIONS (8 POINTS)

1.1. A bit of biological intuition or speculation (6 points): How could you manage

1) Effort:

2) Catchability:

1.2. Of the 2 potential control variables in question 1.1 which one do think is the easiest to control? Why? (2 points)

EXERCISE 2 QUESTIONS (5 POINTS)

2.1. Does CPE index actual population biomass in this exercise, why or why not? (3 points)

2.2. Suppose you are a fishery manager, what **2 values** do you need to record from fishery catch data to calculate CPE? (2 points)

EXERCISE 3 QUESTIONS (8 POINTS)

3.1. How does the graph for exercise 3 compare to that of exercise 2? (2 points)

3.2. What is the cause of any of the differences, if there were any, in question 3.1? (2 points)

3.3. This exercise assumes that catchability gradually increases over time. Does this assumption seem reasonable to you? Why or why not? (4 points)

EXERCISE 4 QUESTIONS (4 POINTS)

4.1. How does the graph constructed for exercise 4 compare to the graph for exercise 3? Why is the difference important? (2 points)

4.2. In each of these exercises, STELLA could be used to calculate CPE. Describe how you would calculate CPE in STELLA (Hint; what converters, connectors, and equation would you use). (2 points)